



ARTIFICIAL INTELLIGENCE IN VOCATIONAL EDUCATION: STRATEGIES FOR DIGITAL INTEGRATION AND PERSONALIZED LEARNING

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Abstract

Relevance. The digital transformation of society significantly alters the requirements for the content and organization of vocational education, necessitating the integration of artificial intelligence (AI) into educational processes. In the context of the digital economy, Industry 4.0, and Ukraine's European integration aspirations, vocational education must ensure the training of specialists capable of working within automated systems, big data environments, and digital ecosystems. The experience of the European Union, as documented in strategic digital education frameworks, demonstrates that AI is not merely a technological tool but a driver of systemic changes encompassing pedagogy, management, curriculum content, and assessment of learning outcomes. Therefore, investigating the implementation of AI in vocational education is both timely and socially significant, particularly in the context of modernizing Ukraine's educational system.

Purpose. The aim of the article is to substantiate the role of artificial intelligence as a strategic resource for the development of vocational education and to identify key directions for its integration into the national educational system in accordance with European standards.

Methods. The study employs analysis of EU and Ukrainian regulatory documents in the field of digital education; systemic and structural-functional analysis to determine the components of vocational education digitalization; comparative analysis of European and Ukrainian experience in AI integration; synthesis of scientific approaches to the formation of future competencies; and forecasting methods to identify the prospects for vocational education development based on analytical platforms and big data.

Results. It has been substantiated that the use of AI facilitates the transition from mass education to personalized educational trajectories, the development of adaptive learning systems, digital mentors, educational analytics, and simulation platforms. Key components of vocational education digitalization have been identified: analytical platforms for labor market needs forecasting, adaptive learning management systems (LMS), digital competency databases, virtual teacher training centers, and academic integrity services. The main barriers to AI implementation in Ukraine have been revealed, including infrastructural, personnel, regulatory, and ethical challenges. The study demonstrates the necessity of transforming the role of the educator into that of a facilitator, analyst, and digital mentor.

Conclusions. Artificial intelligence emerges not merely as an auxiliary technology but as a key factor in the modernization of vocational education. Its integration promotes the development of future competencies, digital literacy, and the harmonization of Ukrainian education with the European educational space. Further development of vocational education requires the creation of a national digitalization strategy, investment in infrastructure, and systematic professional development of teaching staff.

Keywords: *artificial intelligence (AI), vocational education, digital integration, personalization, digital transformation.*

Introduction. The digital transformation of society is fundamentally changing the structure of the economy, social relations, and requirements for professional training. Today, vocational education and training (VET) emerges not merely as a tool for knowledge transfer, but as a complex socio-technological system that shapes competencies for life and work in a world of artificial intelligence, big data, and automated processes. In the context of the dynamic development of information technologies, the issue of integrating artificial intelligence (AI) into the sphere of vocational education acquires special relevance. This is not only a technological innovation but also a strategic factor in the formation of competitive human capital capable of adapting to rapid changes and creating new data-driven solutions. Artificial intelligence is increasingly viewed as a key component of the Fourth Industrial Revolution, necessitating a rethinking of educational goals, methods, and content.

Modern vocational educational systems are shifting from a mass learning model to a personalized development model, where algorithms capable of analyzing the behavior, interests, and educational outcomes of learners play a leading role. Such changes require a new pedagogical paradigm that combines humanistic values with digital (intelligent) technologies (Hurzhii et al., 2025b).

The implementation of intelligent technologies in the educational space is directly linked to the strategic priorities of the European Union. The Digital Education Action Plan (2021–2027) defines the development of the digital readiness of educational systems as a primary condition for competitiveness (European Commission, 2025b). Within this strategy, AI is viewed as a pedagogical resource that facilitates learner-centered, ethical, and competency-based learning.

The EU emphasizes the necessity of ensuring a balance between technological innovations and humanistic values, focusing attention on data security and algorithmic transparency. Particular emphasis is placed on the formation of the digital competence of educators.

The goal of the European Education Area (EEA) is to create a common educational space by 2025. One of the key priorities of the program is the development of artificial intelligence to support individualized learning and improve the quality of vocational education. AI acts as an instrument for the European integration of vocational education, as it ensures common standards of digital literacy and facilitates the creation of transnational educational platforms (European Commission, 2025a).

