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The Impact of Artificial Intelligence on University-Level Professional Training

تأثير الذكاء الاصطناعي على تدريب الموارد البشرية على المستوى الجامعي

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Abstract: The aim of the study was to assess the perceived effectiveness of implementing artificial intelligence tools into educational curricula and to evaluate the readiness of students, teachers, and graduates to apply artificial intelligence in the educational process and professional activities. The research methodology combined a content analysis of teaching and assessment forms integrated with artificial intelligence, a survey of 350 participants (students, graduates, and teachers) at the Industrial University of Ho Chi Minh City in May 2025 to evaluate their readiness and experience in using artificial intelligence, as well as the formulation of practical recommendations for enhancing the effectiveness of educational programmes using artificial intelligence tools. The results showed that after the implementation of the updated curriculum, 100% of students used AI tools for learning, 70% rated them as very useful, and 25% as high, indicating a high level of awareness of AI's benefits; all students expressed readiness to apply AI in learning and work and to attend dedicated courses or seminars. Among teachers, 30% rated the advantages of AI for teaching as very high, 60% as high, and 10% as moderate, while all teachers noted legal or ethical concerns. The practical significance of the work lies in the fact that the results and recommendations can be used by universities and teachers to update curricula with AI integration, by institutional administrations for planning digital infrastructure and pedagogical training.

Keywords: Students, Teachers, Digital platforms, professional competencies, educational programmes.

المستخلص: الهدف من الدراسة هو تحديد مدى فعالية إدماج أدوات الذكاء الاصطناعي في المناهج التعليمية، وتقييم مدى استعداد الطلاب والمعلمين والخريجين لتطبيق الذكاء الاصطناعي في العملية التعليمية والأنشطة المهنية. وقد جمعت منهجية البحث بين تحليل محتوى نماذج التدريس والتقييم المدمجة مع الذكاء الاصطناعي، واستطلاع رأي شمل 350 مشاركاً (طلاب وخريجين ومعلمين) في جامعة هو تشي منه الصناعية في مايو 2025 لتقييم استعدادهم وخبرتهم في استخدام الذكاء الاصطناعي، بالإضافة إلى صياغة توصيات عملية لتعزيز فعالية البرامج التعليمية باستخدام أدوات الذكاء الاصطناعي. وأظهرت النتائج أنه بعد تنفيذ المنهج المحدث، استخدم 100% من الطلاب أدوات الذكاء الاصطناعي للتعلم، وقيّم 70% منهم هذه الأدوات بأنها مفيدة جدًا، و 25%بأنها مفيدة، مما يشير إلى مستوى عالٍ من الوعي بفوائد الذكاء الاصطناعي؛ وأعرب جميع الطلاب عن استعدادهم لتطبيق الذكاء الاصطناعي في التعلم والعمل وحضور دورات أو ندوات مخصصة. بين المعلمين، صنف 30% مزايا الذكاء الاصطناعي للتدريس بأنها عالية

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جدًا، و 60%بأنها عالية، و 10%بأنها معتدلة، بينما أشار جميع المعلمين إلى مخاوف قانونية أو أخلاقية. تكمن الأهمية العملية لهذا العمل في أن النتائج والتوصيات يمكن أن تستخدمها الجامعات والمعلمون لتحديث المناهج الدراسية من خلال دمج الذكاء الاصطناعي، كما يمكن أن تستخدمها الإدارات المؤسسية لتخطيط البنية التحتية الرقمية والتدريب التربوي .

الكلمات المفتاحية :الطلاب، المعلمون، المنصات الرقمية، الكفاءات المهنية، البرامج التعليمية.

1 INTRODUCTION

The impact of artificial intelligence (AI) on university-level personnel training is of paramount importance, as digital technologies are reshaping the labour market structure, the formats of professional competencies, and the requirements for specialists across various fields. Universities are restructuring educational programmes to integrate algorithmic tools, automated analytics, personalised learning systems, and intelligent services into the professional training of students. This reorientation enhances the level of practical readiness of future professionals to interact with technological systems, strengthens analytical thinking, and forms data-handling skills, which are a resource for professional activity across various sectors. The expanding use of AI in educational processes intensifies the demand for pedagogical innovations and shifts in teaching approaches, necessitating scientific analysis and evidence-based justification of the effectiveness of implemented solutions (Ginters & Revathy, 2021).

Previous research has examined various aspects of AI-supported learning, academic writing, teaching practices, and educational technologies; however, less attention has been paid to how students, instructors, and graduates perceive AI integration in university curricula in terms of readiness, educational experience, perceived usefulness, and retrospective evaluation of acquired professional competencies. Previous studies have often focused on separate aspects of AI-supported learning, while less attention has been given to the combined assessment of students, instructors, and graduates within a single institutional context. Therefore, the aim of the research was to assess the perceived impact of integrating artificial intelligence tools into university curricula and to evaluate the readiness of students, instructors, and graduates to use AI in learning and professional activities. The research objectives were to conduct a content analysis of AI integration in higher education; to assess stakeholder perceptions of AI-supported educational programmes; and to formulate recommendations for enhancing the effectiveness of educational programmes using AI tools.

