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Using Augmented Reality Technology in Higher Education Institutions

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Abstract: One way to increase the effectiveness of a mobile-oriented learning environment is to use augmented reality technology, which enables the integration of real and virtual learning tools using mobile Internet devices. The purpose of the article is to theoretically substantiate the use of augmented reality technology in physics classes. The article describes and substantiates the relevance of the application of augmented reality technology, considers possible uses of this technology in the educational process, in particular in terms of mobile distance learning. Examples of mobile applications aimed at practice-oriented learning using augmented reality technology are described. Examples of real educational systems that allow to study the disciplines of physical orientation on the basis of this technology are considered. It was found that augmented reality technologies stimulate the educational process and provide the opportunity to implement knowledge in both humanities and natural sciences. This technology expands the educational process towards clarity and motivates the student to further study the material. Visual education is the best thing that can be offered to modern students, which will contribute to the development of scientific and technological progress. The introduction of augmented reality technology makes it possible to improve the quality of education by motivating students to self-study, increasing audience interest in educational material, developing a desire to use modern interactive technical capabilities and technologies, replacing textbooks and laboratory equipment with multimedia computer models of distance learning.

Keywords: *visualization, learning environment; educational process; physics; physics classes; pedagogical universities.*

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Introduction

The modern world is impossible to imagine without digital technologies that permeate all spheres of human activity, in particular, education. Extensive use of various gadgets in education already leads to a significant decrease in interest in the study of disciplines in higher education institutions (HEI), which, in turn, reduces the quality of knowledge acquisition. Modern students are young people who belong to Generation Z, and therefore many students need visual reproduction through digital means to perceive the educational material. In order to intensify the educational process in the HEI, it is necessary to increase the enthusiasm and interest of students in the use of modern teaching aids. In our opinion, one of the modern technological innovations in education is the use of augmented reality technology.

Elements of augmented reality technology have been evolving since the 1960s and were first seen in interactive films with 3D animated objects. Since then, this area is considered a very promising, powerful and useful tool, especially in education.

The "father" of modern user interfaces is considered to be Sutherland (1968), who developed a helmet of virtual and augmented reality with the apt name "Sword of Damocles" - due to the significant weight and size of the mechanism was permanently mounted above the user.

Due to the lack of mobility of augmented reality technologies, research in this area has not gone beyond individual laboratories for more than 30 years. And only with the advent of mobile devices in the 1990s. Technological prerequisites have emerged for the use of augmented reality technology outside specialized laboratories - in the mobile space of the Internet user.

The term "augmented reality" (AR - augmented reality) was first proposed by researchers Caudell, & Mizell (1992), who worked with engineers from Boeing. Together, they worked on a simple transparent headset that was to help aircraft engineers with complex wiring diagrams. The purpose of applying this augmented reality was to reduce costs and increase efficiency in many operations involving human participation in aircraft construction. The terms "augmented reality", "augmented reality", "augmented reality" are used as synonyms.

The vast majority of people learned about AR or augmented reality technology in 2016 after the release of Pokémon Go (Ne pokemonamy yedynymy. Yak dopovnena realnist zminyuye mystetstvo, 2018). After that,

interest in augmented reality began to grow. The use of AR is not limited to entertainment, penetrating a number of others: global brands "complement" their advertising campaigns, schools use technology to create interactive techniques, and surgeons can "impose" a picture of magnetic resonance imaging or X-ray on the patient's body for more successful carrying out the operation. The use of augmented reality has breathed new life into the work of museums, galleries, in the field of music, cinema, book printing and more.

