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DIGITAL PLATFORM AS A MEANS OF VOCATIONAL TRAINING AND COMMUNICATION FOR FUTURE SKILLED WORKERS IN THE MECHANICAL ENGINEERING INDUSTRY

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Abstract

The relevance of this research is driven by new demands on the vocational education system, particularly in the mechanical engineering sector, amid the digital transformation of the economy and the emergence of Industry 4.0. Given the rapid pace of technological advancement, there is an urgent need to integrate digital educational platforms into the training of skilled workers. Digital platforms can provide access to modern educational resources, personalized learning pathways, and simulations of production processes. This enables vocational training to better align with the needs of a high-tech labor market, making it more flexible, interactive, and effective.

Objective: To develop and justify methodological principles for creating a digital educational platform for the vocational training of future skilled workers in the mechanical engineering industry, taking into account current trends in digitalization, industry-specific features, and learners' educational needs.

Methods: Theoretical analysis of scientific sources on digital platforms, vocational education, and Industry 4.0 technologies; modeling of the functional structure of the educational platform with consideration of its goal-oriented, content-based, methodological, and communicative components; comparative analysis of existing digital platforms based on criteria such as functionality, user interaction, and adaptability to educational needs; expert evaluation of pedagogical and technical solutions for the platform; design and testing of a website that includes interactive learning modules on CAD, CNC, and robotics, as well as analytical tools for progress monitoring.

Results: The study summarizes the classification of digital platforms by functionality and user interaction; formulates methodological principles for the development of educational platforms in the mechanical engineering sector (personalization, accessibility, interactivity, compliance with industry standards); develops a prototype of a digital platform for training future specialists, including adaptive learning, video content, simulations, analytics dashboards, and integration with LMS and social networks; substantiates the feasibility of incorporating digital technologies such as AI, AR/VR, IoT, and blockchain into the platform structure; justifies the need to enhance teachers' digital competence for the effective implementation of platform-based learning.

Conclusions: As a result of the conducted study, it was demonstrated that the digital platform is a key tool for modernizing the vocational education system in the context of digital transformation, particularly for the machine-building industry. It enables the integration of individualized learning with the real demands of the labor market, creating a flexible educational environment that fosters the development of professional competencies in future skilled workers of the machine-building sector. The developed methodological model of the platform, which includes target, content, methodological, and communicative components, ensures the integration of the educational process with modern production technologies and labor market requirements. The implementation of the digital platform concept requires an interdisciplinary approach, technical support, and regulatory legal framework; however, it holds significant potential for the modernization of vocational education. The effectiveness of the digital platform depends on its ability to integrate modern technologies, support educators, provide feedback, and meet professional training standards.

Keywords: digital platform, vocational training, communication, skilled workers, engineering industry

Introduction. The digital transformation of society and the economy necessitates the modernization of vocational education. In the mechanical engineering sector—one of the key industries for implementing innovative solutions—there is an urgent need to integrate digital tools into the training system for future professionals. One such tool is a digital platform—a comprehensive information and educational environment that integrates content, methodology, and communication channels into a single ecosystem.

Sources. In today's digitized society, the issue of implementing digital technologies into vocational education has become especially relevant. The use of information and communication technologies (ICT) in the training of future skilled workers is studied in the context of developing digital competence, modernizing the educational process, using e-learning platforms, virtual laboratories, simulators, and distance learning formats in the research works of V. A. Kruchek, O. B. Koshuk, S. H. Kravets, N. V. Kolisnyk, L. A. Maiboroda, I. I. Holub, N. Yu. Samoylenko, and H. V. Odnoroh.

Theoretical and methodological principles of digitalization in vocational (technical) education, as well as practical aspects of implementing digital tools in the training of skilled workers, are explored in the works of O. Brechko, I. I. Almasii, M. A. Ryaguzova, T. H. Dibrova, and T. V. Pyatnychuk, among others. These studies emphasize the need to improve the digital literacy of educators, enhance the digital learning environment, and adapt educational programs to the challenges of digital transformation, including the development of blended and distance learning. Researchers such as M. A. Pryhodiy, A. M. Hurzhii, Yu. Danka, V. O. Radkevych, Yu. H. Nosenko, R. M. Shevchuk, T. O. Halich, and N. M. Chernyavets analyze the integration of digital technologies in vocational training based on labor market needs, sector-specific education, and international experience. This scientific foundation confirms the importance of digital transformation as a key factor in improving the quality of vocational training for future skilled workers.

