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Immersive technologies in the educational space

Імерсивні технології в освітньому просторі

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Abstract


The article reveals the importance of digital technologies (virtual reality, augmented reality, mixed reality with the use of artificial intelligence) in the educational space of educational institutions, identifies the types and considers the advantages of virtual reality, shows the important role of augmented reality in the educational space of educational institutions; the most well-known means of digital technologies in the educational space of educational institutions are analyzed. The use of immersive technologies is presented as a tool to involve all students in the educational process, where digital technologies are used to personalize learning, a new innovative educational environment is created, motivation is increased, and for understanding reality, providing information, ease of its perception, new opportunities are being searched for the future specialist; The


Анотація


У статті розкрито вагомість цифрових технологій (віртуальна реальність, доповнена реальність, змішана реальність із використанням штучного інтелекту) в освітньому просторі закладів освіти, виокремлено типи та розглянуто переваги віртуальної реальності, показано важливу роль доповненої реальності в освітньому просторі закладів освіти; проаналізовано найбільш відомі засоби цифрових технологій в освітньому просторі закладів освіти. Застосування імерсивних технологій представлено як інструмент залучення всіх студентів до освітнього процесу, де застосовуються цифрові технології персоналізації навчання, відбувається створення нового інноваційного освітнього середовища, підвищення мотивації і для розуміння дійсності, надання інформації,

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advantages of using immersive technologies in professional education are highlighted, the importance of artificial intelligence for higher education is shown, directions for using a chatbot are suggested. In the conditions of the real educational process, we conducted a study on the formation of students with a high level of competence in the use of digital immersive technologies in the educational space of higher education institutions.

Keywords: virtual, augmented and mixed reality, educational activity, educational institutions, students of education, immersive technologies.

Introduction

The problem of modernization and improvement of professional training of specialists is quite acute in the modern information and digital society. Society is entering a new stage of development, therefore higher education institutions face the task of providing an opportunity for each individual to find his place in life, meet the challenges of the times, and fully realize himself as a qualified, modern, competitive specialist (Khmelnitska, 2023).

The implementation of virtual, augmented, and mixed reality systems in education is noted as an innovative learning of educational material, as a new approach to learning. These technologies can be used in different classes and their stages, as they have adaptability and flexibility. Visualization, interactive learning, technological design, construction, technical construction, and virtual travel can be realized thanks to immersive technologies. It is closely related to the intensive rethinking and flexible renewal of the higher education system. Substantial progress in the modern information society is based on the deep immersion in the digital information environment of higher education students and teachers (Khmil et al., 2023).

Therefore, an urgent scientific task arises, which consists of the development of methods and models of immersive technologies in the educational space based on the unification of all functions, procedures, and information bases into a single concentric information technology for the digital transformation of the academic activities of educational institutions.

Summarizing the theoretical and practical developments regarding immersive technologies

зручності її сприйняття, здійснюється пошук нових можливостей для майбутнього фахівця; Виокремлено переваги застосування у професійній освіті імерсивних технологій, показано значення штучного інтелекту для вищої освіти, запропоновано напрями використання чат-бота. В умовах реального навчально-виховного процесу нами було проведено дослідження щодо сформованості у студентів високого рівня компетентнісного застосування засобів цифрових імерсивних технологій в освітньому просторі закладів вищої освіти.

Ключові слова: віртуальна, доповнена та змішана реальність, освітня діяльність, заклади освіти, здобувачі освіти, імерсивні технології.

in the educational space, we note that the issues of training pedagogical workers for the use of immersive technologies in the educational space are accompanied by the aggravation of contradictions between:

- the existing level of development of immersive technologies in the educational space and their insufficient practical implementation in the educational process of educational institutions;
- the need to harmonize the competence formation process regarding the use of immersive technologies in the educational space and the insufficiency of specially developed methods using these technologies;
- the expediency of using immersive technologies in the educational space and the need for coordinated actions in this matter by teachers, parents, social pedagogues, practical psychologists, and students;
- between the need to improve immersive technologies in the educational space with students and the inadequacy of methods for applying these technologies in the formation of students' information competence.

Considering the actuality, social significance, and insufficient development of the specified problem, the following topic of the article was chosen.

Research relies heavily on the accuracy and reliability of the data. In the framework of research work, the quality of data collection and analysis not only adds weight to the research but also contributes to the formation of sound

conclusions, which is the key to academic success.

The following digital data collection tools were useful in the study:

- Google Forms – a simple tool for creating surveys that allows you to collect data from respondents, create different types of questions, and collect answers in spreadsheets.
- SurveyMonkey is a modern survey tool that offers a wide range of customization options and analytical tools for analyzing the collected data.
- JSTOR, Google Scholar, and other academic search engines provide access to scholarly articles, books, and other academic resources that may be useful for literature review and theoretical data collection.
- Zotero or Mendeley – bibliography management programs that help organize research materials, store references, and format bibliographies and citations according to different citation styles.
- Microsoft Excel or Google Sheets – spreadsheets are useful for organizing and analyzing collected data when working with quantitative data.
- SPSS, R, or Python for more advanced data analysis, statistical analysis, and processing of volumes of data.

Literature review

Some foreign and domestic scientists studied certain aspects of virtual, augmented, and mixed reality, as well as their introduction into the educational process. Thus, L. Tarangul and S. Romaniuk (2022) presented the definition of AR technology, revealed its role, advantages, and limitations, and showed the experience of using (AR technology) – augmented reality technology in institutions of higher education; "we found that an effective tool for supporting the educational process in higher education institutions using AR technology is the HP Reveal platform, which is distinguished by its advantages that allow you to visualize educational information and improve teaching methods and the educational process in general".

