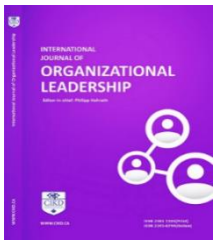

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Leadership in Vocational Education Transformation: Integrating Artificial Intelligence for Personalized Learning Environments

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ABSTRACT

Introducing new technologies, mainly Artificial Intelligence (AI), causes the study's relevance to the personalisation of the learning process in the field of vocational education, providing modern labour market requirements and digitalisation of the educational environment. AI use opens space to individualise learning tasks to enhance the effectiveness of education. The study explores the possibilities of applying artificial intelligence technologies for personalising learning within the VES (vocational education system) framework, aiming to incorporate AI into the learning environment. The research methodology consists of scientific literature analysis, questionnaires and interviews with teachers and students, and the experimental implementations of the adaptive learning platforms based on machine learning algorithms. The results of the study demonstrated the possibility of improving individual efficiency of the educational process by introducing adaptive AI-based learning systems that implement the personalisation of tasks and monitoring of students' progress. A survey of more than 200 respondents showed a positive perception of AI capabilities to improve the quality of education by teachers and students. An adaptive platform experiment showed an 18% increase in student performance due to an individual approach to learning. The practical significance of the work lies in the possibility of implementing the studied technologies in vocational education institutions to increase their efficiency and accessibility. The results obtained serve as a basis for further developing individual learning paths that meet the needs of the labour market and the development of students' digital competences.

The rapid development of digital technologies and their integration into the educational process is one of the most important trends of our time. Artificial Intelligence (AI), arguably one of the new technologies shaping the new educational landscape, is one of the key technologies. Machine learning and adaptive algorithms that allow the analysis of large amounts of data make it possible to start personalising learning in ways that take the student's individual needs into account. Vocational education is particularly in need of innovative approaches to learning, which are directed to the development of specific competences and readiness to meet its requirements in the conditions of the modern labour market.

The primary aim of this paper is to determine whether artificial intelligence technologies can be applied to personalise learning and improve vocational education.

Literature Review

Modern scientific literature concerns relevancy and research into AI use for personalising learning. In addition, Hanassab et al. (2024) argued that AI can also help increase learning outcomes through a tailored approach, in which a single learning piece is modified to be a better fit for an individual. A similar conclusion is being achieved by Barabanova et al. (2022). They emphasise that digital technologies should be applied to realise such vocational education programmes while considering the students' needs. Khine (2024) states that one of the main ethical challenges of using AI, like data privacy and algorithmic bias, requires extra regulation. According to their paper, Kurni et al. (2023), AI can help bring students with specific needs into an educational environment, and the penetration of educational technology is just ever starting.

Windelband (2023) notes that an intelligent decision support system positively relieves the workload and makes the work of teachers easier. However, as İçen (2022) points out, such AI efficiency in education is possible only with the technical infrastructural potential of education institutions in most countries, particularly Ukraine. In addition, studies by Alwaqdani (2024) and Mouta et al. (2024) demonstrate the potential of AI to adapt learning platforms in real-time, which helps to improve learning efficiency. Kejriwal (2023) outlines the prospects of augmented artificial intelligence to improve the educational process. Continuing the analysis of scientific publications, it is important to note the works focusing on implementing artificial intelligence in various educational contexts (Alqahtani & Wafula, 2024; Batsurovska et al., 2024a, 2024b; Kraja, 2023; Raja, 2024). Jadán-Guerrero et al. (2024) explore the potential of AI-based adaptive learning environments to support special education, allowing for the integration of inclusive practices into the learning process. Similarly, Kondakov and Sergeyev (2022) consider the accessibility of education through AI-powered personalisation, particularly in converged learning environments.