Purpose of the Article. The purpose of the article is to develop and justify methodological principles for creating a digital educational platform for training future skilled workers in the mechanical engineering industry, taking into account current trends in digitalization, industry-specific characteristics, and the educational needs of learners.

Methods. This study employs several research methods, including:

- Theoretical analysis of scholarly sources on digital platforms, vocational education, and Industry 4.0 technologies;
- Modeling the functional structure of the educational platform with attention to its target, content, methodological, and communicative components;
- Comparative analysis of existing digital platforms based on functionality, user interaction, and adaptability to educational needs;
- Expert evaluation of pedagogical and technical solutions for the platform;
- Design and pilot testing of a website with interactive learning modules on CAD, CNC, robotics, and analytical tools for monitoring learner progress.

Results and Discussion. A digital platform in the context of vocational education is viewed as an integrated information-educational environment that combines learning resources, digital services, and communication channels. Its structure includes the following components:

1. Target component – focused on ensuring the competitiveness of future workers;
2. Content component – includes training modules, video content, infographics, simulations, and digital laboratories;
3. Methodological component – adapts content to the learner's level, shaping individual learning trajectories;
4. Communicative component – includes forums, chats, feedback systems, and integration with social networks (Gurzhiy, Radkevych, & Pryhodiy, 2023).

According to O. Brechko's approach, digital platforms are classified based on functionality and user interaction. Educational platforms like Coursera, Udemy, and Khan Academy are primarily self-learning oriented. However, in the context of mechanical engineering training, platforms must be

adapted to industrial conditions, including integration with simulators, CNC systems, and virtual labs (Brechko, 2020).

Table 1

CLASSIFICATION OF DIGITAL PLATFORMS BY FUNCTIONALITY AND USER INTERACTION

№	Type of Platform	Functionality and Focus	User Interaction	Example of Platform
1	Marketplaces	Connect buyers and sellers, facilitate exchange operations	Buying and selling	Amazon, Alibaba, eBay
2	Sharing platforms (peer-to-peer)	Renting or using platform resources (cars, apartments, tools)	Service provision, resource and service exchange	Uber, Airbnb, Upwork, Zipcar Couchsurfing TaskRabbit
3	Network platforms and messengers	Professional communication, software development, or data exchange	Personal or business interaction, community building, collaboration	Facebook, LinkedIn, Instagram, GitHub, Reddit, Telegram
4	Cloud platforms	Provide access to computing resources, infrastructure, and services via the Internet	Through private access	Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform
5	Financial and payment platforms	Enable financial transactions, money transfers, and financial management	Via digital wallets or online banking	PayPal, Stripe, Squar, Trustee
6	Entertainment and media platforms	Provide access to entertainment content, multimedia materials, streaming services, etc.	Through subscription services	Netflix, Spotify, YouTube
7	Crowdfunding and crowdsourcing platforms	Allow raising funds for projects, ideas, or products through contributions from the public	Project posting and joint funding	Kickstarter, Indiegogo, GoFundMe
8.	Educational and learning platforms	Provide access to learning materials, courses, training, and other educational resources	Self-learning	Coursera, Udemy, Khan Academy, GoIT
9.	Medical platforms	Assist with medical consultations, diagnostics, treatment, and other medical services online	Interactive medical services	Teladoc Health, Zocdoc, Babylon Health, Amwell
10.	Blockchain-based platforms	Develop infrastructure for smart contracts, decentralized applications, and secure, fast digital asset exchanges	Specialized interfaces or apps, creation of smart contracts	Etheteum, Solana, Hyperledger, Poligon. Repple, BNB

The primary role of digital platforms today is to facilitate convenience, accessibility, and speed of service delivery, especially in education. Hence, their ongoing development and enhancement through the implementation of new technologies and functions is natural. For example, artificial intelligence is used to enhance user experience and personalize recommendations through tools like voice assistants (Google Assistant, Siri) or ChatGPT.