D. Yefimov (2021) paid considerable attention to the issue of research devoted to augmented reality technology, which allowed the scientist to analyze AR technology, and formulate its functions and purposes. A. Torianyk (2019) considered the disadvantages and advantages of

virtual reality technology in education and also proved that virtual programs in educational institutions cannot completely replace traditional teaching, but when studying the most complex topics of various subjects, they can be effectively used.

V. Kovalenko, M. Marienko, and A. Sukhikh (2021) in the system of general secondary education in the context of blended learning considered the use of virtual and augmented reality and identified effective applications that can significantly increase the effectiveness of the educational process. The same problem was dealt with by Yu. Matvienko (2021), analyzed and identified the ways of using the most common applications in the educational space, implemented with AR technology, in the educational process, as well as V. Osadchyi, N. Valko, L. Kuzmich (2021), proved that the process of learning educational space learners improves the use of augmented reality technology, helps in organizing group and teamwork, increases student motivation, and also promotes cooperation.

N. Khmil, T. Halytska-Didukh, Q. Wang (2023) in the educational process of educational institutions made an analysis of opportunities and highlighted the prospects of using virtual and augmented reality technologies; characterized these technologies, identified their advantages in education; analyzed the most common applications based on augmented and virtual reality technologies, which should be used in higher education institutions to promote the effectiveness of the educational process. The stages of introducing virtual and augmented reality technologies into the educational process of higher education institutions are proposed; the advantages of using virtual and augmented reality, and their technical support for implementation in the educational process are shown and analyzed. Ways of using virtual and augmented reality technologies in secondary and higher education institutions have also been developed by V. Klymniuk (2018). An analysis of the current state of virtual and augmented reality was carried out; the main directions of the influence of virtual and augmented reality on the methodology of higher education are identified, and the ways of implementing elements of virtual and augmented reality in multimedia educational complexes are shown.

Scientists, O. Litorovych, and O. Karyi (2020) showed the possibilities and outlined the ways of using virtual, augmented, and mixed reality for

personnel training; offered different types of virtual reality systems; revealed the expediency of using virtual, mixed, and augmented reality technologies as methods of active learning in higher education institutions; disadvantages and advantages of using the specified technologies are shown; examples of staff training using mixed reality are described. O. Khmelnytska (2023) revealed the meaning of the concept of "immersive technologies", and showed the problems and advantages of building a virtual educational space and its practical application in the professional education of specialists. The content of immersive technologies is revealed: technologies of augmented, virtual, and mixed reality. Peculiarities of interaction with the outside world are highlighted: "Virtual reality involves the construction of an artificial world and simulation of real processes in it; augmented reality involves adding elements of the virtual world to reality and creating auxiliary objects in the real world; mixed, in turn, combines the real and virtual worlds, their combination for effective interaction".

The purpose of the study is to consider the content and prove the necessity of digital technologies in the educational space of the university, such as virtual reality, augmented reality, and mixed reality with the use of artificial intelligence, to ensure in practice the high effectiveness of the educational process, which is necessary for the future professional activity of students and to form students have a high level of competence in the use of digital immersive technologies in the educational space of the university.

The research methodology is based on the dialectical method, its application through the prism of the dialectics of technology, and the interaction of the student of higher education to reveal the specifics of virtual, augmented, and mixed realities.

The scientific novelty consists in distinguishing the key categories of immersive information technologies, in particular, the concepts: "mixed reality", "virtual reality", and "augmented reality", the illegal use of which by students of higher education, as synonyms, unreasonably leads to the incorrect use of specific vocabulary.

Methodology

The research used: general scientific research methods – theoretical (analysis, abstraction, synthesis, generalization, deduction, induction, classification, explanation, idealization, ascent

from abstract to concrete, formalization, imaginary experiment, axiomatic method, as well as systemic, functional, concrete sociological: experiment, survey, description, in addition to the above-mentioned general scientific methods, they include: synectics, testing, monitoring preferences, so the selection was based on the research objective and data availability.

Ethical compliance was of critical importance to us during data collection. This included:

- ensuring confidentiality;
- obtaining the informed consent of the participants;
- protection of personal data.

In the conditions of a real educational process, we conducted a study, the purpose of which is to consider the content and prove the need for digital technologies in the educational space of the university, such as virtual reality, augmented reality, and mixed reality with the use of artificial intelligence, to ensure in practice the high effectiveness of the educational process, which is necessary for the future professional activity of students and to form among students a high level of competence in the use of digital immersive technologies in the educational space of the university.

It can be asserted with a probability of 95% that as a result of the formative experiment, there were positive changes in the levels of formation of competence in the use of digital immersive technologies in the educational space of the university in the experimental group.

The type of research conducted is quantitative, and the approach to it is experimental.

The implementation of the pedagogical experiment was carried out in three stages: preparatory, main, and final.

At the preparatory stage, the purpose and tasks of the research were determined, the experimental plan was developed, methods of measurement and processing of results were selected, control and experimental groups were selected, and their homogeneity was checked.

At the main stage, an experiment was conducted.

At the final stage, the results of the experiment were analyzed, their reliability was confirmed, and conclusions were drawn about the pedagogical effect of the experiment.

The reliability and validity of the obtained results, and the objectivity of their assessment were ensured by the methodological soundness of the initial positions and the qualitative mechanism for evaluating the quality under study, the use of a complex of complementary research methods, and the involvement of a group of respondents from a higher educational institution in the analysis of its results.

To assess the homogeneity of experimental and control data, statistical processing was performed using MS Excel and SPSS (Statistical Package for Social Science).