Of considerable interest are the works by Liu et al. (2023) and Ivanova and Kristovska (2023), who analyse the implementation of innovative education in the context of China and Central and Eastern Europe, emphasising the importance of adaptive systems for improving the quality of learning. Hetmańczyk (2024) also confirms that digitalisation, including AI, positively impacts the labour market and the modernisation of education. Geng et al. (2024) and Iyamuremye et al. (2024) focus on the practical application of machine learning and AI tools to analyse educational data, which is the basis for making informed pedagogical decisions. In turn, Rojas and Chiappe (2024) and Ojeda and Castro Arias (2025) focus on

transforming assessment methods through AI, which allows for objective and efficient knowledge assessment. In addition, Kashina et al. (2024) highlight the challenges and opportunities of using digital tools for vocational education, emphasising the need for proper teacher training and adaptation of technologies to local needs. Littlejohn and Pammer-Schindler's (2022) analysis points to the role of AI technologies in vocational training, with a particular focus on workplace skills development.

Despite significant progress in introducing AI for personalised learning, challenges remain due to insufficient funding for educational innovations and limited technical infrastructure in regional educational institutions. Also, this study should apply the ethical aspects of AI use, like data privacy and algebraic transparency.

Method

In 2023-2024, a study was conducted at vocational education institutions in Ukraine. The key goal was to explore how AI technologies affected the personalisation of the educational process and how effective it is. The methods used to achieve these goals are theoretical analysis of scientific literature and empirical research methods. The topic of AI in education was reviewed in modern scientific publications, including studies by Hanassab et al. (2024), Barabanova et al. (2022), and others. The sources were analysed to find out the key areas and technologies for introducing AI in the educational process. Questionnaires and interviews with teachers and students at 15 vocational and higher education institutions in Ukraine were used to collect data. More than 200 respondents who provided feedback on using digital platforms with artificial intelligence elements for education were included in the survey. The experimental part of the study consisted of building an adaptive learning platform through which machine learning algorithms personalise learning tasks. The experiment ran for three months and involved fifty students. The individual learning tasks given to the participants depended on results from the test and the level of progress made.

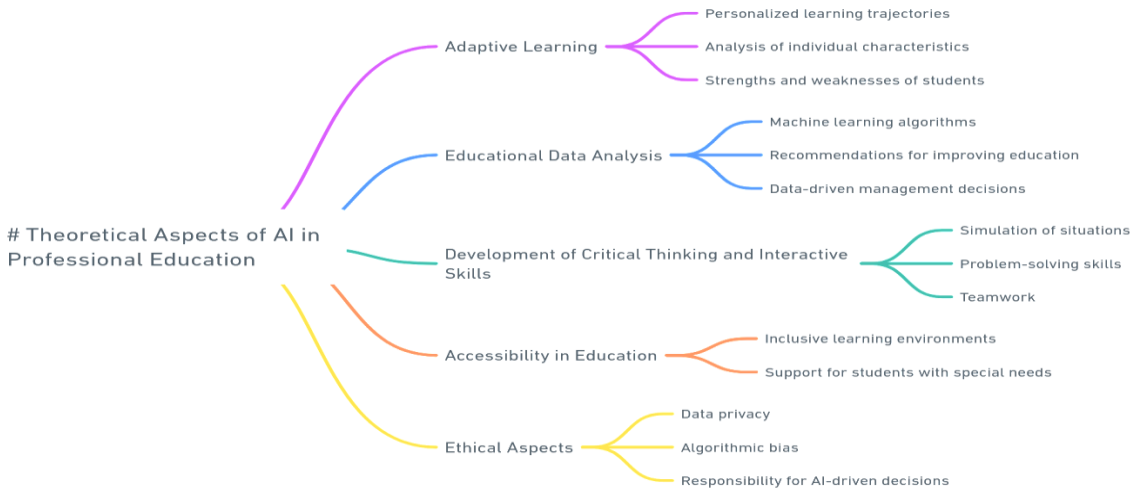
Statistical analysis methods were applied to process the collected data. They used the calculation of averages, percentages and a comparative analysis of the results before and after the experiment, $\chi 2$ Pearson's criterion. The results were accurately analysed using Microsoft Excel software tools. The study results summarised and compared to other similar international practices as described in the studies by Kurni et al. (2023), Windelband (2023) and İçen (2022). We gained insights into how common trends and features of using AI in the educational process were implemented in Ukraine. The study, therefore, incorporated theoretical analysis and questionnaires, followed by interviews and experimental implementation of the platform, as well as statistical analysis for the results to be reliable and valid.