For Ukraine, the integration of AI into vocational education is of strategic importance. It opens opportunities for harmonizing the national education system with European standards and increases the competitiveness of Ukrainian specialists in the global labor market. AI becomes a guide to European standards of VET quality, academic freedom, and open science (Radkevych et al., 2025).

Thus, modern vocational education must reorient itself from a reproductive learning model to a research-analytical one, based on the use of data and flexible learning algorithms. It is the integration of AI that opens opportunities for forming individual educational trajectories, developing critical thinking, creativity, and digital culture, which are becoming decisive for professional success in the digital economy (Pryhodiі & Radkevych, 2025; Hurzhii et al., 2024a).

The aim of the article is to substantiate the role of artificial intelligence as a strategic resource for the development of vocational education and to determine the key directions of its integration into the domestic educational system in accordance with European standards.

Research methods: analysis of regulatory and legal documents of the EU and Ukraine in the field of digital education; systemic and structural-functional analysis to determine the components of the intellectualization of vocational education; comparative analysis of European and Ukrainian experience in integrating artificial intelligence; generalization of scientific approaches to the formation of future competencies; forecasting methods to determine the prospects for the development of vocational education based on analytical platforms and big data.

Results and Discussion. Description of technological solutions and learning models. Artificial intelligence is ceasing to be merely a tool for automating routine processes or a technical auxiliary technology. It is transforming into a powerful factor of systemic changes in the sphere of vocational education, transforming methods of organizing the educational process, management, quality monitoring, and assessment of results. AI acts as a kind of catalyst for the intellectual evolution of the vocational educational space, creating conditions for deeper personalization of learning, the development of adaptive strategies, and the implementation of analytical approaches to making pedagogical decisions (Radkevych et al., 2025).

In modern educational practice, systems based on artificial intelligence are increasingly used to analyze large volumes of educational and socio-economic data. They are capable of identifying hidden patterns in learning achievements, predicting educational risks, and determining the development potential of each learner. This allows not only for the optimization of learning processes but also for the transition to a new paradigm—a self-learning vocational education, that is, one capable of adapting to environmental changes through the constant updating of content and methods (Pryhodi & Radkevych, 2025).

The application of intelligent algorithms ensures the possibility of forecasting labor market development trends. Educational analytical platforms using AI can collect, systematize, and analyze information on the demand for specialists, changes in employment structures, and technological innovations in production in real time. This creates a basis for the prompt adjustment of curricula, updating of VET standards, and ensuring the compliance of specialist training with the needs of the economy.

Thus, artificial intelligence becomes a strategic resource for planning personnel policy in vocational education, facilitating more effective management of human potential. Its use allows for predicting not only quantitative but also qualitative changes in the labor market, and determining key competencies that will be of decisive importance in the near future. Based on such forecasts, it is necessary to form new educational trajectories oriented toward the development of soft skills, creativity, entrepreneurship, and analytical thinking (Pryhodi et al., 2023).

At the same time, the role of artificial intelligence is not limited to the sphere of analytics or planning. It changes the very structure of the educational process—from lesson planning to the formation of individual learning routes, automatic assessment, support for pedagogical decisions, and the creation of adaptive learning environments. The use of intelligent technologies facilitates the transition from a centralized to a flexible, dynamic educational system capable of responding to the challenges of the time. In general, artificial intelligence acts not only as a tool for increasing learning efficiency but also as a factor in updating the philosophy of vocational education itself (Hurzhii et al., 2025a).

One of the important advantages of artificial intelligence is its ability to create individualized, flexible, and dynamic learning environments. Adaptive learning systems, built on machine learning algorithms, automatically analyze a wide range of parameters: the level of prior preparation, the pace of material assimilation, the cognitive and psychological characteristics of the VET learner, as well as their learning preferences. Such an approach allows for the formation of a personal educational route that meets the real needs, abilities, and educational goals of each learner.