The following digital data collection tools were useful in the study: Google Forms; SurveyMonkey; JSTOR; Zotero or Mendeley; Microsoft Excel or Google Sheets; SPSS, R or Python.

When determining the sample of subjects, the general specificity of the research subject was taken into account. The total sample size is 130 subjects. When forming the sample, the criteria of meaningfulness, representativeness, and equivalence were taken into account. The sample was formed by random selection using the technical procedure for calculating the selection step.

The results of the experimental study confirmed the applicability, optimality, and effectiveness of the proposed pedagogical conditions for the formation of the environmental culture of an ecologist in the process of professional training.

Results and discussion

1. The role of digital technologies (virtual reality, augmented reality, mixed reality with the use of artificial intelligence) in the educational space of the university.

In recent years, from another new trend to innovative technologies, virtual computer reality has overcome an innovative path: now in the field of education, it is possible to create sounds and other sensations, realistic images that can transport a student of higher education to a fictional exciting world. Digital technologies in the educational space of the university, such as virtual reality, augmented reality, and mixed reality with the use of artificial intelligence, in turn, strengthen the confidence that innovative technologies will greatly influence the future and bring an element of virtuality to the surrounding reality.

It is the mixed reality that provides the projection of three-dimensional virtual objects that combine digital elements and the real world, thanks to which students of higher education can interact with virtual and physical objects and the environment at the same time, as well as with the help of the latest perception and visualization technologies, manipulate them.

Mixed reality combines virtual and augmented reality, that is, it superimposes non-existent virtual objects on the surrounding world.

The Google translator function is a typical example of mixed reality, which translates text from one language to another using a smartphone in real-time, choosing a similar font and replacing it.

In 1994, the term "mixed reality" was proposed by P. Milgram and F. Kishino (1994) and described the "Reality-Virtuality Continuum" – the space between virtuality and reality, between which mixed reality and augmented reality are located – closer to augmented virtuality, reality, virtuality. C. Bavor (2017) proposes to combine in one term all those technologies that P. Milgram and F. Kishino denote as mixed reality – immersive information technologies. But the term MR eventually gave way to the more innovative "augmented reality", which characterizes digital information superimposed on the real and physical world, and "virtual reality", which is primarily used to describe fully digital environments.

Mixed reality usually requires special equipment: glasses or helmets and is important and interesting for the educational field.

Virtual images in mixed reality are brought into the physical space and placed and visualized according to the objects of reality so that they are perceived as real. A student of higher education continues to interact with the physical world, where virtual objects are also present, which sometimes cannot be distinguished from real ones.

2. Types and benefits of virtual reality.

A highly developed form of computer simulation, this is virtual reality, which allows the user to immerse himself in the artificial world and act directly in it with the help of special sensory devices that connect him with audiovisual effects. At the same time, the motor, auditory, and visual sensations of the student of

higher education are replaced by their imitation, which is generated by a computer. Therefore, the artificial world that exists "in the computer" can be considered virtual reality. At the same time, object models that function in the middle of this innovative world can interact with a person or a group of people, and not only with each other.

Let's distinguish the types of virtual reality:

- computer modeling and simulation;
- network imaginary reality;
- cyberspace hardware.

There are many large-scale installations in the modern world, which are used in various fields of technology and science, dealing not only with the solution of fundamental tasks but also with the improvement of scientific disciplines of higher education.

Let's find out the main feature of VR models – it is an illusion created for the user and ensures the presence of a student of higher education in a simulated computer environment, which is called remote presence. The feeling of remote presence depends most on how convincingly the VR model reacts when interacting with the user of the educational space and how realistically the movements are reproduced. In particular, the model can adequately respond to head rotation and eye movement with appropriate technical support.

Let's highlight the main advantages of using virtual reality in education.

Clearness. Virtual reality, using 3D graphics, makes it possible to show chemical processes in detail, down to the atomic level, and to show how nuclear fission occurs before a nuclear explosion inside the atom itself.

Involvement Virtual reality allows you to influence the course of an experiment, change scenarios, or solve a problem in an accessible and game-like form for understanding. By conducting a virtual class, you can see the world of the past through the eyes of a historical character or go on a journey through the human body in a microcapsule.

Virtual classes. One of the main features of virtual reality for a student of higher education is the feeling of his presence in the drawn world, a first-person view. It is this approach that makes it possible to conduct classes entirely in virtual reality.

Security. It is possible to immerse the viewer without the slightest threat to life in any environment of any important circumstances: control of a space shuttle, a high-speed train, an operation on a human heart, and safety techniques during a fire.

Focusing. The virtual world surrounds the student of higher education at 360 degrees, from all sides, which allows him to focus entirely on specific material and not pay attention to external stimuli.

VR formats in education: in semantic learning, the transfer of empirical material through VR – full-time education; with the effect of the presence of social interaction, group classes – distance education; the opportunity to interact with real students and the teacher, to see what is happening, to be remotely in the classroom – mixed education; any of the developed educational courses can be adapted for independent study – self-education.

At the current stage of the educational process, virtual reality becomes a necessary form that significantly increases the effectiveness of the educational process for obtaining quality education. During the development, improvement, and implementation of virtual reality elements in multimedia educational complexes, it is necessary to take into account the professional level of developers, the capabilities of the higher education institution, the time allocated for implementation in the virtual reality educational process (Klymniuk, 2018).

In education, the use of virtual reality (VR) systems represents a new approach to the assimilation and transfer of scientific-methodical knowledge. Thanks to VR technologies, users can visit any point on the globe, build volumetric diagrams, visit unique experimental laboratories, conduct virtual chemical experiments, observe and actively participate in historical events, go on virtual space trips, explore different countries and cities, interact in a scientific environment with other users: directly participate in scientific research and observe experiments (Kovalenko et al., 2021).