Augmented reality and education have not escaped. Its implementation is supported by the concept of development of the digital economy and society of Ukraine for 2018-2020 (Pro skhvalennya Kontseptsiyi rozvytku tsyfrovoyi ekonomiky ta suspilstva Ukrayiny, 2018). Its priority tasks are the formation of a sound national policy of digitalization of education as a priority part of educational reform, identification of specific initiatives to connect classes to broadband Internet, creation and implementation of modern models of providing students and educational institutions with computers, preparation, adaptation and organization of access to multimedia technologies. and the creation of appropriate digital educational platforms for use in the educational process and education management. The introduction of AR technology in the educational process was considered in order to:

- analysis of use in education (Akcayir, & Akcayir, 2017; Bicen, & Demir, 2020; Ball, 2018; Belchev, 2014; Kaya, & Bicen, 2020; Matviyenko, 2015; Akcayir, & Akcayir, 2017; Sirakaya, & Cakmak, 2018; Herpich, Nunes, Petri, & Tarouco, 2019);
- formation of motivation and interest of students / pupils (Gerasymova et al., 2019; Nerubasska, & Maksymchuk, 2020; Sheremet, Leniv, Loboda, & Maksymchuk, 2019; Tzima, & Styliaras, 2019; Khan, Johnston, & Ophoff, 2019; Iatsyshyn et al., 2019);
- intensification of educational activities (Melnyk, Zaderey, & Nefyodova, 2018; Melnyk et al., 2019; Cieutat, Hughes, & Guayel, 2012) and increasing the efficiency of the educational process (Zagoranski, & Divyak, 2003; Tekederea, & Gükera, 2016; Rizov, & Rizova, 2015; Cai, Wang, & Chiang, 2014);
- combination with other multimedia technologies (Antonioli, Blake, & Sparks, 2014; Yilmaz, 2016; Caudell, & Mizell, 1992; Chubukova, & Ponomarenko, 2018; Ke, & Hsu, 2015; Wojciechowski, & Cellary, 2013);
- interactions between real and virtual worlds (Billinghurst, 2002; Honcharova, 2019b; Kesima, & Ozarslanb, 2012; Shabelyuk, 2014; Kiryakova, Angelova, & Yordanova, 2018; Zhao, Li, Wang, & Shi, 2020);

- supplementing the materials of the textbook by superimposing virtual content on real pages of text based on a combination of traditional and innovative approaches (Duenser, Walker, Horner, & Bentall, 2012; Honcharova, 2019a).

According to Modlo, Yechkalo, Semerikov, & Tkachuk (2017), one of the ways to increase the efficiency of mobile-oriented learning environment is the use of augmented reality technology, which provides an opportunity to combine real and virtual learning tools using mobile Internet devices. Mobile Internet devices implement the concept of mobile learning - learning regardless of time and place.

Based on the research of Ronald (1997), who clearly defined the goals, objectives and capabilities of augmented reality technology, the author defines this technology as one that combines the virtual and the real, interacts with the object in real time, works with 3D. At present, augmented reality covers more and more areas of human life and activity, including education.

The article considers some approaches to the use of augmented reality technology in education. The author conditionally divides such mobile educational systems into three main groups:

1) visualizes 3D images for visual presentation of educational material;

2) uses augmented reality technology to recognize and mark real objects. Such opportunities allow to implement mobile educational systems that are oriented in space;

3) creation on the basis of interaction of a virtual object built by a computer (smartphone) with a person in real time.

The study of scientific sources made it possible to find out that in the field of view of scientists are constantly relevant problems of teaching physics using AR technology. Possibilities of application of the augmented reality technology are considered during studying:

- physics of students / pupils to form motivation, stimulate interests and help increase the level of their activity in classes / lessons, (Cai, Chiang, & Wang, 2013);

- section "Mechanics" based on the Physics Playground platform (Electronic multimedia application Physics Playground, n.d.), where students have the opportunity to actively conduct their own experiments and study them in a three-dimensional virtual world (create virtual models of experimental models to study physical properties, test formulas, develop theories) (Kaufmann, & Meyer, (2008);

-section "Electricity" of the physics course (Restivo et al., 2014; Techakosit, & Nilsuk, 2015).

- performing laboratory work with potentially dangerous equipment (Martin-Gutierrez, Guinters, & Perez-Lopez, 2012);

- fundamental concepts of the section "Thermodynamics" (Strzys et al., 2018).