Intelligent learning systems ensure the possibility of continuous monitoring of learning activity, identification of individual difficulties, and prompt adjustment of the educational process. AI is capable of identifying knowledge gaps in real time, offering additional explanations, educational videos, or practical tasks, as well as regulating the complexity of content depending on the success of the VET learner. Such an approach turns the learning process into an interactive dialogue between the learner and the education system.

The use of adaptive technologies changes not only the form but also the philosophy of learning. Education becomes flexible, individualized, and oriented toward human needs. The learner gains the opportunity to study at their own pace, choosing a convenient format. Such a level of personalization contributes to increasing internal motivation, and developing self-regulation and autonomy in learning (Hurzhii et al., 2023a).

Adaptive learning opens new opportunities for educators, who receive tools for deeper educational analytics. The artificial intelligence system provides detailed reports on the dynamics of knowledge acquisition. This strengthens the analytical component of pedagogical activity and

allows for making grounded decisions regarding the content, methods, and forms of vocational training.

Adaptive learning technologies are of great importance for ensuring the inclusivity of the vocational educational process. AI is capable of adapting educational content for VET learners with special needs. Thanks to this, every learner receives equal access to quality education (Hurzhii et al., 2024b).

The application of adaptive technologies facilitates the realization of the "lifelong learning" concept. Thanks to artificial intelligence, the educational process goes beyond the classroom—it can continue at any time and in any place. Such a format creates conditions for forming a culture of self-learning and increases the competitiveness of specialists (Pryhodii, 1999).

Virtual assistants, chatbots, decision support systems, and personal tutors are already becoming integral participants in the educational process today. They play the role of digital mentors capable of interacting with VET learners in a dialogue format, explaining complex concepts, offering examples, or providing instant feedback. Such tools form a new type of vocational educational environment, where learning continues at any moment and in any place.

Modern artificial intelligence systems working in the format of educational chatbots use natural language processing (NLP). This creates the effect of a "live dialogue," which is especially valuable in the process of self-learning. The learner can ask questions and receive explanations without waiting for the teacher's response. Such interactivity increases motivation to learn and simultaneously relieves educators from performing routine consultative tasks.

Digital mentors have another important advantage—the individualization of pedagogical interaction. Based on data about the user's learning activity, artificial intelligence can adapt the communication style and select the appropriate level of task complexity. Thanks to this, an effect of personal accompaniment is created, simulating the work of a tutor or mentor.

Special attention should be paid to simulation models—special software environments that allow for modeling real professional situations. Thanks to virtual laboratories, simulators, and digital "sandboxes," VET learners can practice professional actions without risk to themselves or equipment. This is especially relevant for technical, medical, transport, aviation, and military specialties.

The use of virtual simulators contributes to the development of practical skills and critical thinking, as the learner not only performs tasks but also analyzes the consequences of their actions.

Intelligent systems based on AI can record errors, explain the reasons for failures, and offer ways for improvement. This creates a "learning by doing" effect. Simulation technologies also ensure a safe environment for experimentation (Hurzhii et al., 2023b).

Thus, the integration of digital mentors, simulation platforms, and learning bots into the vocational educational process creates conditions for the transition to intelligent learning, where human and machine interact in a partnership format.

Artificial intelligence not only changes technological learning tools but also significantly influences the content and goals of education. The modern system of vocational education must form a complex of future competencies that ensure the individual's ability to act successfully in conditions of rapid changes (Pryhodii, 2011). Critical thinking, creativity, analytical abilities, digital culture, big data skills, and the ability to collaborate are becoming key competencies of the future (Pryhodii et al., 2019).

Modern intelligent learning systems facilitate the transition from a traditional model of knowledge assimilation to a model of knowledge creation. Learners become not passive consumers of information, but active researchers, analysts, and developers of innovative solutions. Artificial intelligence helps create learning environments in which theory is integrated with practice, and learning tasks imitate real professional situations (Hurzhii et al., 2024a).

The formation of future competencies is impossible without the development of digital culture. In the context of the rapid spread of artificial intelligence, ethical aspects acquire special weight: respect for privacy, copyright, and academic integrity. Vocational education must not only teach how to use technologies but also form ethical and social responsibility in learners for the consequences of their application.

It is also important that the development of future competencies implies the integration of interdisciplinary approaches. AI helps combine knowledge from different fields—technical, humanitarian, natural sciences—within single projects or cases. This forms a systemic vision and the ability to analyze complex problems in learners.