Nowadays, there are a significant number of virtual reality applications, which are constantly increasing. More than 300 companies operate on the European market, which has been implementing their technologies in the education sector for a long time (in particular: Microsoft, Samsung, Oculus, Sony, HTC, etc.), offer schools and higher education institutions services

for the development of unique educational programs for successful use in the educational process.

3. The role of augmented reality in the educational space of the university.

Augmented reality (AR) is a technology that makes it possible to add digital data to the physical world in real time with the help of such computer devices as tablets, smartphones, and AR glasses. AR, using the environment, only adds virtual elements to such an environment (sounds, response to touches, graphics), which differs from virtual reality (VR), which immerses the user completely in a virtual environment (Chaban & Pashkevich, 2022). Let's highlight the key advantages of augmented reality technology in the educational process (Korkishko, 2021):

- increases the level of concentration of students of higher education and their interest in repeating and studying new material;
- allows you to conduct experiments and your own innovative research;
- provides an opportunity, compared to the usual static illustrations in maps, textbooks, etc., for a detailed examination of processes and objects;
- provides an opportunity to carry out dangerous and complex observations and experiments without harming the health of students of higher education.

However, some aspects must be taken into account when working with educational technologies based on AR. Including (Tymchyna & Tymchyna, 2020):

- dependence on the availability of supported AR applications on smartphones for all students;
- insufficient professional level of teacher training;
- problems with content mobility on different devices and platforms (Khmil et al., 2023).

4. The most famous means of digital technologies in the educational space of the university: are virtual reality, augmented reality, and mixed reality with the use of artificial intelligence.

Teachers of higher education institutions, applying professionalism, imagination, and creativity, to increase the motivation of students to study, try to use the most modern means,

methods, and technologies, focusing on their popularity among students of higher education.

Let's name the most famous means of digital technologies in the educational space of the university, such as virtual reality, augmented reality, and mixed reality with the use of artificial intelligence:

Labster – 3D project, which is interactive, was developed in the USA in cooperation with leading institutions of higher education – Harvard, Stanford, and Massachusetts Institute of Technology. The peculiarity of the *Labster* – the 3D project is that those who have obtained a higher degree can conduct experiments remotely in scientific laboratories while gaining access to the full range of laboratory equipment;

Lecture VR – virtual reality platforms (HTC Vive, Oculus Rift, PlayStation VR) provide an opportunity to watch a series of lectures by eminent scientists with the support of visual visualization, which are available for group sessions, supplementing classes, and for individual viewing;

Google Expeditions Pioneer Program – an innovative program that allows students of higher education to go on virtual excursions to inaccessible, exotic places on our planet. More than 100 such excursions are provided by the platform and with the help of Google Cardboard; *Human Body (Male) Educational VR 3D* – the application presents the main systems of the human body, and human organs and allows you to enlarge and view the organs of the human body with preset angles. Most 3D scenes include captions, entertaining animated quizzes, embedded animations and narration, and other visuals (Khmil et al., 2023);

Assemblr Studio is an application that, from categories grouped for the convenience of the user, allows you to create an authentic model in augmented reality; view ready-made objects, namely: science, education, nature, technology, cartoon animation, etc.;

ARLOOPA AR application is available in 6 languages and Contains *Assemblr Studio* cases with a set of ready-made and categorized objects for use. After downloading the application, you need to open the case of one of the required categories and place the selected AR object on the screen (Rohman et al., 2024);

AR Solar System is an application designed for the study of the Solar System and provides a combination of informatics and astronomy;

AR 3D Animals – AR-application provides integration of informatics and biology, natural

sciences contain cases of animated 40 species of animals – 3D-models;

TryCam AR – Cut Paste AR, Virtual Try-On – an application that provides the transformation of an ordinary image from a smartphone into an object of augmented reality. Students create models in 2D format independently, which provides an opportunity for the development of creativity, imagination, and creation (Bondar, 2020).

Virtual education takes place in a virtual educational space, its existence is impossible without the communication of participants in the educational process. Educational virtual systems represent the result and process of interaction between students of higher education and teachers, they cannot completely replace traditional teaching in institutions of higher education, because they only simulate objects in the digital space and reality. However, their constant use in the educational space is appropriate when studying the most complex topics and is necessary for in-depth assimilation of the material by students and provides additional educational opportunities (Babiuk, 2022).

It is important to note the technical aspect of higher education students' access to virtual reality. A budget version of Esperanza Glasses 3D VR – virtual reality glasses is available to students during their studies. With the help of virtual reality glasses, it is possible to immerse yourself in the virtual world of the scientific process only when using a smartphone (Khmil et al., 2023).

5. Application of immersive technologies.

As a tool for involving all students in the educational process, digital technologies are used to personalize learning, create a new educational environment, increase motivation, and search for new opportunities to understand reality, provide information, and facilitate its perception. In modern education, an actual trend is the use of immersive technologies, which involve active interaction of the individual with information, with the educational space, and the creation of informational, flexible environments. Immersive technologies make it possible to learn in an "artificial" virtual space, to gain practical knowledge in the professional field, blur the boundaries between the virtual and real world, and provide the opportunity to partially or fully immerse yourself in information (Khmelnyska, 2023).

Immersive technology represents, on the one hand, the integration of the virtual world with the physical environment, which allows the student of higher education to naturally interact with mixed reality, which embodies two types of reality: virtual (VR) and augmented (AR). On the other hand, immersive technologies are considered devices and methods that, with the help of sensory stimuli, create the effect of identification with immersive media, which makes it possible to use displays and simulations to immerse students in virtual worlds that may not always be available in real life (Sandoval-Henriquez, 2022).