Results

The use of Artificial Intelligence (AI) in vocational education is theoretically based upon the three concepts of personalised learning, adaptive learning environments, and intelligent recommender systems (Figure 1). AI is capable, to some degree, of using large amounts of data to provide individualised support to the learner, tailoring content to their needs and their level of knowledge.

Figure 1

Theoretical Aspects of Using Artificial Intelligence in Vocational Education



Adaptive learning is one of the key parts of generating personalised trajectories for each student. AI analyses students' unique features, strengths and weaknesses, and needs for education and continues to adapt the education process to students' specific needs. Improving the quality of education is very important, and that is a place where educational data analysis serves a significant role. By collecting and analysing learning outcomes, machine learning algorithms can suggest ways to improve education and draw informed management decisions based on data. Critical thinking and interactive skills are important area. Through AI, we can convey the processes of real-life learning situations and pool this into skill building for problem-solving, teamwork and bringing the learning closer to practical realities.

Education becomes an inclusive educational environment that ensures its accessibility. AI helps keep students with special educational needs on the same playing field by equipping them with the same learning and professional development capabilities. An ethical component around implementing AI is the final piece to the puzzle. There are thus data privacy issues to be reckoned with in the case of artificial intelligence, avoiding algorithmic bias and determining who is to bear responsibility for decisions based on AI. Artificial intelligence opens new opportunities in professional education and presents problems that must be solved within the system.

Personalised learning made possible with artificial intelligence can account for the unique characteristics of individual students. Intelligent algorithms introduce flexibility, efficiency, and result orientation in the educational process. Adapting learning materials, analysing student data, and creating interactive learning environments are just some of the ways that key AI technologies can be used (Table 1).

Table 1

Key AI Technologies

Key AI technologies	Description	Application in the educational process
Machine Learning (ML)	Algorithms that learn from data to identify patterns and make predictions	Automatic determination of the student's level of knowledge and creation of individual tasks
Adaptive learning systems	Platforms that adapt to the needs of the student in real-time	Providing individual learning materials and assignments based on progress
Natural Language Processing (NLP)	Text analysis and comprehension that allows for interacting with students through chatbots or virtual assistants	Automatically provide explanations, answer questions, and analyse text works
Analysing educational data (Learning Analytics)	Collecting and processing data on learning outcomes to identify individual needs	Monitoring progress, identifying gaps in knowledge and recommendations for training
Artificial neural networks (ANN)	Models that mimic the human brain for complex training data analysis	Analysing large amounts of information to personalise learning content
Intelligent decision support systems	Technologies for data-driven decision-making	Supporting teachers in choosing methods and resources for individual learning

Source. Compiled by the authors based on (Alwaqdani, 2024; Hanassab et al., 2024; Mouta et al., 2024)

Virtual Learning Environments (VLEs), in combination with AI, are becoming widely used in education in different countries. They ensure the adaptability, accessibility, and efficiency of the learning process. Global experience demonstrates successful examples of integrating these technologies into education at different levels (Table 2).

Table 2

AI Implementation in the World: Key Examples

Country	Example of implementation	AI technology	Results and effect
USA	The Carnegie Learning platform uses AI to personalise maths learning.	Adaptive learning	Increased student performance by 20% thanks to individualised assignments.
United Kingdom	The Century Tech platform analyses learning data and adapts tasks to the student's knowledge level.	Learning Analytics	Reducing the teaching load of teachers by 30% and increasing their interest in learning.
China	The use of AI in the Squirrel AI system provides an adaptive approach to teaching STEM subjects.	Machine learning (ML)	Improved student performance by 15% compared to traditional education.
India	Vedantu's AI-powered natural language processing platform provides interactive lessons and feedback.	Natural language processing (NLP)	Increase individual student engagement through interactive feedback.
Finland	The Eduten Playground project uses AI to automate assessment and provide individual tasks.	Adaptive learning systems	Reduced assessment time by 40% and improved motivation to learn.
Australia	Smart Sparrow develops adaptive learning modules for higher education, focusing on the needs of students.	Artificial neural networks (ANN)	Increased academic performance by 25% and created individualised educational trajectories.
Singapore	Using the AI Singapore platform to analyse educational data and improve teacher training.	Learning data analytics	Improving teaching effectiveness and supporting teachers in decision-making.
Germany	The Ada Learning platform offers adaptive lessons based on artificial intelligence for technical education.	Intelligent decision support systems	Optimise the learning process with personalised content.