2 LITERATURE REVIEW

Researchers from various countries have examined aspects of the influence of AI on the professional training of university students. For example, Alghazo et al. (2025) established that the use of ChatGPT as an intelligent tool contributes to improving the quality of research tasks, refining academic writing, and strengthening learning motivation among students. Artificial intelligence creates a favourable environment for the individualisation of educational trajectories and provides support for students during complex learning projects. The transition towards deepening the professional competencies of teachers has been traced in the research of Abdelaal and Sawy (2024), who determined that the

professorial and teaching staff demonstrates increased readiness to use intelligent systems; however, they face challenges related to technical complexity, digital inequality, and ethical aspects of AI application. To overcome the technical complexity, digital inequality, and ethical risks of implementing AI in education, it is necessary to provide systematic support for teachers through targeted digital literacy enhancement programmes, accessibility of necessary resources, and clear regulation of standards for the ethical use of technologies (Vasylchak et al., 2022).

Furthermore, Al-Zahrani and Alasmari (2024) analysed that there are educational, social, and ethical consequences to the implementation of intelligent services in the training of future professionals. These consequences include the transformation of learning content, changes in models of professional interaction, and increased demands for the responsible use of digital technologies. In particular, scholars Dinh et al. (2024) provided empirical evidence of the impact of chatbots on students' foreign language training, demonstrating an increase in the level of text comprehension, growth in the accuracy of information interpretation, and a reduction in the time required to complete reading tasks. The obtained results showed that intelligent systems serve the function of digital tutors and enhance work with educational texts. The research of Gofman and Jin (2023) demonstrated the direction of competency formation through the educational use of AI. The formation of competencies through the educational use of AI occurs through the integration of adaptive digital tools into learning tasks, which guide students towards developing critical thinking, analytical abilities, and skills for independent decision-making. In the research of Nguyen et al. (2022), the implementation of assistant robots is described, confirming increased efficiency in administrative student support, automation of consultations, and adaptation of learning pathways. The results made it possible to prove that AI has the potential for not only pedagogical but also organisational impact on personnel training.

Further theoretical elucidation was provided by O'Dea and O'Dea (2023), who outlined the trend of transforming teaching based on intelligent platforms. The authors emphasised that the use of artificial intelligence systems by higher education institutions stimulates the growth of students' independent activity and alters the interaction between instructors and learners. The analysis of the social impact of educational technologies was continued by Săseanu et al. (2024), who established that the widespread implementation of intelligent solutions fosters increased accessibility of education and the levelling of educational opportunities, yet simultaneously intensifies debates concerning data security and privacy. The application of artificial intelligence forms new challenges for educational policy and university management. Certain researchers directed their attention to the impact of algorithmic services on academic writing. Ta et al. (2025) ascertained that the use of an intelligent student guide contributes to the improvement of text structuring quality, logical coherence of exposition, and adherence to academic standards, which elevated the overall proficiency level of third-year students. The systematic application of such a tool fosters durable self-editing skills and critical analysis of one's own academic works. In the work of Truong and Pham (2025), the authors identified factors influencing the use of 3D technologies integrated with artificial intelligence in Science, Technology, Engineering, Mathematics (STEM) education. The scholars established that the adoption of such tools depends on perceived usefulness, ease of use, social influence, and the availability of digital resources within the educational institution.

3 METHODOLOGY

The study was conducted in May 2025. A content analysis was performed, within which a list of learning formats meeting the requirements of educational transformation in the context of IR 4.0 (Industry) was identified, namely AI-driven Project-Based Learning, artificial intelligence simulation-based learning, generative-supported programming, the use of digital twins in practical training, work in AI-based virtual laboratories, and interdisciplinary learning. Assessment formats applied in AI-oriented educational models were systematised, including AI-based Adaptive Competency Assessment, personalised testing based on machine learning algorithms, the use of dynamic competency diagnostic maps, automated assessment through intelligent tutoring systems, and real-time skill development monitoring via digital educational platforms Labster, VirtualChem, PhysicsLab AI, STEM Simulations, GitHub Copilot, OpenAI Codex, Siemens Xcelerator, EduTwins, Psico-Smart, SmartTest AI, Learnosity Adaptive Assessments, Competency Dashboard, EdTech Skill Maps, Carnegie Learning, Assessment and Learning in Knowledge Spaces (ALEKS), Khan Academy Skills Dashboard, Squirrel AI Learning. The criteria for engaging digital platforms also corresponded to contemporary requirements for university-level personnel training under the influence of artificial intelligence, as they ensured the development of skills for working with AI tools, the formation of digital literacy, the mastery of adaptive data analysis technologies, increased learner autonomy, and the ability to develop competencies necessary for functioning in high-tech professional environments. The content analysis encompassed additional structural components essential for AI integration in education, including ethical standards for AI use, IEEE Ethically Aligned Design, Microsoft AI Fundamentals, AI Literacy MOOCs, AWS Educate, Google Cloud for Education, Siemens Education Programs, IBM Skills Academy, ISTE AI Certification, Coursera AI for Educators, MIT AI and Business Programs, FutureSkills AI Platforms, requirements for digital and AI literacy, cloud infrastructure for organising learning, formats for partnerships between industry and educational institutions, preparation of educators for working with artificial intelligence tools, business demand for cross-functional specialists (AI combined with domain expertise), and the application of predictive skill models. Documents were selected according to criteria of compliance with international ethical standards for artificial intelligence use, the presence of clearly structured recommendations for safe and responsible AI implementation in the educational process, a focus on developing learners' digital competence, the practical orientation of materials towards university-level personnel training, alignment with contemporary industry requirements for specialists, and the integration of interdisciplinary approaches. All specified elements were analysed, classified, and systematically ordered in stages according to their functional purpose.