Augmented reality makes it possible to visualize a three-dimensional image of an object in front of you, select its constituent elements, rotate the object in space, scale it, while obtaining additional explanations. It is a technology of supplementation in the field of human perception of virtual information, which is perceived as elements of real life.

Based on the analysis of literature sources and publications, it was found that AR technology combines the capabilities of traditional and computer-based teaching methods, their use has an impact on the quality of the educational process of freelance students and students of general secondary education. As a result of these researches the theory of use of AR technology in educational process is enriched and ways of its realization are solved. Studies of domestic and foreign scientists have shown that AR technology, using a variety of dynamic resources (applications), improving motivation, stimulating interests and helping to increase the level of their activity make classes / lessons interesting for both teachers and students.

Unlike virtual reality technology, the augmented reality does not create a completely virtual environment, but combines virtual elements with the real world: virtual objects are added to the real environment of the user, which change as a result of his actions.

Modern achievements of scientists allow us to interpret augmented reality as a promising area in education, as it allows to attract a significant number of students / students to gain knowledge, interest and motivate them to continue their studies. In their opinion, the application of this innovation helps to increase the effectiveness of the visual principle of learning, as it expands its capabilities: clarity; visualization; interest.

Augmented reality technologies create unique opportunities in education. Applying these AR technologies in the educational environment, supplementing them with appropriate visual information, you can build a visual model of educational material. As a result, the development of students' spatial imagination is obtained, which enhances their deep understanding of processes, properties, proof of theorems, etc. *The purpose of the article* is to theoretically substantiate the use of augmented reality technology in physics classes.

Analysis of opportunities to expand the boundaries of traditional (classroom) learning

Analysis of pedagogical theory and practice shows that mobile devices provide an opportunity to expand the boundaries of traditional (classroom) learning by transferring it to a mobile learning environment. Based on the idea of an audio guide in museums, which tells visitors about the most interesting exhibits or paintings, the developers have created mobile software designed to study various disciplines, both socio-humanitarian (including history) and fundamental (including chemistry) and professional. Such tools become a kind of guide, providing information about the most important objects, their compositions, structures and meanings. Other tools are used in the study of botany, providing information about plants as they become acquainted with them in their natural habitat. Mobile Internet devices, in fact, take the literal meaning of the statement that the world is a classroom. In several projects in North America and Europe, mobile devices have been used to immerse themselves in augmented reality. Based on geolocation data, the programs identified processes and structures that take place in the physical world but are invisible to the naked eye. For example, with the help of tablet software, future engineers could "see" where bridge piers are when viewed visually at different angles.

Research data allow us to say with confidence that the use of AR technology provides students with free opportunities and prospects aimed at practice-oriented learning, promotes the development and self-education of each student, provides opportunities for them to obtain the latest knowledge, practical training. The use of AR technology combines science and life, recreates real life situations, helps to create fictional spaces for unsolved problems. It creates new opportunities for mastering practical skills, provides research experience, makes learning a bright process, prevents distractions from learning and increases motivation to learn, helps to better understand complex concepts, definitions, theorems, properties that students must learn while learning.

The authors' research shows that with the development of AR, the set of visual aids will also change - because the need for cumbersome layouts will decrease. There will be an opportunity to see three-dimensional halls and exhibitions of world museums without leaving the classroom. Significant prospects for the use of AR in computer classes, where students in front of a monitor and webcam can, for example, assemble a virtual computer from blocks, view three-dimensional interactive models of

processor, hard drive or put in augmented reality experiments in physics or chemistry. Imagination paints a huge opportunity for new technology in educational and not only computer gamesTherefore, supplemented virtual objects can be viewed with the help of books from different angles and objects. For example, the Dokeo project offers an encyclopedia for little "chomuchok" by the French publisher Nathan. German publishing house ArsEdition based on augmented reality technology in collaboration with Metaio released a prototype of an interactive 3D book "Aliens and UFOs".