In summary, artificial intelligence acts as a catalyst for the transition of vocational education to a model of "human-centric intelligence," where the main result of learning is not the volume of knowledge, but the capacity for its updating, analysis, and creative use (Radkevych et al., 2025).

Problems and limitations of AI technologies. The implementation of artificial intelligence technologies in the educational sphere of Ukraine is accompanied by a number of infrastructural and regulatory challenges (Table 1) (Hurzhii et al., 2025b).

Table 1

Infrastructural and Regulatory Challenges of AI Implementation in Education

Challenges	Characteristic
Infrastructural	Consists of the insufficient level of digitalization of educational institutions. A significant part of educational institutions is not equipped with modern computer hardware, high-quality Internet access, and secure data storage systems. AI implementation requires powerful computing resources, cloud services, and professional technical support, which are currently available only to select leading universities.
Staffing (Personnel)	Many educators lack basic knowledge regarding the principles of how AI algorithms work. The majority of pedagogical staff require professional development and mastery of digital tools. It is also necessary to form a new category of specialists—educator-analysts and digital tutors who combine pedagogical, informational, and research competencies.
Regulatory (Normative-legal)	Relates to the absence of clear state standards, recommendations, and control mechanisms for the use of intelligent technologies. There is a lack of a coherent concept of digital education and unified approaches to AI integration. The issue of educational data protection also requires regulation. Without an appropriate regulatory framework, the application of AI creates risks for academic integrity and confidentiality.
Ethical	Requires educational institutions to ensure the ethical use of artificial intelligence, preventing algorithmic bias, discrimination, or manipulation of results. It is important to form a culture of responsible AI use among educators and students.

Created by the author based on the analysis of sources presented in the article

Overcoming these barriers requires the development of a unified national strategy for the digitalization of vocational education.

The role of the educator. Successful integration of artificial intelligence requires a change in the role of the educator. In the AI era, the teacher ceases to be the sole source of knowledge. Instead, the educator transforms into a facilitator, analyst, curator, and mentor of the learning process who guides the learner, helping to comprehend information and evaluate it critically.

The role of the educator in the digital vocational educational environment can be defined as a mediator between human and technology. They do not simply use intelligent tools but teach learners to apply them consciously and ethically. One of the most important tasks is the development of critical thinking, the ability to distinguish reliable information from manipulative information, evaluate data sources, and understand the

algorithmic logic of decisions. The educator becomes a mentor in the sphere of digital literacy.

At the same time, the psychological profile of the educator also changes. For effective work with artificial intelligence technologies, it is necessary to develop not only digital skills but also emotional intelligence, communicative culture, and flexibility of thinking.

No less important is the issue of ethical upbringing in the context of AI use. The teacher must form an awareness in learners of the consequences of its application; this concerns the culture of observing academic integrity and respect for intellectual property.

Another component is supporting the motivation and psychological comfort of learners. The task of the educator consists of creating a learning system in which technologies become not a barrier, but a means of social interaction (Radkevych et al., 2025).

AI System Model in Education. The intellectualization of education implies the creation of a holistic national digital system of vocational education that will function as an open ecosystem. Its goal is to ensure the continuity of learning,

flexibility of educational trajectories, and effective monitoring of the quality of specialist training. Structurally, it may include several complementary components (Table 2) (Pryhodii et al., 2023).

Table 2

Components of the Intellectualization of Vocational Education

Component	Characteristic
Analytical platforms for forecasting educational needs	Systems using AI and big data to model labor market development trends and identify promising professions and competencies.
Adaptive Learning Management Systems (LMS)	Intelligent educational platforms capable of automatically adjusting the learning process to the level, pace, and learning style of a specific learner.
Digital competence databases	Open electronic resources storing descriptions of professional qualifications and learning outcomes. They ensure transparency in the recognition of qualifications at national and European levels.
Virtual teacher training centers	Innovative learning environments for developing the digital literacy and pedagogical mastery of teachers regarding AI implementation.
Integrated academic integrity verification services	Software solutions based on AI that help prevent plagiarism and automatically check the originality of texts.