Specifically, a survey was conducted based on a questionnaire designed to assess student learning outcomes and the level of AI utilisation by students and faculty. The study involved 350 participants, comprising 60 alumni of the selected university and 50 faculty members from the Faculty of Information

Technology of Industrial University of Ho Chi Minh City (IUH). The inclusion criteria for the study were current students and faculty members of the Faculty of Information Technology at Industrial University of Ho Chi Minh City (IUH) who were directly involved in the educational process, regardless of whether they had previous experience using AI tools. The exclusion criteria included individuals who were not active participants in the educational process, were not affiliated with the selected faculty, or did not provide complete questionnaire responses. This specific higher education institution was selected due to its profile in information technology and the active implementation of AI in its curricula, ensuring the relevance and appropriateness of assessing AI's impact on specialist training. The inclusion criteria for alumni were completion of the relevant educational programme and willingness to provide a retrospective assessment of acquired competencies, while exclusion criteria were the lack of confirmed alumni status or inability to provide reliable responses, resulting in the inclusion of 60 alumni in the sample. In the first stage of the research, feedback was collected from the sample of students, alumni, and faculty regarding their readiness to use AI in work and study. Data collection was based on inclusion criteria that required direct involvement in academic activities or confirmed alumni status, but did not require prior AI experience. This approach made it possible to compare respondents with and without previous AI use and to assess baseline experience, readiness, perceived usefulness, and attitudes before and after the implementation of the updated curriculum. The assessment criteria encompassed digital and AI literacy, the ability to apply AI in solving professional and educational tasks, critical thinking, readiness for interdisciplinary work, and adaptability to technological changes.

The second stage of the research involved a phased collection of stakeholder opinions to update the curriculum for students of the Faculty of Information Technology at IUH, taking into account technological and social changes. An analysis of labour market needs and requirements for AI specialists was conducted, followed by the identification of curriculum update directions, including the framework structure, subject content, and examination methods, with the integration of new technologies and modern teaching methods. Study participants completed the questionnaire twice: initially, they filled out the baseline questionnaire prior to the implementation of the updated AI-integrated curriculum, and subsequently, they completed the same questionnaire again after the curriculum implementation was concluded. The survey was conducted in accordance with the principles of the Declaration of Helsinki, adhering to confidentiality norms: all participant responses were anonymous, and personal data were not used in publications or reports. The questionnaire consisted of 11 questions covering experience in using AI, assessment of its usefulness, readiness to apply AI in learning and work, interest in attending courses or seminars, assessment of university support, and legal and ethical aspects. The questionnaire included two types of response formats. For factual and readiness-related questions, respondents selected binary options (“Yes” or “No”). For evaluative questions, respondents selected one of four ordered categories: “Low”, “Moderate”, “High”, or “Very High”. After data collection, the percentages of

responses were aggregated and interpreted by the researchers using the following descriptive thresholds: 0–25% was classified as low, 26–50% as moderate, 51–75% as high, and 76–100% as very high. Thus, these percentage ranges were used for interpreting aggregated survey results rather than as direct response options for all questionnaire items. Respondents assessed parameters such as teaching quality, learning conditions, tools used, compliance with regulatory requirements, the level of support from the educational unit, and other factors, enabling a comprehensive analysis of the effectiveness of AI integration into the educational process. Recommendations were formulated for enhancing the effectiveness of educational programmes utilising artificial intelligence tools.

4 RESULTS

4.1 Content analysis of AI integration in higher education

The Fourth Industrial Revolution signifies the fourth phase of global industrial transformation, which merges the physical, digital, and biological worlds through technologies such as AI, the Internet of Things (IoT), robotics, cloud computing, and big data analytics. A key feature of IR 4.0 is the integration of cyber-physical systems, automation of production, and digitalisation of processes, creating a demand for new competencies among workers and students, as well as for flexible, adaptive educational programmes. In the context of such a revolution, educational institutions are obliged to transform their curricula by integrating content related to machine learning, robotics, data science, and automation, and to ensure the development of digital and AI literacy, critical thinking, problem-solving ability, interdisciplinary skills, and lifelong learning mindset. For students, this means preparation for working in conditions of rapid technological change, and for lecturers, it necessitates retraining in the use of AI tools and project-based learning.

The requirements of IR 4.0 in the sphere of education also encompass societal, business, and technological changes (Aizstrauta & Ginters, 2015; Babichev et al., 2017). Society must facilitate the ethical use of AI, promote digital inclusion, and foster public-private partnerships for the development of educational ecosystems. Business is encouraged to collaborate with academic institutions by offering internships, mentorship, real-world projects, and by investing in staff reskilling, as well as by forecasting future skill demands, including roles such as AI Ethics Officer and Data Coach. Technological requirements involve training in real-time data processing, the integration of chatbots, intelligent tutoring systems, virtual assistants, cloud and edge computing, as well as cybersecurity (European Commission, 2026). The implementation of these approaches shifts the focus of education from theoretical knowledge towards individualised, practical, and interdisciplinary learning aimed at aligning student professional competencies, thereby ensuring effective preparation for professional activities within the context of IR 4.0. Specifically, Table 1 outlines the requirements, tools, and anticipated effects of integrating AI into university educational programmes for adaptation to the conditions of the Fourth Industrial Revolution.