To implement augmented reality technology in the learning process can be used:

1. Textbooks and manuals that contain specialized objects with augmented reality technology. With the help of specialized mobile applications, printed illustrations are transformed into animated three-dimensional objects on the subject, which can perform certain movements and are accompanied by sound information.

2. Educational games. Best practice shows that in many cases, the information provided in the form of interactive games is positively perceived by students, activates motivation to participate in the process and helps to increase the level of learning materials.

3. Modeling of objects and situations. Creating graphic objects and designing certain situations that can be used to learn the material saves a lot of material and financial resources, as well as allows you to conduct practical classes directly in the classroom.

4. Skills training applications. When teaching certain disciplines, it is possible to create content in an augmented reality format that can be used as a tool to acquire certain professional skills and abilities. It can be used by students to independently work out specific practical tasks outside the school.

Sharing the opinion of the authors, we emphasize that the use of augmented reality technology in education will:

- to increase the interest of modern students in the educational material through the use of interactive content;
- to form new competencies with the help of augmented reality technology;
- to diversify the educational process with innovative forms of work with the audience;
- to increase the level of motivation of students to independent educational activities in the learning process through the introduction of game, competitive and cognitive stimuli;
- to use during training innovative types of educational search-

cognitive tasks of the generalizing and systematizing orientation which activate educational activity of students;

- to provide the process of processing educational materials with a new organizational form that is attractive to students;

- to create conditions for the development of personal qualities that are not inherent in the educational process in most free educational institutions of Ukraine, which will eventually lead to an increase in students' self-esteem, etc.

Application of augmented reality technology in teaching physics

The authors considered the possibility of applying augmented reality technology in teaching physics, in particular, the section "Electricity". Researchers point out that, despite the widespread research approach in teaching, students are not always able to perform an experiment in the classroom due to lack of time or materials. Performing experimental work in extracurricular time carries additional risks, especially when working with hazardous materials. The use of modern technology provides a safe way to perform experiments both under the guidance of a teacher and independently. Online experiments with augmented reality and sensory devices visualize real research for users and are aimed at giving students the opportunity to observe and describe the work of real systems in the process of changing their parameters and partial replacement of material resources and experimental installations by augmented reality objects. Therefore, the use of augmented reality in various types of physics classes facilitates students' understanding of drawings, technical documentation, operating instructions, etc.

Consider a few examples of projects that allow the use of augmented reality technology in the educational process:

Physics Playground (Electronic multimedia application Physics Playground, n.d.) - a multimedia application in physics that allows you to model using augmented reality technology physical experiments to teach the physics section "Mechanics" (Fig. 1).

The use of this tool is aimed at increasing interest in such areas as physics and supporting active learning of physics in the form of games.

Students have the opportunity to actively design, organize and conduct experiments, study them in three-dimensional virtual space. A variety of tools are available for analyzing the forces, mass, trajectories, and other properties of objects before, during, and after experiments. The use of

the described educational content Physics Playground contributes to the high quality of the educational process in physics.

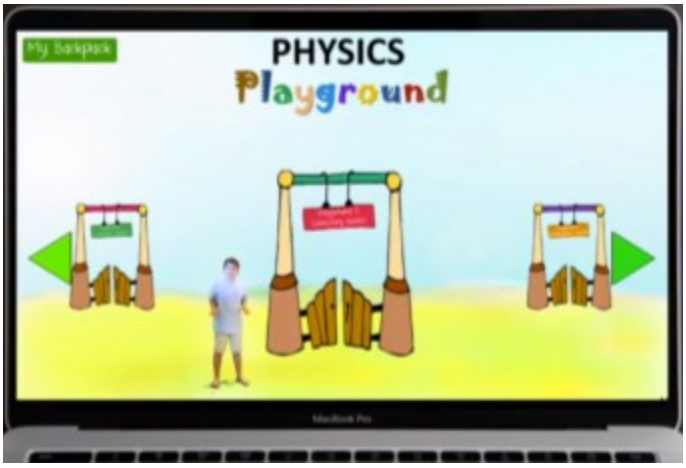


Fig. 1. *Multimedia application Physics Playground*
(Electronic multimedia application Physics Playground, n.d.).