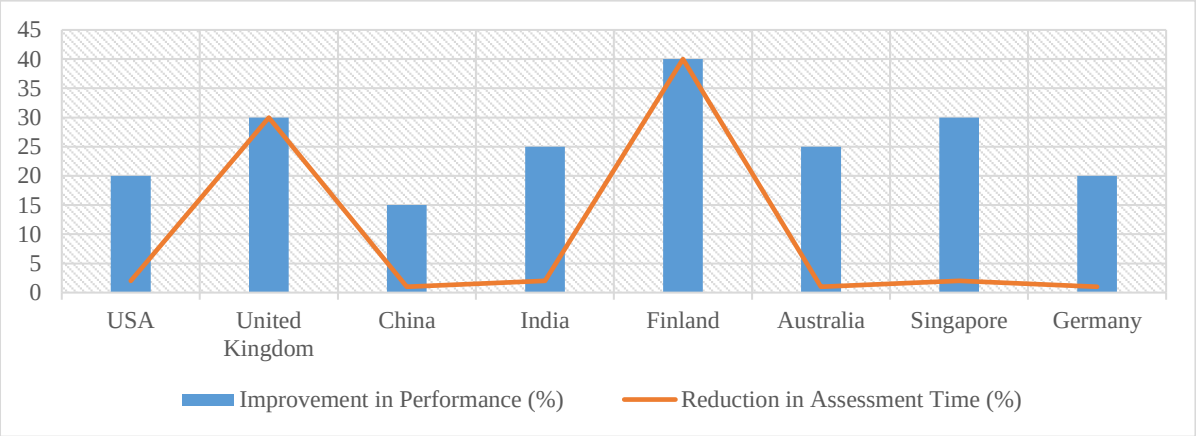
Source. Compiled by the authors based on (Barabanova et al., 2022; Hanassab et al., 2024; Windelband, 2023)

The analysis of global experience shows that the integration of AI into virtual educational environments enables personalisation of the learning process, improves student performance, and reduces teachers' workloads.

Figure 2 shows the impact of VLEs on the effectiveness of AI in education in different countries.

Figure 2

The Impact of VLEs on the Effectiveness of AI in Education in Different Countries



Source. Compiled by the authors. This is a generalised interpretation based on the data obtained from the global platforms Carnegie Learning (USA), Century Tech (UK), Squirrel AI (China), Vedantu (India), Eduten Playground (Finland), Smart Sparrow (Australia), AI Singapore (Singapore), Ada Learning (Germany)

The graph demonstrates the impact of VLEs on the effectiveness of AI in education, comparing the increase in student performance and reduction in assessment time in eight countries. Finland recorded the highest increase in student achievement at 40% and the highest reduction in assessment time at 40%. The United Kingdom showed significant improvements with a 30% increase in pass rates and a 30% reduction in assessment time, indicating the effectiveness of adaptive learning platforms such as Century Tech. Pass rates increased by 30% in Singapore, but assessment time remained unchanged. The United States and Germany show a moderate increase of 20%, while China has the lowest rate of 15%. At the same time, India and Australia show an average improvement of 25%, which indicates the positive impact of innovative AI technologies on the educational process. In general, Finland and the UK are leaders in the efficiency of AI use, combining both the growth of academic performance and the optimisation of assessment time. This suggests that intensive integration of AI into HE provides the best results in countries that actively implement advanced educational technologies.

It is crucial to compare the global experience with the local one in using artificial intelligence in vocational education.

1. The level of AI integration into professional education. Global experience demonstrates a high level of AI integration into learning platforms, such as *Carnegie Learning* (USA), *Century Tech* (UK), and *Squirrel AI* (China), which use adaptive technologies to personalise education. In Ukraine, the application of AI in vocational education is still in the initial stages. The main focus is on the use of distance learning platforms (e.g., Moodle), which do not always fully integrate AI technologies.