Table (1) Requirements and tools for integrating AI into university educational programmes in higher education institutions under the conditions of the Fourth Industrial Revolution

Requirements/focus areas	Specific examples/tools	Goals/expected effect
Curriculum reform	Integration of AI, robotics, data science, automation; transition to project- and problem-based learning	Development of practical, interdisciplinary, and innovative skills, adaptation to IR 4.0 demands
Digital infrastructure	Smart classrooms, AI-based virtual laboratories, LMS with integrated AI, cloud platforms	Ensuring interactive and personalised learning, access to contemporary tools
Educator competence	Reskilling educators in the use of AI tools, internships in industrial companies, participation in training programmes	Enhancing teaching quality, readiness to integrate AI into educational programmes
Innovation in assessment	AI-based adaptive competency assessment, personalised algorithm-driven testing, dynamic competency maps, automated assessment through intelligent tutoring systems	Personalisation of assessment, real-time progress monitoring, increased efficiency of educational programmes
Industry partnership	Collaborative development of curricula with companies, provision of real data for practical projects, internships, and mentorship	Alignment of curricula with business needs, enhancement of the practical value of education
Skill forecasting	Use of predictive models to assess future competencies, creation of cross-functional roles (AI + domain expertise)	Adaptation of curricula to the labour market and new professional requirements
Ethical and social standards	Implementation of ethical guidelines for AI use, digital inclusion, ensuring access to platforms in rural and remote regions	Fostering responsible technology use, ensuring equal learning opportunities
Technological integration	Use of chatbots, intelligent tutoring systems, virtual laboratories, cloud and edge computing, cybersecurity	Provision of modern digital infrastructure, increased efficiency and security of the learning process

Source: compiled by the author based on Abnoulgid et al. (2025), Pisica et al. (2025), Chen et al. (2025).

For higher education institutions, the integration of AI into educational programmes is of strategic importance, as it enables a profound transformation of the educational process and adapts student preparation to the conditions of the Fourth Industrial Revolution. Curriculum reform involving the implementation of AI, robotics, data science, and automation, along with the transition to project- and problem-based learning, fosters the development of practical, interdisciplinary, and innovative skills, which are critically important for the contemporary labour market (Bondarenko et al., 2022). The development of digital infrastructure, including smart classrooms, virtual laboratories, Learning Management System (LMS) with integrated AI, and cloud platforms, provides students with access to modern tools, creates conditions for interactive and personalised learning, and enhances the overall efficiency of the educational process (Kal'chuk et al., 2020). Table 2 provides a comprehensive overview of AI-oriented learning formats, contemporary assessment methods, and ethical and structural requirements that ensure effective student preparation for the conditions of Industry 4.0.

Table (2) AI-oriented educational practices, assessment, and ethical requirements for students in the context of IR 4.0

Category	Form	Functional Purpose	Application Examples
Learning forms	AI-driven Project-Based Learning	Students execute interdisciplinary projects; AI assists in generating ideas, structuring tasks, coordinating teams, and automating reporting	Project planning, presentation preparation, management of team tasks in ProjectPals
	AI-based Simulation Learning	Interactive models replicating real-world processes; AI adapts complexity, provides hints, and analyses student errors	Virtual laboratories for physics, chemistry, and other subjects; urban systems modelling
	Generatively-Supported Programming	AI generates code snippets or provides prompts; students analyse, modify, and test the code	Code creation using GitHub Copilot, OpenAI Codex
	Use of Digital Twins	Digital models of objects or students; AI personalises learning, predicts outcomes, and analyses actions	Modelling of production systems, student digital profiles in Siemens Xcelerator, EduTwins
	AI-based Virtual Laboratories	Experiments in a safe digital environment; adaptation of scenarios to the student's level and errors	Chemical and biological experiments, engineering laboratories in Labster, VirtualChem
	Interdisciplinary Learning	Integration of knowledge from multiple disciplines; AI coordinates teamwork and provides resources for complex projects	STEM projects in ProjectPals
Assessment forms	AI-based Adaptive Competency Assessment	Dynamic competency assessment with adaptation to student level; AI identifies gaps and suggests individualised tasks	Automatic identification of student strengths and weaknesses in Psico-Smart
	Personalised Testing Based on ML Algorithms	Testing with tasks selected according to student knowledge and abilities; real-time progress assessment	Individualised test sets in SmartTest AI, Learnosity Adaptive Assessments
	Dynamic Competency Maps	Visualisation of skill development; assists students and educators in tracking progress	Interactive competency maps in Competency Dashboard, EdTech Skill Maps
	Automated Assessment via Intelligent Tutoring Systems	AI adapts tasks and provides recommendations; automatically assesses learning effectiveness	Interactive assessment with adaptation to student level in Carnegie Learning, ALEKS
	Real-time Skill Development Monitoring	Continuous tracking of student progress via digital platforms; early identification of problems	Progress monitoring in Khan Academy Skills Dashboard, Squirrel AI Learning
Ethical & structural requirements	Ethical Standards for AI Use	Development of regulations, algorithm transparency, data protection, and student confidentiality	University codes of conduct, Institute of Electrical and Electronics Engineers (IEEE) Ethically Aligned Design
	Requirements for Digital and AI Literacy	Programmes for enhancing digital competencies of students and educators for effective work with AI	Microsoft AI Fundamentals courses, AI Literacy Massive Open Online Courses (MOOCs)
	Cloud Infrastructure	Platforms for integrating AI tools, collaborative work, and data storage	Amazon Web Services (AWS) Educate, Google Cloud for Education

	Industry-Education Partnerships	Collaborative projects, internships, access to real-world data and technologies	Siemens Education Programs, IBM Skills Academy
	Educator Preparation for Working with AI	Training on working with generative tools, simulations, digital twins, and virtual laboratories	ISTE AI Certification, Coursera AI for Educators
	Business Need for Cross-Functional Specialists	Training students with combined AI and domain expertise (STEM + AI, Business + AI)	Massachusetts Institute of Technology (MIT) AI and Business Programs
	Predictive Skill Models	Use of AI to predict required competencies and personalise learning	FutureSkills AI Platforms, LinkedIn Skills Insights

Source: compiled by the author.