We consider immersive technologies through the possibility of implementing a new approach to presenting and learning new material. Therefore, during training, we single out technologies of augmented, virtual, and mixed reality, which have their own peculiarities in application, even though they have a common goal – to replace dummies, tables, and diagrams.

Let's highlight the advantages of using immersive technologies in professional education:

- safety and accessibility in use;
- multimedia and interactive content of the educational process;
- the student's ability to concentrate on what is important;
- complete immersion in the immersive educational space of the student of higher education;
- the ability to work in a team;
- application of partner technologies;
- providing student motivation through game elements of learning;
- the creation of educational own developments;
- prognostic analysis of the research problem;
- provision of an individual educational trajectory for the student of higher education;
- formation of information, communication, and digital competencies in higher education students;
- automated verification and monitoring of a specific student of higher education or a group of students on the performance of practical tasks, etc.

In the educational field, the use of immersive technologies involves the construction of a structured scenario with a detailed system of tasks, rules, and strategies, i.e. an educational

simulation, which allows the student to apply professional skills and contributes to the formation of specific professional competencies in the student of higher education in further professional activities (Khmelnyska, 2023).

6. The importance of artificial intelligence for higher education. Directions for using the chatbot.

Due to the rapid development of artificial intelligence, there is an opportunity to increase or improve the effectiveness of using augmented, virtual, and mixed reality. Artificial intelligence, based on large data sets, makes it possible to plan an employee's training course automatically and create an individual education trajectory for each student. Chatbots are an example of the use of artificial intelligence in the educational process. A chatbot is an information communication technology, a program, or a virtual interlocutor that simulates the behavior of a student during communication with several or one interlocutor. Chatbots are created based on such applications as Skype, Telegram, Viber, and FB Messenger (Raskopa, (s.f)).

Today, the education space uses chatbots to communicate with teachers, students, employers, and more. The application of such innovative technology for the training of a future specialist does not present significant difficulties. A chatbot is necessary during the training of students to master new knowledge and to automate their acquisition in the format of interactive interaction. This approach to education enables every student to have round-the-clock access to a virtual mentor, to consolidate the material they have passed and pass tests, and to request the necessary information right at the workplace. At the same time, the load on the educational department is minimal.

Let's consider the directions for using a chatbot in student education, depending on the chosen goals:

1. corporate culture training. Chatbot conducts interviews, sends files;
 2. on-the-job training:
- creation of a chatbot platform, which makes it possible to independently adjust the educational process to the goals of employees and the student's own goals;
 - creation of a program with a chatbot, which makes it possible to detect gaps in the

student's experience and knowledge and to offer such topics to the student in which he lacks knowledge.

Due to the fact that in the current state, chatbots cannot completely replace a person, they work together with a mentor. When the bot cannot answer the student's reply, the operator is included in the dialogue. The dialog system creates new options for answers by analyzing the operator's answer and the student's reply. The advantage of such an algorithm is that it is controlled by a mentor.

So, we see that increasing the availability of adaptive-interactive systems and reducing their cost, in particular those that can be used in the educational process of a higher school, stimulates their use in an increasingly large educational format around the world. Modern digital technologies in practice are highly effective in the innovative educational process through independence, easy search for information, increased attention and concentration of students, simultaneous safety of the student's educational activities, and acquisition of practical skills (Litorovych & Karyi, 2020).

7. An experimental study of the levels of formation of competence in the use of digital immersive technologies in the educational space of the university.

The data obtained from the survey of the EC Eurostat statistical agency are interesting. In particular, access to the Internet depends on the level of education and age of users:

- 85% of young people use the Internet between the ages of 16 and 24;
- only 13% of elderly Europeans access the Internet.

Inequality of access to the Internet directly depends on education:

- those who graduated from higher school and continue to study – 62.2% of respondents go online;
- those who graduated from higher school and stopped their education – 43% of respondents go online;
- those who did not finish school – 20% of respondents go online.

This is because students have a desire to use the World Wide Web, and there are more opportunities, as well as the intellectual potential

of the student, his education, knowledge of foreign languages, and the social and cultural level of parents and teachers.

In the conditions of a real educational process, we conducted a study, the purpose of which is to consider the content and prove the need for digital technologies in the educational space of the university, such as virtual reality, augmented reality, and mixed reality with the use of artificial intelligence, to ensure in practice the high effectiveness of the educational process, which is necessary for the future professional activity of students and to form among students a high level of competence in the use of digital immersive technologies in the educational space of the university.

The research methodology was based on the dialectical method, its application through the prism of the dialectics of technology, and the interaction of the student of higher education to reveal the specifics of virtual, augmented, and mixed realities.

Scientific novelty can be seen in the demarcation of key categories of immersive information technologies, in particular the concepts: of "mixed reality", "virtual reality", and "augmented reality", the illegal use of which by students of higher education, as synonyms, unreasonably leads to the incorrect use of specific vocabulary.

The research used: general scientific research methods – theoretical (analysis, abstraction, synthesis, generalization, deduction, induction, classification, explanation, idealization, ascent from abstract to concrete, formalization, imaginary experiment, axiomatic method, as well as systemic, functional, concrete sociological); empirical: experiment, observation, survey, description, to process the results of observations and experiments.

In addition to the aforementioned general scientific research methods, special methods

were also used. These include synectics, the Monte Carlo method, and monitoring. Each method had its own limitations and advantages, so the choice was based on the research task and data availability.

Ethical compliance was of critical importance to us during data collection. This included:

- ensuring confidentiality;
- obtaining the informed consent of the participants;
- protection of personal data.