2. Personalisation of learning. In Finland and China, AI-based platforms such as *Eduten Playground* and *Squirrel AI* provide deep personalisation of learning by adapting tasks to the needs of each student. In Ukraine, personalisation is limited to essential functions, such as choosing modules or task options, which depend on the teacher, not intelligent algorithms.

3. Technical infrastructure. In countries with a developed technical base (the United States, Singapore, and the United Kingdom), the introduction of AI is accompanied by broad access

to high-speed Internet and modern equipment. In Ukraine, infrastructure problems, particularly in rural and remote areas, limit the use of advanced digital tools.

4. Ethical aspects and data confidentiality. Much attention is paid to ethical issues and protecting students' data in the EU and the US. Ukraine also adheres to international standards, but teachers and students are not aware of these issues, which creates risks for data security.

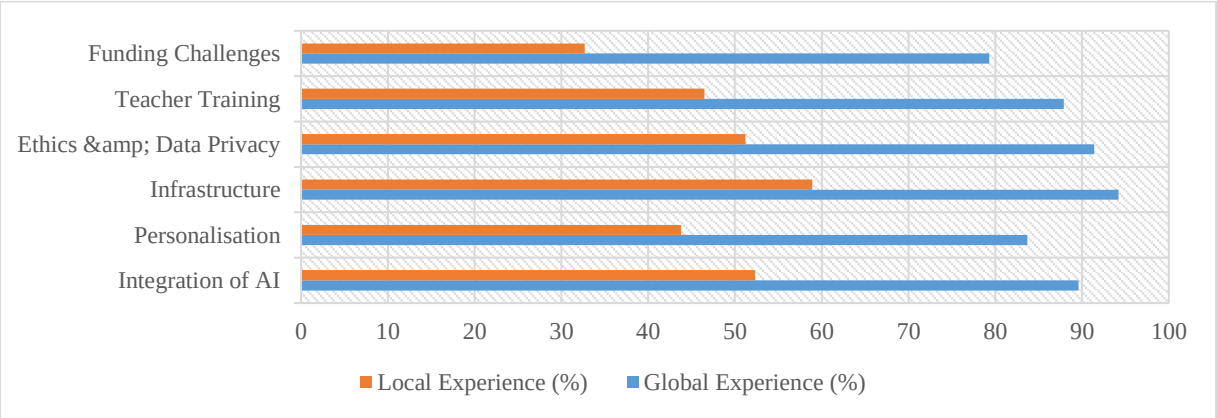
5. Teacher training. Teachers' training on using AI in education is actively conducted abroad (for example, *AI Singapore* offers comprehensive training programmes). In Ukraine, teacher training is mainly focused on basic digital skills, and AI training is rare.

6. Challenges in implementation. Global experience shows significant investment support for platforms like *Smart Sparrow* in Australia or *Century Tech* in the UK. In Ukraine, however, the funding problem limits the possibility of large-scale implementation of AI in vocational education.

Global experience demonstrates a high level of AI integration in professional education, emphasising personalised learning, big data analysis, and teacher support through intelligent systems (Figure 3). In Ukraine, AI is used mainly within general digital platforms without advanced functions. To reach world-class levels, it is necessary to develop the technical base, introduce teacher training, and attract investments in the creation of local AI solutions.

Figure 3

Comparison of Global and Local Experience in Implementing Artificial Intelligence in Vocational Education



Source. Compiled by the authors based on (Barabanova et al., 2022; Hanassab et al., 2024; İçen, 2022; Khine, 2024; Kurni et al., 2023)

The graph in Figure 3 demonstrates the differences between global and local (Ukrainian) experiences in implementing AI in vocational education in six key categories. The highest rates of global experience are observed in technical infrastructure (94.2%) and AI integration (89.6%), while local experience is significantly lower, with the best result in the technical infrastructure category (58.9%). The lowest local score is in financing (32.7%), highlighting the dependence on government support. Overall, the data indicate the need to invest in local R&D, teacher training, and regulatory improvements to bridge the gap between local and global levels.