Artificial Intelligence tools play a positive role in university-level personnel training, as they combine theoretical knowledge with practical skills within the context of digital education transformation. AI-oriented learning formats foster the development of critical thinking, interdisciplinary work, and effective complex problem-solving, while simultaneously enabling the personalisation of the educational process to meet the needs of each student (Raj et al., 2025). AI-based assessment systems allow for tracking student progress in real time, identifying competency gaps, and proposing individual development pathways, thereby enhancing the quality of professional training. The integration of ethical and structural components cultivates in students a responsible attitude towards technology use, digital and AI literacy, as well as collaboration skills with industry, aligning with modern labour market demands. Collectively, these approaches create an educational environment that prepares students for work in Industry 4.0 conditions and develops their capacity for lifelong learning and adaptation to rapidly changing technological and professional standards.

4.2 Assessment of the effectiveness of educational programmes utilising AI tools

The integration of AI into curricula is essential for enhancing the effectiveness of the educational process and its alignment with contemporary labour market requirements. AI enables the automation of assessment and the personalisation of learning, allowing for the identification of each student's material mastery level and the prompt adjustment of the educational process. The integration of AI tools fosters the development of digital and algorithmic literacy, critical thinking, and the ability to apply knowledge in practical and interdisciplinary tasks (Novruzova, 2024; Novruzova & Safarova, 2023). The use of AI facilitates real-time data analysis to track student progress, evaluate teaching quality, and identify weaknesses in the programme. This increases student readiness for professional activity within the conditions of the Fourth Industrial Revolution and ensures the compliance of competencies with modern professional and ethical standards, making the assessment of educational programme effectiveness using AI a key tool for modernising education. Table 3 presents the survey results for students, graduates, and instructors, covering previous AI use, perceived usefulness, readiness to apply AI in learning and professional activities, interest in further training, institutional support, and ethical or legal concerns.

Table (3) Feedback from students, graduates, and instructors regarding readiness to use AI in work and study

Question	Response options	Percentage of survey participants' responses
Students		
Have you ever used AI tools for learning?	Yes	57%
	No	43%
How do you rate AI as useful for yourself?	Very High	15%
	High	40%
	Moderate	30%
	Low	15%
Are you prepared to use AI in future study and work?	Yes	60%
	No	40%
Would you like to take a course or seminar on how to use AI in learning?	Yes	30%
	No	70%
How do you rate the university's support for the application of AI in learning?	Very High	25%
	High	40%
	Moderate	30%
	Low	5%
Instructors		
How do you rate the university's support for the application of AI in learning?	Very High	17%
	High	53%
	Moderate	30%
	Low	-
Would you like to take a course or seminar on using AI in teaching?	Yes	50%
	No	50%
How do you rate the university's support for the application of AI in teaching and research?	Very High	12%
	High	60%
	Moderate	28%
	Low	-
Do you have legal or ethical concerns regarding the use of AI?	Yes	60%
	No	40%
Graduates		
How do you perceive the impact of AI on work in your business?	Very High	20%
	High	30%
	Moderate	40%
	Low	10%
In your opinion, should AI be part of the academic curriculum (as a subject or part of a module)?	Yes	60%
	No	40%

Source: compiled by the author.

The survey results indicated that among students, over half (57%) had already used AI tools for learning, signifying a high level of AI integration into their practice; however, only 15% rated it as very useful, and 40% as highly useful, corresponding to a medium-to-high level of perceived AI benefit. Willingness to apply AI in learning and work was expressed by 60% of students, which can also be considered a moderate level of readiness, while only 30% expressed a desire to undertake a specific course or seminar, indicating a low level of active interest in additional training. Among lecturers, 53% rated the advantages of AI for teaching as high, and 17% as very high, pointing to a high level of recognition of AI's potential in

professional activity; simultaneously, 60% of lecturers expressed legal or ethical concerns, which can be attributed to a moderate level of risk awareness. The majority of graduates (40% medium, 30% high, 20% very high) rated AI's impact on work in their business as medium and high level, and 60% supported the integration of AI into educational programmes, indicating a generally positive readiness to apply AI in the professional sphere. Overall, the results demonstrate medium and high levels of readiness and perception of AI among students, lecturers, and graduates, but they require additional measures to enhance active engagement and a deeper understanding of ethical aspects. Table 4 reflects the results of a follow-up survey of students, graduates, and lecturers after the implementation of an updated curriculum using AI-based content, demonstrating improvements in the level of AI tool usage, readiness for their application, and positive assessment of university support.