Some platforms incorporate augmented reality (AR) and virtual reality (VR) to provide immersive user experiences, such as virtual clothing try-ons or AR museum tours. Financial and commercial platforms apply blockchain to secure transactions and build decentralized data management systems. The functionality of digital platforms increasingly relies on the integration of IoT solutions, enabling connectivity between devices and sensors through smart technologies, like mobile apps for home automation (Brechko, 2020).

According to Ukrainian scholar M. Pryhodiy, digital platforms play a critical role in improving, automating, and personalizing the assessment of vocational education quality. These platforms offer tools such as Learning Management Systems (LMS), AI-based analytics, and virtual simulations to support evaluation processes. They enable real-time monitoring by collecting, analyzing, and visualizing learner data, allowing educators to adjust teaching strategies accordingly. Dashboards integrated into platforms like Moodle, Blackboard, and Coursera provide insights into learner engagement, course completion, and performance trends (Pryhodii, 2023).

Key Methodological Principles. Key methodological principles for developing digital platforms for training skilled workers in mechanical engineering include:

- Relevance of learning activities that are subject-specific, creative, and learner-centered;
- Goal-setting based on qualification standards and sector-specific digitalization needs, considering users' technical and personal characteristics;
- Development of original dynamic content with an intuitive interface and unified design, optionally excluding specific functional modules like calendars or forums;
- Application of digital technologies based on systemic, informational, and technological approaches, as well as didactic principles of scientific validity and clarity. This includes principles of informatization, open education, multimedia, and personal data protection;
- Orientation towards learners' cognitive activity, ensuring purposeful learning outcomes both in product form and in personal development for lifelong learning;
- Selection of digital technology implementation methods depending on educational goals related to training future mechanical engineering workers (Kruchek et al., 2020).

Teachers' digital competencies are vital for effectively integrating Industry 4.0 innovations, blended learning, intelligent production systems, and digital platforms into the learning process. This approach supports student-centered learning tailored to individual needs and prepares learners for the evolving demands of the profession, especially in mechanical engineering.

Modern mechanical engineering increasingly employs advanced digital technologies like automation, robotics, and 3D printing. Skilled workers must possess relevant knowledge and abilities to work with these technologies. There is a growing demand for professionals who can adapt quickly to new labor market requirements. Digital platforms offer fast access to up-to-date learning materials and interactive simulators (Korchenyuk, 2024).

The industry is constantly evolving, and the use of digital platforms allows educational programs to adapt to modern technological standards. Such platforms strengthen the connection between learning and industrial processes through industrial simulators and virtual labs.

Mechanical engineering heavily depends on advanced technologies such as CAD (Computer-Aided Design), CNC (Computer Numerical Control), robotics, and automation. These technologies are integral to modern production processes and require skilled workers proficient in digital tools (Svistunov, 2020).

As the sector undergoes digital transformation, the role of educators becomes more complex. They must not only understand and teach the technical aspects of Industry 4.0 technologies but also guide students in applying these technologies in real-life settings. Staying ahead in this dynamic field requires continuous professional development and a commitment to lifelong learning.

Industry 4.0 technologies like IoT enable machine-to-machine communication, optimizing processes and reducing downtime. AI facilitates predictive maintenance, improving efficiency by servicing machines before failures occur. Robotics is revolutionizing manufacturing by automating repetitive tasks, increasing precision, and improving worker safety.

Digital competence is increasingly essential in all production sectors, including mechanical engineering. Educators proficient in digital technologies can continuously update their knowledge, access a wide array of resources, and collaborate with other educators and industry professionals. This promotes lifelong learning and provides a foundation for professional development. In mechanical engineering, where technologies evolve rapidly, staying current is a key requirement for educators to ensure the high-quality preparation of future skilled workers (Section 3. Digitalization and Ecologization of Vocational Education for Accelerating Post-War Recovery of Ukraine, 2024).

The platform is developed based on principles of openness, adaptability, accessibility, and compliance with industry requirements. It

integrates didactic concepts, information approaches, gamification, and analytics to monitor the learning process ((Pryhodii, 2024).