Pearson's χ^2 test was used to assess the statistical dependence between local and global experience in six categories for the statistical analysis.

Formulation of hypotheses:

1. The null hypothesis (H_0): no significant differences exist between local and global experience scores.

2. Alternative hypothesis (H_1): significant differences exist between local and global indicators.

The expected values for local and global experience are calculated based on the average distribution of values between the two groups using the formula:

$$E_{ij} = \frac{R_i C_i}{T} \quad (1)$$

where R_i is the sum of the observed values in the row, C_j is the sum of the values in the column, and T is the total sum of all values.

The sum of local values:

$$R_{local} = 25 + 45 + 40 + 55 + 50 + 60 = 275 \quad (2)$$

$$R_{global} = 85 + 75 + 70 + 90 + 80 + 85 = 485 \quad (3)$$

Total amount

$$\mathrm{T} = 275 + 485 = 760 \quad (4)$$

Expected values for the category "*Financing*" (expected local and expected global):

$$E_{\mathrm{local}} = \frac{275*110}{760} = 39{,}80 \quad (5)$$

$$E_{\mathrm{global}} = \frac{485*110}{760} = 70{,}20 \quad (6)$$

These calculations are repeated for all categories. Table 3 shows all the calculated expected values.

Table 3

Comparison of Local and Global Experience by Category with Expected Values

Category	Local experience (%)	Global experience (%)	Expected Local (%)	Expected Global (%)
Financing	25	85	39.80	70.20
Teacher training	45	75	43.42	76.58
Ethics and data privacy	40	70	39.80	70.20
Infrastructure	55	90	52.47	92.53
Personalisation	50	80	47.04	82.96
Integration of artificial intelligence	60	85	54.47	90.53

The value of χ^2 was calculated using the formula:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad (7)$$

where O_i - observed values, E_i - expected values.

Let us calculate the category "Financing"

Observed values:

$$O_{\mathrm{local}} = 25 \quad (8)$$

$$O_{\mathrm{global}} = 85 \quad (9)$$

Expected values

$$E_{\mathrm{local}} = 39{,}80 \quad (10)$$

$$E_{\mathrm{global}} = 70{,}20 \quad (11)$$

Calculation for local:

$$\sum \frac{(O_{local} - E_{global})^2}{E_{global}} = \frac{(25-39.80)^2}{39{,}80} = \frac{14{,}80^2}{39{,}80} = \frac{219{,}04}{39{,}80} = 5{,}50 \quad (12)$$

$$\sum \frac{(O_{local} - E_{global})^2}{E_{global}} = \frac{(85-70.20)^2}{70{,}20} = \frac{14{,}80^2}{70{,}20} = \frac{219{,}04}{70{,}20} = 3{,}12 \quad (13)$$

These steps are repeated for all categories. The sum of all the values gives:

$$\chi^2 = 10{,}90 \quad 14)$$

The calculated value is $\chi^2 = 10{,}90$ is $p = .053$, almost meeting the critical significance level ($\alpha = .05$). Thus, it can be concluded that the difference between local and global indicators is significant, especially for categories with considerable differences.

The results show that the most significant gaps between local and global performance are in the Financing and AI Integration categories. In financing, the local experience is only 25%, which is significantly lower than the global figure of 85%, highlighting the acute lack of resources for innovation. In the category of AI integration, the local figure is 60%, while the global figure is 85%, indicating the need for further adaptation and implementation of modern technologies in local conditions. The gap in the infrastructure category is also significant (55% vs. 90%), indicating an insufficient technical base at the local level. This confirms the need to invest in and improve the efficiency of local education systems to meet global standards.

We will outline recommendations for integrating artificial intelligence to personalise the education of future professionals.

