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USE OF IMMERSIVE TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION INSTITUTIONS

ВИКОРИСТАННЯ ІМЕРСИВНИХ ТЕХНОЛОГІЙ ТА ШТУЧНОГО ІНТЕЛЕКТУ В ЗАКЛАДАХ ВИЩОЇ ОСВІТИ

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Abstract. The article highlights the impact of immersive technologies and artificial intelligence on the transformation of education. It analyses the use of virtual, augmented and mixed reality, as well as intelligent digital systems that contribute to the improvement of the educational process, the development of professional and digital competences, provide personalised learning and support the motivation of learners. The didactic potential of innovative tools and their advantages for improving the quality of knowledge acquisition are highlighted. Key implementation challenges, including technical, ethical, methodological, and organisational ones, are outlined. Contemporary scientific approaches to the integration of immersive technologies into professional training are summarised.

Key words: immersive technology, digitisation, virtual reality, artificial intelligence, augmented reality, virtual environment.

Introduction.

The directions of education modernisation depend on globalisation processes in the world, labour market needs, external factors such as the COVID-19 quarantine, etc.

With this in mind, the digitisation of education opens up many opportunities for improving the quality of the learning process. Thus, with the rapid development of information and communication technologies (ICT), teaching methods in education institutions are changing. So-called ‘immersive technology’ is becoming increasingly relevant.

In the context of digitalisation, vocational education faces the challenges of rethinking traditional teaching methods, updating the content of educational programmes and introducing innovative technological tools capable of providing high-quality training for specialists to meet the needs of the modern labour market. Immersive technologies (virtual reality (VR), augmented reality (AR), mixed reality (MR)) and artificial intelligence (AI), occupy a leading position among such tools. They open up new perspectives for modelling the professional environment, increasing



motivation to learn, and developing practical skills and abilities in a context that is as close as possible to the real conditions of future professional activity.

Main text

Immersive technology is the integration of virtual content with the physical environment, allowing the user to interact naturally with mixed reality, which includes two main types of reality: augmented reality (AR) and virtual reality (VR) [3].

Immersive technologies, as powerful visualisation and simulation tools, create conditions for immersing students in learning situations that simulate real professional practice. Artificial intelligence, in turn, allows for a high level of individualisation of the learning process, adapting the content, pace and form of learning to the needs of each student.

However, there are a number of problems of a technical, pedagogical, methodological and ethical nature that require comprehensive scientific analysis.

In recent years, researchers have shown considerable interest in studying the role of digital technologies in modernising the education system. In particular, O. M. Spirin analyses the functional characteristics of adaptive educational platforms and emphasises their importance for personalising learning. S. O. Sysoeva stresses the need to develop theoretical and methodological foundations for the use of ICT to create a new type of educational environment that promotes professional self-development.

R. Mayer, drawing on cognitive theory of multimedia learning, states that the right combination of visual, textual and interactive content improves understanding and retention of learning material. M. Prensky draws attention to the change in the cognitive style of modern students — representatives of the digital native generation — under the influence of the technological environment. C. Dede substantiates the effectiveness of using VR and AR for the development of higher cognitive abilities and professional flexibility. Ukrainian researchers V. Volynets, V. Klymnyuk, O. Kryvonos, and M. Kovalchuk confirm that immersive technologies in Ukrainian education demonstrate high potential in the field of professional training. The researchers emphasise the possibilities of VR/AR in modelling production situations and implementing simulation training, which improves not only the quality of



knowledge but also the level of practical readiness of future specialists [1].

I. Melnyk, N. Zaderii, and H. Nefyodova emphasise that digital educational environments created using immersive technologies are changing the educational paradigm — from reproductive to constructive type of learning. This approach involves actively engaging students as participants in educational interaction, which promotes the development of critical thinking, reflection and independence [2].

However, despite the significant amount of research, a number of unsolved scientific and applied problems still remain. First of all, there is a shortage of models for implementing such technologies that are adapted to the Ukrainian educational context, taking into account the specifics of professional training content, the psychological and pedagogical characteristics of the student audience, and the existing infrastructure of educational institutions. Besides, the low level of digital skills among teachers, their psychological reluctance to use new tech, and the lack of systematic support for professional development in EdTech are serious barriers to fully realising the potential of innovation. In addition, the ethical and legal foundations for the use of AI in the educational process remain virtually undeveloped, especially in matters of assessment of learning outcomes, processing of personal data, and academic integrity. Therefore, solving these problems requires a holistic, interdisciplinary approach that combines pedagogical science, educational technology, cognitive psychology, and digital ethics.