Digital communication tools are a foundational component of the platform's interactive educational environment. According to communication types, they include:

Digital communication tools used during the platform development constitute a fundamental component of the interactive educational environment. According to the types of communication, the following are distinguished:

- Horizontal communication — peer-to-peer interaction (between students, between teachers), which promotes collaboration, experience exchange, and team-based learning;
- Vertical communication — hierarchical interaction (teacher–student, administration–teacher), which supports pedagogical and managerial processes;
- External communication — interaction with external stakeholders (employers, industrial partners, professional associations), which enhances the practical orientation of education and ensures compliance with labor market demands (Formanova, 2020; Nosenko, Nosenko, & Shevchuk, 2023; Cherniavets & Almashii, 2019).

Within the scope of the study, the staff of the Department of Digital Educational Resources at the Institute of Vocational Education of the NAPS of Ukraine developed a website for training future workers in the mechanical engineering industry (see Fig. 1). The platform has the following features: an adaptive learning system; modules for automated design (CAD), robotics, CNC; a progress monitoring dashboard for learners; and the capability to integrate with e-Learning analytics.

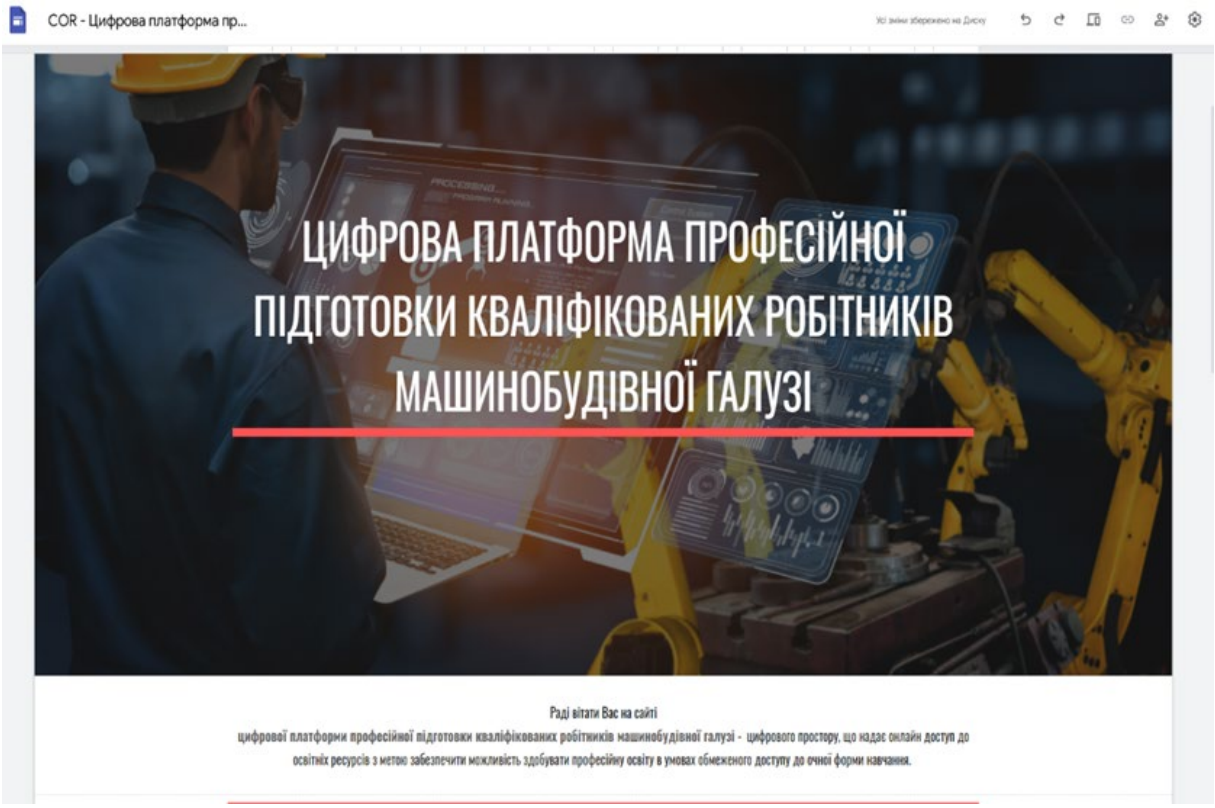

Figure 1. An example of a website for training future workers in the machine-building industry, developed by the Institute of Vocational Education of the National Academy of Sciences of Ukraine