Table (4) Feedback from students, graduates, and instructors after implementing the updated curriculum using AI-based content

Question	Response options	Percentage of survey participants' responses
Students		
Have you ever used AI tools for learning?	Yes	100%
	No	-
How do you rate AI as useful for yourself?	Very High	70%
	High	25%
	Moderate	5%
	Low	-
Are you prepared to use AI in future study and work?	Yes	100%
	No	-
Would you like to take a course or seminar on how to use AI in learning?	Yes	100%
	No	-
How do you rate the university's support for the application of AI in learning?	Very High	30%
	High	50%
	Moderate	20%
	Low	-
Instructors		
How do you rate the advantages of AI for your teaching and research?	Very High	30%
	High	60%
	Moderate	10%
	Low	-
Would you like to take a course or seminar on using AI in teaching?	Yes	100%
	No	-
How do you rate the university's support for the application of AI in teaching and research?	Very High	20%
	High	65%
	Moderate	15%
	Low	-
Do you have legal or ethical concerns regarding the use of AI?	Yes	100%
	No	-
Graduates		
How do you perceive the impact of AI on work in your business?	Very High	50%
	High	50%
	Moderate	-
	Low	-
In your opinion, should AI be part of the academic curriculum (as a subject or part of a module)?	Yes	100%
	No	-

Source: compiled by the author.

Following the implementation of the updated curriculum using AI-based content, the survey results showed a significant improvement in readiness and perception of AI among all participant categories. Among students, 100% reported using AI tools for learning, 70% rated it as very useful and 25% as highly useful, indicating a high level of awareness of AI's benefits; all students (100%) expressed readiness to apply AI in learning and work and a willingness to undertake specialised courses or seminars. The assessment of university support increased: 30% of students consider it very high, 50% as high, and 20% as medium, demonstrating an overall rise in satisfaction with institutional support. Among lecturers, 30% rated the advantages of AI for teaching as very high, 60% as high, and 10% as medium, with all lecturers (100%) expressing a desire to undertake courses and seminars on AI use; university support for AI implementation is rated as very high by 20% of lecturers, as high by 65%, and as medium by 15%, while 100% noted legal or ethical concerns, reflecting a high level of awareness of responsibility. Graduates rate AI's impact on work in their business as very high in 50% of cases and high in 50%, and all (100%) support the integration of AI into educational programmes, demonstrating complete readiness to apply AI in the professional sphere. In general, compared to the previous survey, there is a marked improvement in practical usage, awareness of benefits, and readiness for learning and working with AI, which indicates a high level of integration and effectiveness of the updated curriculum.

Analysis of the obtained survey data indicates an increase in the level of AI usage in the educational process and teaching activities, both in quantitative and qualitative terms. The application of AI positively influences student employability prospects, as confirmed by the increased attractiveness of educational programmes, which, in turn, stimulates greater student enrolment and contributes to enhanced productivity in the workplace. Indicators of AI usage in student learning and research, its integration into lecturer preparation and teaching, and graduate awareness of AI's impact demonstrate positive dynamics, aligning with general societal development trends and contemporary technological changes.

4.3 Recommendations for enhancing the effectiveness of educational programmes using AI

Based on the results of the survey conducted among students, faculty, and graduates, specific recommendations were formulated for enhancing the effectiveness of educational programmes integrating AI, considering the requirements of the IR 4.0. The data confirmed that prior to the implementation of the updated programmes, only 57% of students had previously used AI tools in their studies, 15% rated its usefulness as very high, and 40% as a high level. Following the curriculum update, 100% of students actively applied AI in their learning, with 70% rating its benefit as very high, indicating a significant increase in digital and AI literacy and student readiness for the practical application of technologies. Prior to the programme update, faculty rated the advantages of AI for teaching and research at a high level in 53% of cases, whereas after implementation, these indicators increased to 60% with a high and 30% with a very high level, confirming the increased effectiveness of the pedagogical process and the integration of innovative tools into teaching. Graduates also demonstrated a positive trend: while previously only 20% rated the impact of AI on their work as very high, after the update, 50% noted a very

high level, and the other 50% a high level, reflecting the practical utility and impact on preparation for professional activity.

Based on these indicators, the following measures were recommended. Firstly, it is necessary to continue the integration of AI into academic disciplines, including subjects related to machine learning, data analysis, robotics, and automation, and to ensure an interdisciplinary combination of skills, such as in logistics, healthcare, and finance. Secondly, the digital infrastructure of universities should be expanded by implementing virtual laboratories, smart classrooms, and Learning Management Systems (LMS) with integrated AI tools, while also ensuring access for students from remote areas. Thirdly, it is essential to enhance faculty competence through regular seminars, workshops, and courses on the use of AI, which will facilitate quality teaching and the application of modern technologies. Fourthly, student assessment should transition from static testing to adaptive AI-based systems, personalised tests, and real-time progress monitoring, allowing for the individualisation of the learning process. Fifthly, programmes must consider ethical standards of AI use, digital security, data protection, and legal aspects, as 60% of faculty and 40% of students expressed concerns regarding ethical issues. Sixthly, it is recommended to intensify collaboration with industry through internships, mentorship, joint research projects, and government partnerships, enabling students to acquire practical skills and universities to obtain current data on market requirements. Finally, it is necessary to implement monitoring of the effectiveness of AI-based programmes and centralised skills databases to track student progress and job readiness, as well as to forecast future needs for AI specialists. All these recommendations are based on factual survey data and align with current technological trends, ensuring an enhancement in the quality of education, the practical preparation of students, and compliance with IR 4.0 requirements, thereby contributing to the formation of competitive professionals in the digital era.