1. *Development of adaptive learning platforms.* Educational institutions should implement platforms that use machine learning algorithms to analyse student data. This will allow the creation of individual educational trajectories based on each student's level of knowledge, interests, and progress. For example, platforms like *Squirrel AI* have proven effective in STEM education. Developing local solutions will ensure adaptation to the needs of regional labour markets.
2. *Integration of virtual assistants based on natural language processing (NLP).* Chatbots and voice assistants will be used to provide advice and answer students' questions, increasing support efficiency and accessibility. For example, *Vedantu's tools* help create interactive learning experiences. Such technologies reduce teachers' time on repetitive tasks and increase student engagement.
3. *Conducting training for teachers.* Organising systematic professional development programmes to teach teachers how to work with AI tools is necessary. For example, *AI Singapore* has programmes to train teachers to implement artificial intelligence technologies. Such training will help ensure high-quality AI integration into the educational process and increase trust in technology among the teaching staff.

These recommendations will help implement artificial intelligence in vocational education and achieve a higher degree of personalisation and generalisation of the learning process.

Discussion

The study outcomes prove that applying Artificial Intelligence (AI) to purposeful learning helps people personalise the educational process and enhance students' academic performance. Data analytics, adaptive systems, learning systems, and algorithms for machine learning support practical analysis of individual student needs and tasks in the context of personalised learning. These findings are consistent with Hanassab et al. (2024), who argue that AI helps individualise learning and improves learning outcomes. Meanwhile, researchers are split as to whether AI integration is effective. Khine (2024) attributes the fact that AI is introduced into educational processes with ethical challenges like data privacy and integrity through introducing algorithms into ED systems. Kurni et al. (2023) emphasised the considerable progress that AI can make to provide education to students with disabilities on an equal basis. However, our results support the assumptions made by Kurni et al. (2023) about the adaptation

of educational platforms to the specific needs of students but highlight the necessity to control safety and algorithm legitimacy.

In addition, Windelband's (2023) study demonstrates that intelligent decision support systems facilitate the work of teachers by reducing their teaching load. Our study found similar results: AI systems significantly optimise the learning process, allowing teachers to focus on pedagogical aspects rather than routine tasks. At the same time, as noted by Alwaqdani (2024) and İçen (2022), the effectiveness of AI depends on the technical infrastructure of the educational institution, which, as our results show, remains a problem for many regions of Ukraine. The results of our study indicate that the development of critical thinking and interactive skills using AI is a key element in the modernisation of the educational process. This is supported by Barabanova et al. (2022), who emphasise the importance of modelling real-life learning situations for training future professionals. Second, our results are consistent with the studies by İçen (2022) and Anisimova and Efremova (2022) and show that financial resources and teacher training limit the introduction of AI in Ukraine.

However, the main limitation of the positive results is that our data are not time series data on how long AI has affected the education process. More research in verticals, such as analysing the effectiveness of AI in various educational systems, also needs to be done while building local adaptive platforms to address local needs. Our work demonstrates that AI is a positive force in personalised learning. There is still work to address the technical, financial, and ethical obstacles associated with deploying these technologies.

Conclusion

Artificial Intelligence (AI) can be used to systemise and personalise learning on a grand scale, representing new opportunities for individualising the educational process. Adaptive learning systems, educational data analytics and machine learning technologies facilitate consideration of individual needs, level of knowledge and progress of the students in order to engage them to the maximum and provide actual effectiveness. Studies have also revealed that introducing AI helps save teachers' workloads by making things they previously had to do automatically, so this automaticity does not reduce teachers' perceived performance; rather, it enhances it. It enables a concentration on the creative and pedagogical aspects of the educational process. The study's significant contributions include identifying the relevant AI technologies that can potentially modernise job education: adaptive platforms, Natural Language Processing (NLP) systems, and intelligent decision support systems. These technologies are important because they need to be implemented in Ukrainian educational institutions, considering their specifics. At the same time, the study identified several limitations, including insufficient technical infrastructure and funding and limited training of teachers in the use of AI. These factors require additional attention to achieve positive results. The practical significance of the findings lies in the possibility of creating individual educational trajectories for students, which will help train highly qualified specialists to the requirements of the labour market. Further research in this area should be aimed at developing local adaptive learning platforms that consider the needs of the Ukrainian educational system. Another important area is the study of ethical aspects of AI implementation and data privacy. In general, the development of AI technologies and their integration into vocational education is a key step towards improving the quality of

the educational process, which requires a comprehensive approach and cooperation between the state, educational institutions, and technology companies.

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