In addition, the methodological principles for developing a digital platform for the professional training of qualified workers in the mechanical engineering industry should include:

- the actualization of subject-specific, creative in nature, and personality-oriented in content educational and professional activities of learners;
- the purpose of developing the digital platform, which is determined considering the content of qualification characteristics and the specifics of the digitalization of education for future qualified workers in the mechanical

engineering industry, as well as the personal needs and technical-technological capabilities of access to and use of digital technologies by learners and vocational education instructors;

- all sections and pages are designed in a uniform style (template), with exceptions allowed only for certain functional blocks (for example: calendar/schedule, forum, etc.);

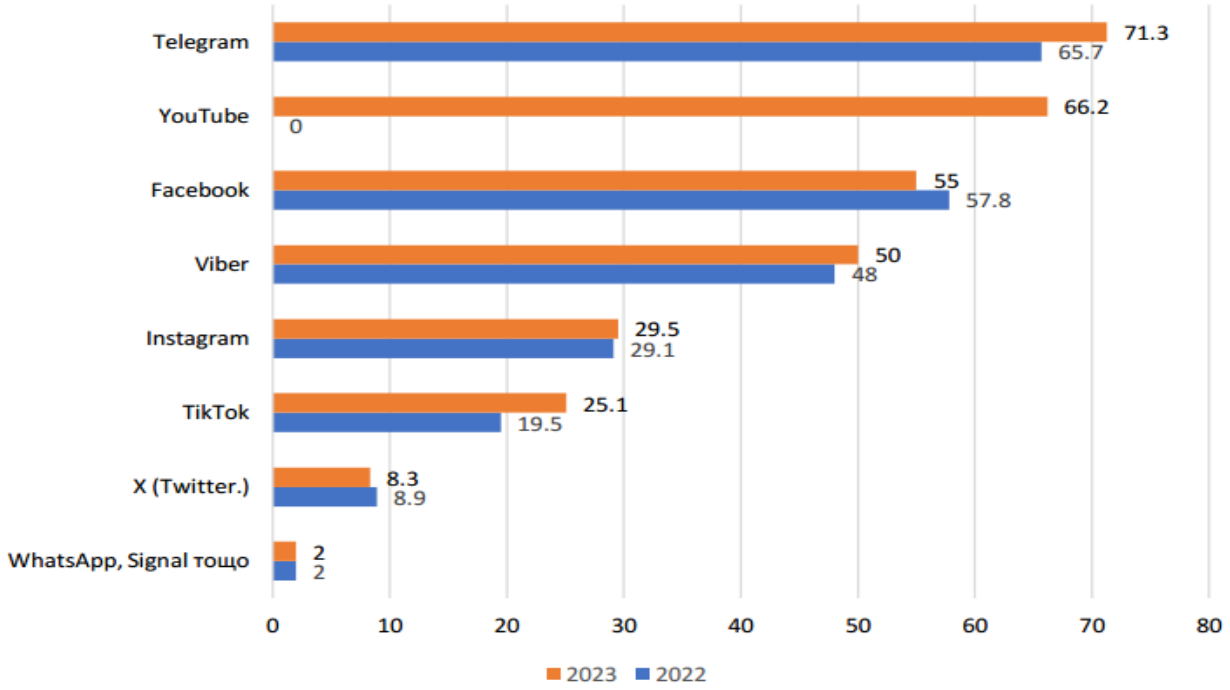

Fig. 2. The dynamics of using social media as the main source of news in Ukraine during the war in 2022-2023, %.

- Interactivity of the platform should employ interactive teaching methods such as video lectures, tests, simulations, virtual laboratories, forums, and chat;
- the selection and application of digital technologies within the online platform are based on a combination of methodological approaches (systemic, informational, technological), didactic principles (scientific basis, visual clarity), and specific principles (informatization of education, open education, multimedia, personal data protection);
- the platform should be accessible 24/7 from any device with internet connection and be usable by learners with varying levels of digital literacy;
- consideration of the specific features of educational and cognitive activities of vocational education learners (Pryhodiĭ, 2024).