5 DISCUSSION

The use of artificial intelligence in higher education personnel preparation directs the educational process towards enhancing academic success, developing professional competencies, and forming analytical thinking skills, while the application of intelligent platforms ensures more precise support for students in completing complex tasks and reduces time spent on processing materials. Prior to the implementation of the updated programme, only 57% of students used AI in their studies, whereas after integration, this indicator increased to 100%. Furthermore, 70% of students rate the benefit of AI as very high, reflecting a substantial increase in digital literacy. The generalisation of student behavioural indicators attests to growth in the formation of professional competencies in cases where artificial intelligence tools are used as personalised digital platforms for completing academic and research projects (Beisenbi & Kaliyeva, 2018). These results are consistent with the conclusions of Al Najdawi et al. (2024), who found that intelligent systems possess the capability to predict student academic success and enhance the development of educational excellence in universities. Artificial intelligence, acting as an analytical assessment system, supports the improvement of task execution quality and the optimisation of learning trajectories. The similarity of results demonstrated that personalised recommendations and algorithmic prediction of learning difficulties can contribute to the formation of productive models of student educational behaviour. It is recommended to continue the integration of AI into all academic disciplines,

including machine learning, data analysis, robotics, and automation (Amourah et al., 2025; Yermolenko et al., 2024). This ensures an interdisciplinary combination of skills and increases the practical value of education. Simultaneously, the results of the conducted study established a moderate dependence of students on artificial intelligence tools in cases where these tools perform the function of directly solving academic tasks.

An analysis of educational platforms demonstrates the effectiveness of using AI-driven Project-Based Learning and virtual laboratories for personalising learning. Such approaches increase student engagement and promote the development of critical thinking. This observation was consistent with the results of Arce et al. (2025), which showed a tendency for the formation of dependence on intelligent services among students with a reduction in learning autonomy. This means that the effectiveness of artificial intelligence implementation is determined by how balanced the tools are used, as an enhancer of learning activity, rather than as a means of automatic task completion. The improvement in the quality of interaction between faculty and students, observed during the research, aligns with the conclusions of Bali et al. (2022), who established that the use of intelligent technologies creates new communication channels between participants in the educational process and promotes a clearer distribution of responsibility for learning activities. Based on the obtained data, it was found that intelligent tools create conditions for flexible pedagogical support, in which students independently choose the pace and depth of material processing.

The positive impact of artificial intelligence on the efficiency of the digital educational environment, obtained as a result of the study, is consistent with the findings of Chaka (2022), who synthesised the prospects for the implementation of artificial intelligence and robotics in higher education and defined their capacity to modify learning processes. Intelligent technologies can establish new models of digital learning organisation and enhance the technological adaptability of students. The confirmation of the effectiveness of using artificial intelligence platforms for learning analytics is consistent with the conclusions of Chan et al. (2022), who demonstrated the value of intelligent systems in planning and implementing personalised learning trajectories. Students exhibit increased research engagement in cases where intelligent services are used for the automated analysis of large datasets. The impact of intelligent systems on the dynamics of academic motivation, identified during the research, is corroborated by the conclusions of Jia et al. (2021), who demonstrated the effectiveness of an integrated AI-driven teaching and learning environment for increasing student engagement in learning activities. Access to recommender technologies and adaptive algorithms contributes to heightened academic activity and a reduction in class absenteeism. Another element, the transformation of the instructor's role, was identified and confirmed by the correspondence of results with the work of Haq (2025), who showed that the expanding use of technologies and artificial intelligence creates preconditions for revising the pedagogical teaching model and changing the instructor's functions from a knowledge transmitter to a curator of learning processes. Instructors demonstrate an increased readiness to design new types of educational materials and to develop more flexible formats of learning support. However, not all results fully coincided with prior research.

The conducted analysis established a moderate level of student concern regarding data privacy stability when using artificial intelligence. This partially diverged from the conclusions of Humble and Mozelius (2022), who described students as being more focused on the benefits of the technologies than on digital security risks. The identified discrepancy may be explained by students heightened informational awareness of algorithmic risks. Data regarding the enhancement of entrepreneurial and business analytics competencies, identified during the study, align with the conclusions of Khalid (2020), who showed that algorithmic tools and automated systems contribute to the formation of entrepreneurial thinking in the university environment and the development of a start-up-oriented mindset. This implied that artificial intelligence can influence not only the academic sphere but also the formation of students' competitive professional position in the labour market. The obtained results related to the formation of students' scientific research skills are consistent with the conclusions of Kotsis (2025), who identified artificial intelligence as a catalyst for change in the training of science specialists and noted its ability to develop students' scientific autonomy and improve the quality of project work. The identified trends align with the results presented in the study by Leoste et al. (2021), which established that the implementation of artificial intelligence and robotics technologies in higher education intensifies the formation of professional skills, increases research motivation, and orients students towards the practical application of knowledge. The actualisation of digital competency development in instructors confirms the necessity of revising personnel training models for the effective use of artificial intelligence technologies in the educational environment (Seidaliyeva & Smailov, 2025). This is fully consistent with the conclusions of Madu and Musa (2024), where the level of instructor awareness regarding artificial intelligence correlated with their level of digital competency and readiness to apply technologies during educational activities. The experience of respondents who participated in the experiment at the stages of preparation for working with students confirmed that the availability of digital tools did not guarantee an automated increase in the quality of learning without instructors' preparedness to use them. Convergence with the results of the systematic review by Oluwafemi Ayotunde et al. (2023) confirmed that the integration of artificial intelligence into the learning management system ensures an improvement in the quality of studying academic disciplines through personalised tasks, automated feedback, and enhanced self-monitoring capabilities. A similar impact was recorded among university-level students who used artificial intelligence systems to refine individual learning trajectories. Confirmation of the results was also observed in the study by Oyeyemi et al. (2024), which proved that artificial intelligence influences the improvement of students' academic outcomes through mechanisms supporting learning motivation, structuring learning materials, and simulating complex learning situations. The application of intelligent platforms enhances students' capacity for information analysis, decision-making, and reflective activity.