The integration of immersive technologies into vocational education is an important step towards transforming traditional teaching methods and developing new, effective approaches to vocational training.

Immersive technologies are one of the strategic vectors of modern education. In the context of pedagogical science, it is a teaching method with elements of relaxation, play, and immersion in an artificially simulated reality. Several concepts of immersive technologies have been identified: virtual reality (VR); augmented reality (AR); mixed reality (MR); holography, TelePresence; digital twin; FPV drone flight, etc.

The essence of the immersive approach in education is a set of techniques and means for organising productive interaction between participants in the educational



process in a virtual (immersive) educational environment, which ensures interactive learning and comprehensive and targeted professional development. An immersive learning environment is understood as a dynamic process of influencing the user with various elements of a simulated external/internal environment. Thus, immersion is primarily associated with a subject-spatial simulated environment designed to draw the viewer into itself.

The advantages of an immersive environment have been identified: the ability to visualise complex processes and phenomena; minimisation of extraneous factors; a high degree of personalisation of the learning process; stimulation of the accumulation of experience in independent cognitive activity and the development of activity in educational activities; rapid and clear reflection of the results obtained; facilitation of communication between participants in the educational process, etc.

It is worth noting some examples of how immersive technology is used in practice by teachers at foreign educational institutions, reflecting the application of four types of immersion, namely: full immersion, partial immersion, no immersion, and a combination of virtual and augmented realities.

So, the following tools are in high demand:

–Google Expeditions, implemented through Google Cardboard and a smartphone, which helps users travel to a virtual destination and explore it; direct their attention to additional information to explain certain landmarks and details during tours of historical sites, study human anatomy, visit museums around the world, etc. [7];

–InMind 2 – a scientific VR game about the chemistry of human emotions, which can be useful in biology, psychology or social studies classes to help students immerse themselves in the subject matter and explore it (<https://program-ace.com/blog/vr-in-education-features-use-cases-implementation/>);

–Labster (<https://www.labster.com/simulations/>), which provides a safe environment for studying STEM subjects, offering more than 100 types of virtual laboratories that teachers can freely use with their students to conduct experiments in virtual environments with augmented reality;

–HistoryMaker VR (<https://historymakervr.schellgames.com/educator->



resources/#ClassroomGuides) is a virtual reality content creation tool where students can embody and act as famous American figures using the Oculus Rift VR headset;

–zSpace Labs (<https://zspace.com/>) is a universal AR and VR space offering hundreds of educational programmes that provide realistic three-dimensional experiences; pupils/students can interact with the human heart, dissect mechanical objects, visualise architectural drawings, etc.

It is quite interesting to see how some foreign educational institutions have used AR and VR.

For example, a unique learning experience is the “Excursion to Mars” (<https://www.adweek.com/creativity/lockheed-martin-rigged-school-bus-group-vr-take-kids-tour-mars-170968/>), which was launched by Lockheed Martin, which, with the help of McCann and Framestore, created the Lockheed Martin Mars Experience Bus, in which the windows are screens. Using the Unreal game engine as a platform for the experience, Framestore created a 200-square-mile ‘world space’ based on the actual street configurations of Washington, D.C. The team digitally covered the area with geological features and drew objects along the bus route, creating a system that would allow the bus's real speed, GPS, and accelerometer to be translated into Unreal, creating a real school bus that would exist in the video game realm. The bus itself became a headset: transparent 4K screens allowed passengers to look at the city streets before transporting them to the rocky terrain of Mars. This is the world's first experience with virtual reality without headsets.

VR labs can be used for any subject, such as chemistry, biology, and physics. Students can use VR to learn about atomic structures, animal genetics, fermentation, and much more. VR technology helps teachers create incredible learning experiences for their students – experiences that will motivate them to learn and be remembered faster and longer than traditional lectures.

According to scientific research, immersive technologies improve students' spatial understanding and memory, allowing them to experience learning first-hand and see everything that is happening around them. Such technologies provide visual learning and promote students' overall understanding of more complex subjects,



theories and languages.