The experiment covered 130 students of higher education. Homogeneous control and experimental groups are grouped together. At the initial stage of the research, we conducted a survey among students of higher education regarding their use of immersive technologies during the educational process. The following survey questions were proposed:

1. Do you understand the meaning of the terms: "immersive technologies", "mixed reality", "virtual reality", and "augmented reality"?
2. What are the differences between these technologies?
3. Do you use immersive technologies in your practice?
4. What are the means of digital technologies, their types and what are the advantages of virtual reality?
5. Do you use artificial intelligence and chatbots in practice?

During the ascertaining initial stage of the research, we received the following data.

Do you understand the meaning of the terms: "immersive technologies", "mixed reality", "virtual reality", and "augmented reality"?

Yes, I understand – 65% of respondents answered, I don't quite understand – 35% of respondents.

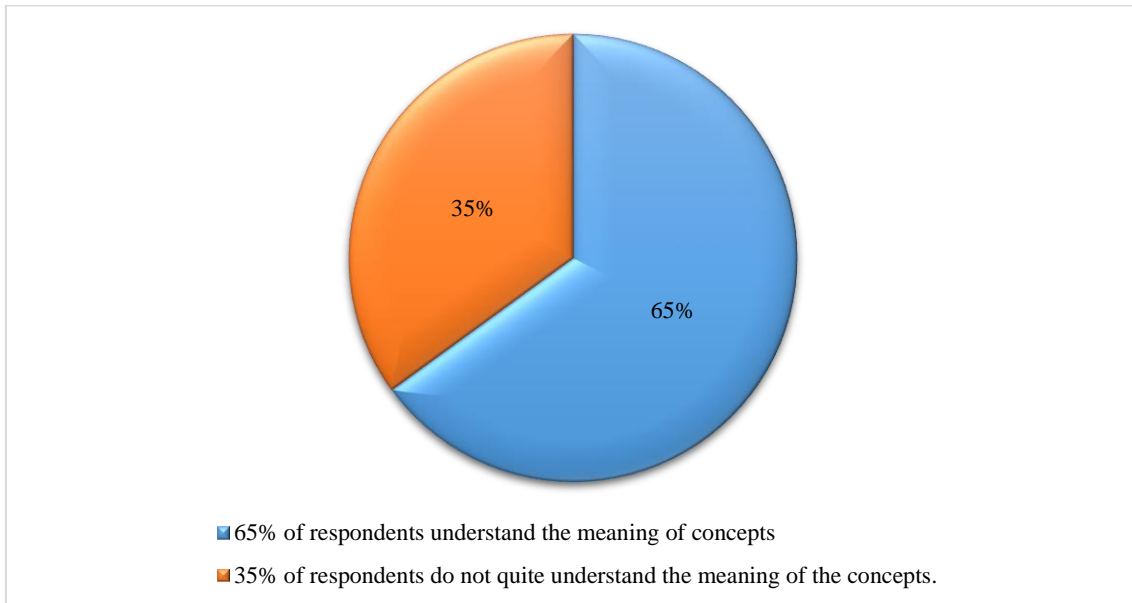


Fig. 1. Do you understand the meaning of the terms: "immersive technologies", "mixed reality", "virtual reality", and "augmented reality"?

But when answering the question – "How do these technologies differ from each other?", we observe the following results: only 18% of

respondents gave correct answers, and 82% of respondents gave incorrect answers.

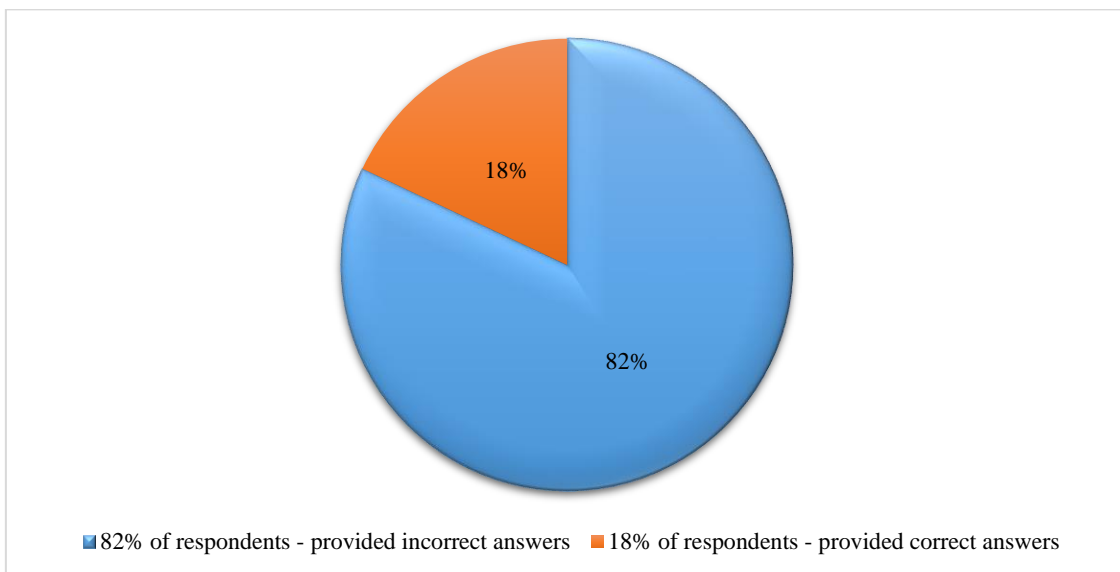


Fig. 2. How do these technologies differ from each other?

Answers to the question "What are the means of digital technologies, their types and what are the advantages of virtual reality?" again we were not pleased. We received comprehensive answers

from 17% of respondents, and 83% of respondents gave superficial, incomplete answers.