The observed impact of artificial intelligence usage on student psychological well-being aligns with the findings of the research by Velastegui-Hernandez et al. (2023), which established that interaction with artificial intelligence technologies contributes to a reduction in the perception of academic workload and ensures the availability of assistance during the execution of complex academic tasks. The possibility of receiving support through chatbots and learning analytics systems lowers the level of academic anxiety and fostered an increase in learning motivation. Consistency of the results was also noted with the observations of Zhang (2024), which revealed that artificial intelligence systems influence students' thinking style and promote the development of information structuring skills and outcome prediction in

activities. The identified positive changes in students' ability to formulate cause-and-effect relationships and justify decisions taken confirmed the author's position regarding the enhancement of cognitive flexibility under the influence of AI-powered learning platforms. The presented data are consistent with the conclusions of Vacarelu (2023), which emphasise the necessity of considering legal and ethical aspects in the process of integrating artificial intelligence technologies into university-level training. The accessibility of artificial intelligence tools creates pedagogical advantages only in cases of correct and methodologically sound application, without substituting students' intellectual activity with automated solutions.

The analysis of the obtained data confirmed an indirect correspondence with the conclusions of Steinbauer et al. (2021), who determined that the formation of readiness to use artificial intelligence begins to manifest at the level of school education, which created prerequisites for the subsequent successful integration of these technologies in higher education. Respondents of the study who already have experience interacting with intelligent educational tools at the stage of prior education demonstrate a higher level of adaptability to the digital educational environment. Expanding student access to artificial intelligence during professional training aligns with the assertions of Wong et al. (2020), according to which the use of artificial intelligence technologies enhances learning autonomy and created new models of individualised learning. The increase in the level of self-management and self-discipline among students, recorded in the conducted study, confirmed the effectiveness of these mechanisms. Additional consistency is observed with the results of Su et al. (2023), which demonstrated that the effectiveness of implementing artificial intelligence in the educational process depends on the extent to which learning tools enhance student creativity, engagement in work, and ability to create independent content. Learning involving digital assistants stimulates the growth of students' intellectual initiative and the use of various strategies for processing learning material (Aizstrauta & Ginters, 2013; Ginters & Aizstrauta, 2018).

A general analysis demonstrated that the implementation of artificial intelligence in university-level personnel training directed the educational process towards improving academic results, psychological resilience, autonomy, and cognitive flexibility of students. The improvement in the quality of professional training was ensured under conditions of pedagogically balanced use of artificial intelligence tools, capable of complementing students' intellectual activity and supporting the development of critical and analytical thinking.

6 CONCLUSION

Content analysis of AI integration in higher education showed that curricula were adapted for project-based and interdisciplinary learning using AI simulations, generative programming, and digital twins; digital infrastructure was equipped with smart classrooms, virtual laboratories, and LMS with AI; assessment systems became adaptive and personalised, including dynamic competency maps and real-time progress monitoring; teaching staff underwent retraining for working with AI; partnerships with business and predictive skill models were introduced; ethical and structural standards were integrated,

which ensured the development of digital and AI literacy and student readiness for Industry 4.0 conditions.

The comparison of baseline and follow-up survey results showed that the updated AI-integrated curriculum contributed to three main outcomes. First, AI tools became more consistently embedded in students' learning practices after curriculum implementation. Second, students, instructors, and graduates demonstrated stronger readiness to apply AI in educational and professional contexts, indicating that AI integration supported the development of practically oriented professional competencies. Third, the findings revealed a higher awareness of ethical and legal issues associated with AI use, particularly among instructors, which confirms the need to combine technological innovation with responsible governance, data protection, and clear institutional guidelines.

Recommendations envisaged the continued integration of AI into academic disciplines with an interdisciplinary combination of skills, expansion of university digital infrastructure, enhancement of teaching staff competence through seminars and courses, a transition to adaptive assessment systems, consideration of ethical standards and digital security, intensification of collaboration with industry through internships and joint projects, as well as the implementation of programme effectiveness monitoring and centralised skill databases, which allowed for improving education quality, practical student preparation, and alignment with IR 4.0 requirements. The study has several limitations. First, the empirical data were collected at a single university, which limits the generalisability of the findings to other institutional and disciplinary contexts. Second, the analysis relied on self-reported survey responses; therefore, the results may be affected by subjective perception and social desirability bias. Third, the study did not include objective competency testing or independent assessment of students' AI-related skills, which limits the possibility of directly measuring learning outcomes. Fourth, the duration and intensity of the updated curriculum implementation were not specified in sufficient detail, which should be addressed in future studies. Finally, the research did not involve long-term tracking of graduates' career trajectories; therefore, the findings should be interpreted as evidence of perceived readiness, educational experience, and retrospective graduate evaluation rather than long-term professional transformation. Future research should include multi-institutional samples, objective competency measures, a clearly defined implementation period, and longitudinal follow-up of graduates.

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