The future educational platform includes links to the Institute's and department's pages on popular social networks: Facebook, Instagram, Twitter, YouTube, Viber, and Telegram. It is worth noting that among all the mentioned networks, YouTube is considered the most effective for communication and learning. This popular video platform offers several advantages:

- integration with Google services simplifies the setup and management of the Institute of Vocational Education's channel;
- access settings for educational videos allow restricting the audience to targeted users — future mechanical engineering workers;
- support for high-quality video playback on various devices makes the content highly accessible;
- the ability to embed videos into Moodle-based educational courses (Danko, 2012).

To ensure high-quality video content, it is recommended to follow certain upload formats and standards that guarantee optimal YouTube encoding and playback (Halich, 2010; Pryhodiĭ, 2022). However, according to research by OPORA (Fig. 2), after Russia's full-scale invasion of Ukraine, Ukrainians gave the highest preference to Telegram — 71.3% of respondents in 2023, which is related to convenient access to news and other

information via this social network (OPORA, 2023).

As noted by Ukrainian scientist Yu. Nosenko, according to her student survey, Telegram leads among similar services used in the educational process. Among the important functions of this messenger, the possibility to create chatbots is worth highlighting, as it is a promising tool to support education based on artificial intelligence (Nosenko, Nosenko & Shevchuk, 2023).

Also, Instagram is gaining increasing popularity in vocational education for training future qualified workers. Initially, it had limited functionality and was designed only for photo sharing without text or video. Over time, Instagram's functionality improved, and new user features appeared. Updates considered the growing number of social network subscribers, which increased exponentially. By December 2010, Instagram had 1 million registered users; by September 2017, the service had 800 million users, with 500 million daily visitors; and by June 2018, Instagram's audience reached 1 billion users. Thus, Instagram transformed from a purely entertainment and user platform into a powerful business and information platform, which can be used for educational purposes.

Considering the advantages of Instagram – such as a large user base, predominantly young active users and students, the amount of time spent on the platform, and ease of use for both content creators and viewers — we believe this social network will become a popular means of communication among participants in vocational education, who are mostly under 20 years old and regularly use this platform (TechCrunch, 2018).

In conclusion, one of the key aspects of creating a digital platform is ensuring the security of users' personal data, regulated by relevant normative acts and standards. The development process includes implementing modern information protection mechanisms, which cover:

- user authentication with multifactor verification;
- data encryption during storage and transmission;
- regular security audits and system updates in response to detected threats (Pryhodiĭ, 2022; Ryahuzova & Dibrova, 2012).

Supporting platform accessibility for people with disabilities is also essential, meeting inclusive education requirements and ensuring equal learning opportunities for all users (Kruchek et al., 2020).

The digital platform is equipped with analytics tools that allow educators and administrators to obtain detailed information about learners' progress, identify problem areas, and promptly adjust educational materials. Key functions include:

- tracking users' activity time;
- analyzing test results and task completion;
- generating individual performance reports (Pryhodiĭ, 2023, 2024).

Thanks to these data, the learning process is personalized, and its effectiveness increases.

Conclusions. The conducted study proved that the digital platform is a key tool for modernizing the vocational education system amid digital transformation, particularly in the mechanical engineering sector. It enables the combination of individualized learning with real labor market demands, creating a flexible educational environment that fosters the development of professional competencies of future qualified mechanical engineering workers. This implies for the industry: close integration of education and production; continuous updating of content according to technological changes; development of pedagogical digital competencies; and orientation towards learners' independence, flexibility, and mobility.

Implementing the digital platform concept requires an interdisciplinary approach, technical support, and regulatory frameworks, but it has significant potential for vocational education modernization. The effectiveness of the digital platform depends on its ability to integrate modern technologies, support educators, provide feedback, and comply with professional training standards.

It should be noted that the digital platform promotes personalized learning, simulations, and digital laboratories, provides access to interactive content, supports the development of professional competencies, digital literacy, and learner autonomy. Effective use of digital tools such as artificial intelligence, AR/VR, Internet of Things, LMS, and analytics services allows creating an adaptive, flexible, and competitive educational environment.