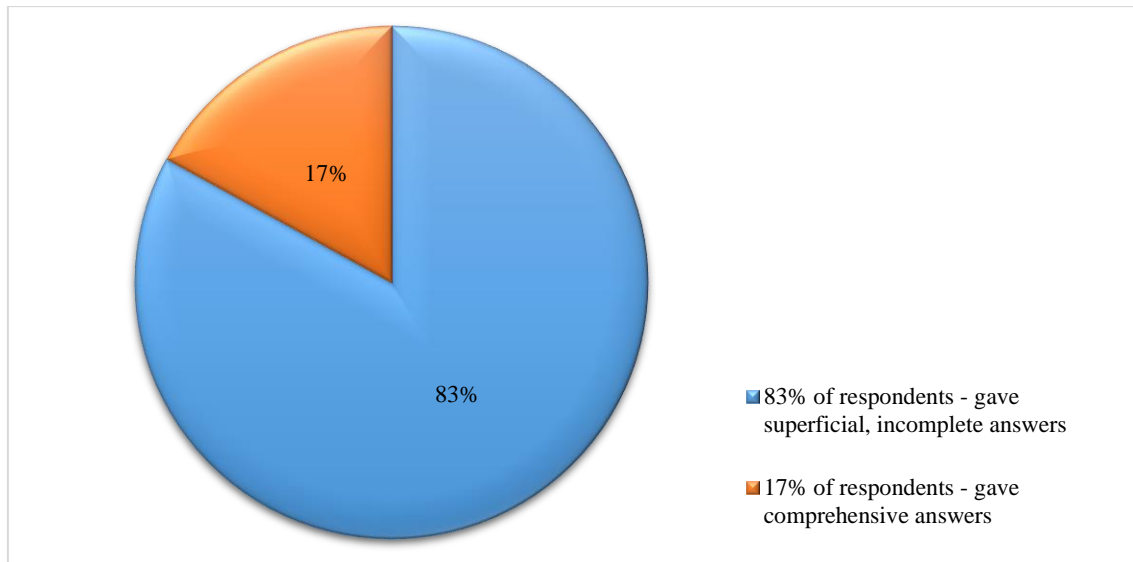


Fig. 3. What are the digital technologies, their types and what are the advantages of virtual reality?

The question "Do you use artificial intelligence and chatbots in practice?" showed that a small number of respondents use artificial intelligence and chatbots in practice. In particular, 17% of

respondents gave affirmative answers, and 83% of respondents denied the use of artificial intelligence and chatbots in practice.

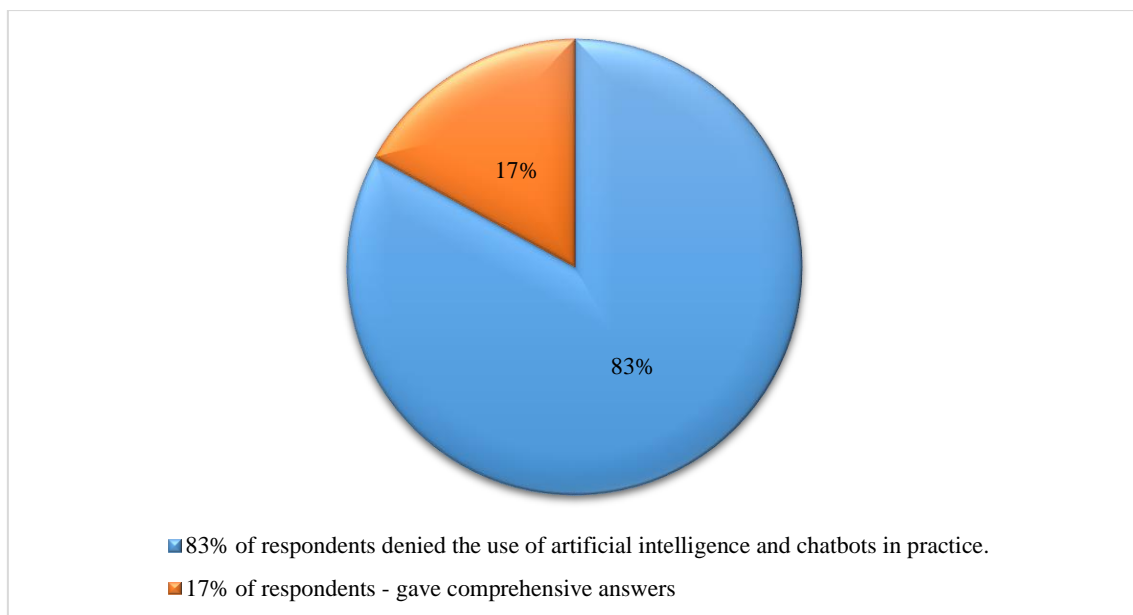


Fig. 4. Do you use artificial intelligence and chatbots in practice?

Among the students of higher education in the control and experimental groups, the results of the survey regarding the understanding and use of immersive technologies during the educational process impressed us with the low level of knowledge and application of all the positions proposed in the questionnaire.

Therefore, every week, we held classes and meetings in the mentoring studio for the students of the experimental group.

The main purpose of the classes was to acquaint the students of the experimental group with:

- the role of digital technologies (virtual reality, augmented reality, mixed reality with the use of artificial intelligence) in the educational space of the university and the human workplace;
- disclosure of types (computer modeling and simulation; network virtual reality; cyberspace hardware) and advantages of virtual reality;

- the role of augmented reality in the educational space of the university.
- practical application in the educational process of the university of well-known means of digital technologies: virtual reality, augmented reality, and mixed reality with the use of artificial intelligence;
- highlighting the advantages of using immersive technologies in professional education;
- as a tool to involve all students in the educational process of applying digital technologies to personalize learning, create a new educational environment, increase motivation and understand reality, provide information, and facilitate its perception, the search for new opportunities for future specialists was carried out;
- clarifying the main areas of using a chatbot;
- proving the importance of artificial intelligence for higher education and the further professional career of the student.