Immersive technologies are technologies for complete or partial immersion in a virtual world or various types of blending real and virtual reality. Immersive technologies are also called augmented reality technologies. They include virtual and augmented reality, as well as 360° video. They provide the effect of complete or partial presence in an alternative space and thus change the user experience in completely different areas.

- RR (real reality) — ‘real reality’ or objective reality, in which we exist and which we perceive with our senses.

- VR (virtual reality) — virtual reality — a completely simulated reality using modern technologies. This is not only 3D or 360 scenes, but also sound, tactile sensations and even smells.

- AR (augmented reality) — augmented (‘added’) reality. That is, we add elements of virtual, simulated reality to our real reality (RR).

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Technologies such as virtual reality (VR), augmented reality (AR) and mixed reality (MR) enable the creation of innovative immersive educational environments that bring the learning process closer to real working conditions. They enable students to interact with virtual objects, simulating real production processes and emergency situations, which in turn allows them to gain practical experience without risk to health and without the need for specialised equipment. Thanks to VR, students can immerse themselves in virtual laboratories, allowing them to practise complex tasks and situations in a safe environment. Augmented reality allows the real world to be combined with virtual elements, enabling training to be conducted directly in the



workplace, while mixed reality supports interaction between real and virtual objects, increasing the effectiveness of training in various professional fields, such as medicine, mechanical engineering and engineering. The integration of these technologies promotes the active involvement of students in the learning process and the development of their practical skills, which is an important aspect of professional competence formation [6].

Artificial intelligence (AI) plays a special role in this process, providing new opportunities for personalising learning and adapting educational trajectories to the individual needs of students. The use of AI allows for the creation of adaptive learning platforms that analyse student progress, identify weaknesses and provide personalised recommendations, thereby increasing the effectiveness of learning.

Intelligent systems, such as chatbots or virtual tutors, help students at all stages of the learning process by accompanying them, providing feedback and monitoring their progress. A significant advantage of immersive technologies is also a change in the approach to learning compared to traditional methods, in particular lecture-based learning.

Immersive technologies allow creating situations in which students learn through experience, actively interacting with virtual objects, which ensures deeper assimilation of material and development of critical thinking [8]. The use of such technologies stimulates an increase in student motivation. The interactivity and innovation of these approaches make learning more exciting and interesting, which contributes to increasing student engagement and developing their independent skills. Immersive technologies also help develop creative and critical skills through the ability to interact with realistic situations.

Despite huge potential of immersive technologies, their implementation in vocational education faces certain difficulties, including the high cost of equipment, the limited technical base of vocational education institutions, and the lack of sufficient content adapted to the specifics of vocational training. However, thanks to the development of digital technologies, the growing popularity of the EdTech sector, and the demand for specialists with new skills, there is real potential for the further



development of immersive solutions in education [4].

The integration of artificial intelligence (AI) and immersive technologies into education opens up new opportunities, but at the same time raises important ethical and legal issues that require special attention. One of the key aspects is ensuring confidentiality and data protection, as any leak or misuse of personal information can have serious consequences. It is therefore important to comply with national and international standards, such as the EU General Data Protection Regulation (GDPR), and to ensure that educational institutions inform students how their data is processed [5]. Another important ethical issue is transparency in the application of AI algorithms, particularly when it comes to automated assessment. Since many AI-based learning platforms use complex algorithms to make decisions, it is essential that these decisions are understandable to users. Students and teachers must be able to find out how and why certain decisions are made in order to avoid misunderstandings or unforeseen consequences. In modern approaches to professional education, it is important to apply Khan's Learning Framework (KLF), which acts as an integrative model for organising the learning process through an interconnected structure of key components: pedagogy, technology, assessment, management aspects, ethics and interface design.

The integration of AI into the learning process is one of the key components that allows educational materials to be adapted to the individual needs of students, ensuring personalised learning. AI is used to automatically monitor student progress and adjust learning materials according to their level of knowledge and pace of learning, which helps to improve learning effectiveness. Immersive technologies, in particular virtual and augmented reality, create unique conditions for students, allowing them to actively engage in professional scenarios, modelling real situations and performing practical tasks. This enables students to immerse themselves more deeply in the professional environment, gaining experience that is close to the real conditions of their future professional activities.