Successful implementation of such platforms requires an interdisciplinary approach, technical support, digital competence of educators, and regulatory backing.

Thus, the proposed model can serve as a basis for further development of digital solutions in vocational training and for integrating innovative technologies into the education process of future qualified mechanical engineering workers

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ЦИФРОВА ПЛАТФОРМА ЯК ЗАСІБ ПРОФЕСІЙНОЇ ПІДГОТОВКИ ТА КОМУНІКАЦІЇ МАЙБУТНІХ КВАЛІФІКОВАНИХ РОБІТНИКІВ МАШИНОБУДІВНОЇ ГАЛУЗІ

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Реферат:

Актуальність дослідження зумовлена новими вимогами до системи професійної освіти, особливо в галузі машинобудування, в умовах цифрової трансформації економіки, зокрема індустрії 4.0. З огляду на динамічні зміни технологій, постає нагальна потреба в інтеграції цифрових освітніх платформ у процес підготовки кваліфікованих робітників. Цифрові платформи здатні забезпечити доступ до сучасних освітніх ресурсів, персоналізованих навчальних траєкторій і симуляцій виробничих процесів. Це дає змогу адаптувати професійну підготовку до потреб високотехнологічного ринку праці, зробити її більш гнучкою, інтерактивною та ефективною.

Мета: розробка та обґрунтування методичних засад створення цифрової освітньої платформи для професійної підготовки майбутніх кваліфікованих робітників машинобудівної галузі, яка враховує сучасні тенденції цифровізації, особливості галузі та освітні потреби здобувачів.

Методи: теоретичний аналіз наукових джерел з тематики цифрових платформ, професійної освіти та технологій Індустрії 4.0; моделювання функціональної структури освітньої платформи з урахуванням її цільового, змістового, методичного та комунікативного компонентів; порівняльний аналіз існуючих цифрових платформ за критеріями функціональності, взаємодії з користувачами та адаптованості до освітніх потреб; експертне оцінювання педагогічних і технічних рішень щодо платформи; проектування та апробація веб-сайту, який включає інтерактивні навчальні модулі з САПР, ЧПК, робототехніки, а також аналітичні інструменти моніторингу прогресу.

Результати: В результаті дослідження: узагальнено класифікацію цифрових платформ за функціональністю та взаємодією з користувачами; сформульовано методичні принципи розробки освітніх платформ у машинобудівній галузі (персоналізація, доступність, інтерактивність, відповідність галузевим стандартам); створено прототип цифрової платформи для підготовки майбутніх фахівців, що включає адаптивне навчання, відеоконтент, симуляції, аналітичні панелі, а також можливість інтеграції з LMS та соціальними мережами; доведено доцільність використання цифрових технологій, таких як AI (штучний інтелект), AR/VR, IoT (інтернет речей), блокчейн у структурі освітніх платформ; обґрунтовано необхідність підвищення цифрової компетентності педагогів для ефективної реалізації навчального процесу на базі платформи.

Висновки. У результаті проведеного дослідження було доведено, що цифрова платформа є ключовим інструментом модернізації системи професійної освіти в умовах цифрової трансформації, зокрема для машинобудівної галузі. Вона дозволяє поєднати індивідуалізоване навчання з реальними запитами ринку праці, створює гнучке освітнє середовище, що сприяє формуванню фахових компетентностей майбутніх кваліфікованих робітників машинобудівної галузі. Розроблена методична модель платформи, яка включає

цільовий, змістовий, методичний та комунікативний компоненти, забезпечує інтеграцію навчального процесу з сучасними виробничими технологіями та вимогами ринку праці. Реалізація концепту цифрової платформи потребує міждисциплінарного підходу, технічної підтримки та нормативно-правового регулювання, однак має значний потенціал для модернізації професійної освіти. Ефективність цифрової платформи залежить від її здатності інтегрувати сучасні технології, підтримувати педагогів, забезпечувати зворотний зв'язок і відповідати стандартам професійної підготовки.

Ключові слова: *цифрова платформа, професійна підготовка, комунікація, кваліфіковані робітники, машинобудівна галузь.*

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