Students were offered immersive technologies in the educational space of the university, as well as new or updated programs and digital applications. Students learned to use virtual tours and virtual laboratories in the educational space of the university. In the class, they received comprehensive and detailed information about the possibilities of using immersive technologies and virtual laboratories in the educational process. To facilitate the assimilation of new educational material, they got acquainted with various mobile applications and online services. The work continued in practical, seminar classes and during group work. After a set of such events, students had the opportunity to apply the acquired competencies in practice. Respondents actively used digital technologies (virtual reality, augmented reality, mixed reality with the use of

artificial intelligence) in the educational space of the university and at the workplace, and used modern mobile applications and virtual laboratories to diversify practical tasks.

A repeat survey among students (formative stage of the experiment) was conducted after the implementation of the measures described above. It was conducted to find out specific digital educational tools that improve students' perception of educational material.

We again surveyed the final stage of the study (the formative stage of the experiment).

Its result testifies to the effectiveness of the experimental work of mastering the content and proving the necessity of digital technologies in the educational space of the university, such as virtual reality, augmented reality, and mixed reality with the use of artificial intelligence, to ensure in practice the high effectiveness of the educational process, which is necessary for the future professional student activities.

We are talking about the formation of students' competent use of digital immersive technologies in the educational space of the university: virtual reality, augmented reality, and mixed reality with the use of artificial intelligence and a chatbot.

We provide data on the general levels of formation of competence in students' use of digital immersive technologies in the educational space of the university at the final stage of research and experimental work.

In EG, 20.3% of students with a worldview and functional level of formation of competent application of digital immersive technologies in the educational space of the university were recorded (in CG – 11.7%).

Table 1.

Worldview and functional level of formation of the competent application of digital immersive technologies in the educational space of the university

Groups	Students
EG	20.3%
CG	11.7%

It was recorded that 73.2% of EG students showed an optional and productive level of formation of competence in the use of digital

immersive technologies in the educational space of the university (23.5% in CG).

Table 2.

Optional-productive level of formation of competence in the use of digital immersive technologies in the educational space of the university

Groups	Students
EG	73,2%
CG	23.5%

The reproductive-normative level of formation of competence in the use of digital immersive technologies in the educational space of the

university was found in 11.5% of EG students (in CG – 62.7%).

Table 3.

Reproductive-normative level of formation of competence application of digital immersive technologies in the educational space of the university

Groups	Students
EG	11,5%
CG	62.7%

Quantitative data on the levels of formation of competence in the use of digital immersive technologies in the educational space of the university at the ascertainment and final stages of research and experimental work increased significantly in EG, while in CG they did not change enough.

Yes, the number of EG respondents increased:

- by 7.8% with the worldview and functional level of formation of competence in the use of digital immersive technologies in the

educational space of the university (in the CG there was an increase of 1.9%);

- by 51% – with the optional productive level of formation of competence in the use of digital immersive technologies in the educational space of the university (in CG the increase occurred by 5.9%);
- by 56.7% – with the reproductive-normative level of formation of competence in the use of digital immersive technologies in the educational space of the university in EG (in CG the increase occurred by 7.8%).

Table 4.

Quantitative data on the levels of formation of competence in the application of digital immersive technologies in the educational space of the university at the ascertaining and final (formative) stages of research and experimental work

	Groups	
	CG	EG
Worldview and functional level of formation of competence in the use of digital immersive technologies in the educational space of the university	1,9%	7,8%
Optional-productive level of formation of competence in the use of digital immersive technologies in the educational space of the university	5,9%	51%
The reproductive-normative level of the formation of competence in the use of digital immersive technologies in the educational space of the university	7,8%	56,7%

So, it can be asserted with a probability of 95% that as a result of the formative experiment, there were positive changes in the levels of formation of competence in the use of digital immersive technologies in the educational space of the university in the experimental group.

Conclusions

The role of digital technologies (virtual reality, augmented reality, mixed reality with the use of artificial intelligence) in the educational space of the university is shown, and types are distinguished (computer modeling and simulation; network virtual reality; cyberspace hardware) and the advantages of virtual reality

are considered, the important the role of augmented reality in the educational space of the university. the most well-known means of digital technologies in the educational space of the university are analyzed: virtual reality, augmented reality, and mixed reality with the use of artificial intelligence.

The use of immersive technologies is presented as a tool for involving all students in the educational process, where digital technologies are used to personalize learning, a new innovative educational environment is created, motivation is increased and for understanding reality, providing information, ease of its perception, new opportunities are being searched for a future specialist; The advantages of using immersive technologies in professional education are highlighted, the importance of artificial intelligence for higher education is shown, directions for using a chatbot are suggested.

In the conditions of a real educational process, we conducted a study, the purpose of which is to consider the content and prove the need for digital technologies in the educational space of the university, such as virtual reality, augmented reality, and mixed reality with the use of artificial intelligence, to ensure in practice the high effectiveness of the educational process, which is necessary for the future professional activity of students and to form among students a high level of competence in the use of digital immersive technologies in the educational space of the university.

It can be asserted with a probability of 95% that as a result of the formative experiment, there were positive changes in the levels of formation of competence in the use of digital immersive technologies in the educational space of the university in the experimental group.

Further research is needed to substantiate the ways of using artificial intelligence in the educational space of universities.

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