Gamification, as an element of interactive learning, motivates and encourages students through game mechanisms that stimulate them to achieve learning goals. It helps to form active interaction between students and the learning process, creating a



competitive atmosphere, which in turn contributes to better assimilation of the material. An important aspect of the effective integration of these technologies is the use of an assessment system that monitors learning outcomes, analyses the effectiveness of the methods used, and helps to adjust learning strategies. AI and digital technologies greatly simplify the automation of assessment and feedback, making the process more accurate, faster, and more objective. Thanks to its comprehensive approach, KLF promotes the development of management strategies and resource support for the effective implementation of innovations in the educational process.

Before introducing new technologies, it is important to conduct a comprehensive assessment of the state of the educational environment. This includes assessing the availability of the necessary technical equipment, software, and access to specialised laboratories and virtual environments. The assessment also involves evaluating the readiness of teaching materials for adaptation to new technologies. Teachers must undergo training to effectively use immersive technologies and artificial intelligence. The training covers the basics of VR, AR and other digital platforms, as well as the adaptation of teaching methods to new conditions. This will enable the development of interactive programmes and ensure effective learning for students, taking into account their individual needs. For the successful implementation of technologies, it is important to provide all participants in the educational process with technical and methodological resources. This includes providing students with instructions, learning materials and feedback, as well as supporting teachers in the use of new platforms and methodologies. The next step is to adapt educational content to the conditions of use of immersive technologies. This may include the creation of virtual laboratories, simulations or 3D models that are integrated into the learning process. The integration of new technologies should be gradual in order to avoid overwhelming those involved in the process. Once the teaching materials have been adapted, it is necessary to test the results of implementing the latest technologies. The effectiveness of the teaching process, the level of student engagement, and the achievement of learning objectives are assessed.

Thanks to immersive technologies such as virtual and augmented reality, students



can practise their skills without needing real access to complex and expensive resources, making learning more accessible and safer. Artificial intelligence, in turn, allows for the automation of many aspects of the learning process, such as assessment, feedback, and personalisation of learning. This enables each student to receive an individual learning path that matches their pace, level of knowledge, and interests.

Immersive technologies can visualize complex concepts, making them easier to understand in the early stages of learning. The transition to more complex levels, such as ‘application,’ ‘analysis,’ and ‘evaluation,’ will become natural thanks to the integration of artificial intelligence. The AI system can provide feedback to students, helping them to adjust their actions and make decisions in real or simulated situations. This allows students not only to apply the knowledge they have acquired, but also to analyse information, compare different approaches, and evaluate the results of their activities. The final level — ‘creation’ — allows students to use their acquired skills and knowledge to develop new solutions or projects, such as creating models or developing new strategies for solving practical problems. Immersive technologies and AI help create learning situations that stimulate creativity and innovation, where students have the opportunity to generate new ideas based on their research and analysis.

Summary and conclusions.

Summarising the results of the study, it can make conclusions that the integration of immersive technologies and artificial intelligence into vocational education has the potential to become a driver of its transformation. Such technologies not only expand the arsenal of tools available to teachers, but also change the very philosophy of learning — from a reproductive to a constructivist approach.

The use of virtual and augmented reality makes it possible to create conditions for safe immersion in a professional environment that simulates real-life production situations. This is particularly important in high-risk areas (medicine, aviation, construction). An analytical review of current approaches, selected educational platforms, and digital tools has shown that the most effective solutions are those that combine technological innovation with pedagogical expediency.



The systematic combination of immersive technologies and AI makes it possible to improve the quality of professional training, making it more flexible, adaptive, and oriented towards the needs of the labour market.

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Анотація. У статті висвітлено вплив імерсивних технологій та штучного інтелекту на трансформацію освіти. Проаналізовано використання віртуальної, доповненої та змішаної реальності, а також інтелектуальних цифрових систем, які сприяють вдосконаленню освітнього процесу, розвитку професійних та цифрових компетентностей, забезпечують персоналізоване навчання та підтримують мотивацію учнів. Підкреслено дидактичний потенціал інноваційних інструментів та їхні переваги для підвищення якості набуття знань. Визначено основні виклики впровадження, зокрема технічні, етичні, методологічні та організаційні. Узагальнено сучасні наукові підходи до інтеграції імерсивних технологій у професійну підготовку.

Ключові слова: імерсивна технологія, цифровізація, віртуальна реальність, штучний інтелект, доповнена реальність, віртуальне середовище.