Developed by the author based on the generalization of sources presented in the article

In perspective, the creation of a national vocational educational system based on AI should ensure the sustainability of reforms and the improvement of its quality at all levels.

Conclusions. Artificial intelligence is a fundamental factor in the modernization of vocational education. Its integration opens the way to a new quality of professional training built on individualization, analytics, and forecasting. Ukraine has all the prerequisites for forming its own model of digital vocational education, aligned with European standards. It is important that this process be based on scientifically grounded approaches, pedagogical ethics, and state support. This is precisely how artificial intelligence will become not a threat, but an instrument of sustainable

development, social mobility, and professional self-realization of citizens.

Prospects for further research are related to the empirical verification of the effectiveness of artificial intelligence systems in vocational education, particularly adaptive learning platforms, digital tutors, and educational analytics, as well as the development of methodologies for forming the digital and analytical competencies of educators. Separate scientific attention is required for the ethical and legal aspects of using artificial intelligence, issues of data protection, algorithmic transparency, and academic integrity, as well as comparative studies of European and international experience in integrating AI into educational systems.

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ШТУЧНИЙ ІНТЕЛЕКТ У ПРОФЕСІЙНІЙ ОСВІТІ: СТРАТЕГІЯ ЦИФРОВОЇ ІНТЕГРАЦІЇ ТА ІНДИВІДУАЛІЗАЦІЇ НАВЧАННЯ

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Реферат:

Актуальність. Цифрова трансформація суспільства істотно змінює вимоги до змісту та організації професійної освіти, що зумовлює необхідність інтеграції штучного інтелекту в освітні процеси. В умовах розвитку цифрової економіки, індустрії 4.0 та євроінтеграційних прагнень України професійна освіта має забезпечити підготовку фахівців, здатних працювати в умовах автоматизованих систем, великих даних і цифрових середовищ. Досвід Європейського Союзу, зафіксований у стратегічних документах цифрової освіти, демонструє, що штучний інтелект є не просто технологічним інструментом, а чинником системних змін, які охоплюють педагогіку, управління, зміст навчання та оцінювання результатів. Тому дослідження проблематики впровадження штучного інтелекту в професійну освіту є своєчасним і соціально значущим, особливо в контексті модернізації освітньої системи України.

Метою статті є обґрунтування ролі штучного інтелекту як стратегічного ресурсу розвитку професійної освіти та визначення ключових напрямів його інтеграції у вітчизняну освітню систему відповідно до європейських стандартів.

Методи: аналіз нормативно-правових документів ЄС та України у сфері цифрової освіти; системний і структурно-функціональний аналіз для визначення компонентів інтелектуалізації професійної освіти; порівняльний аналіз європейського й українського досвіду інтеграції штучного інтелекту; узагальнення наукових підходів до формування компетентностей майбутнього; методи прогнозування для визначення перспектив розвитку професійної освіти на основі аналітичних платформ і великих даних.

Результати: обґрунтовано, що використання штучного інтелекту забезпечує перехід від масового навчання до персоналізованих освітніх траєкторій, розвитку адаптивних систем навчання, цифрових

наставників, освітньої аналітики та симуляційних платформ; визначено ключові компоненти інтелектуалізації професійної освіти (аналітичні платформи прогнозування потреб ринку праці, адаптивні LMS, цифрові бази компетентностей, віртуальні центри підготовки педагогів та сервіси академічної доброчесності); виявлено основні бар'єри впровадження штучного інтелекту в Україні (інфраструктурні, кадрові, нормативні, етичні); доведено необхідність трансформації ролі педагога у фасилітатора, аналітика й цифрового наставника.

Висновки: штучний інтелект постає не як допоміжна технологія, а як ключовий фактор модернізації професійної освіти; його інтеграція сприяє формуванню компетентностей майбутнього, розвитку цифрової культури та гармонізації української освіти з європейським простором; подальший розвиток професійної освіти потребує створення національної стратегії цифровізації, інвестицій в інфраструктуру та системної підготовки педагогічних кадрів.

Ключові слова: *штучний інтелект (ШІ), професійна освіта, цифрова інтеграція, індивідуалізація, цифрова трансформація.*

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