JigSpace (Mobile application with augmented reality technology JigSpace, n.d.) is a free mobile application with augmented reality technology for iPhone and iPad running the iOS 11 operating system. Its use helps to acquaint users with the structure and principle of operation of a number of units, devices, equipment (Fig. 2).



Fig. 2. *JigSpace mobile application*
(Mobile application with augmented reality technology JigSpace, n.d.)

Atom Visualizer (Mobile application with augmented reality technology Atom Visualizer, n.d.) - a mobile application that allows you to get acquainted with the internal structure of atoms, to view three-dimensional images of how the microworld is arranged how atoms, electrons, etc. move (Fig. 3).

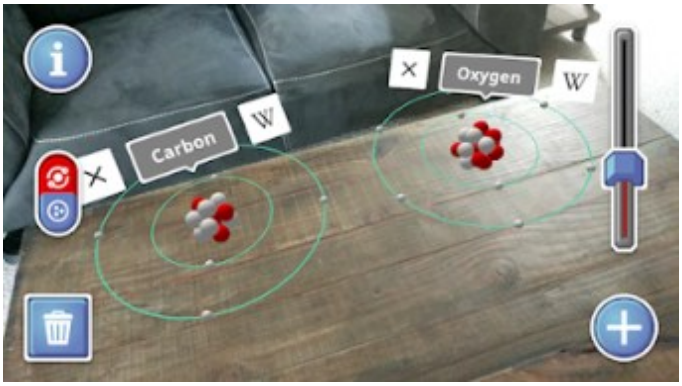


Fig. 3. *Atom Visualizer mobile application* (Mobile application with augmented reality technology Atom Visualizer, n.d.)

Electric Circuit AR (Mobile application with augmented reality technology Electric Circuit AR, n.d.) is a mobile application with augmented reality technology that allows students to learn electrical circuits. Based on dragging the elements of electrical circuits, it is possible to create different combinations of circuits (Fig. 4).



Fig. 4. *Electric Circuit AR mobile application* (Mobile application with augmented reality technology Electric Circuit AR, n.d.)

Particularly relevant and appropriate are the possibilities of using augmented reality technologies in distance learning, ie during quarantine or illness of students.

In our activities today we use available augmented reality software. For example, during the development and formation of students' basic ideas about electrical meters, it will be appropriate to use the mobile application Electricity AR for Android (Mobile application with key images Electricity AR, n.d.) with augmented reality technology, which was developed at the Department of Crystal Physics, Faculty of Physics, Kharkiv National University named after Karazin. It is designed to get acquainted with the symbols of devices, mastering the skills of finding the price of the division of analog devices, finding their readings and measurement limits. To work with the application you need:

1. Print one of the key images at https://www.researchgate.net/publication/330511184_Electricity_AR (Figure 5).

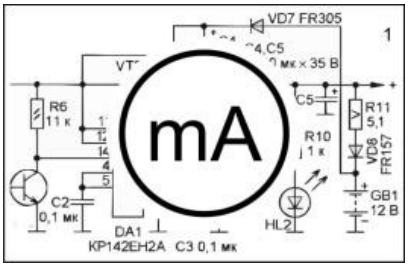


Fig. 5. *Key image for acquaintance with a microammeter* (Electronic application with key images Electricity AR*,* n.d.)

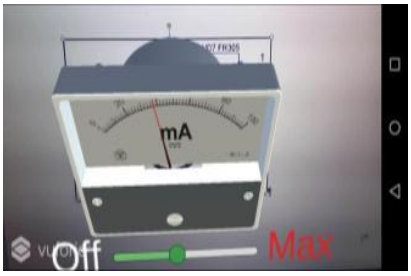


Fig. 6. *Visualization of the microammeter in Electricity AR* (Mobile application with augmented reality technology Cg-physics AR, n.d.)

2. Download the mobile application to your tablet or smartphone.

3. Turn on the application, point the camera at the printed image. As a result, you can see 3D models of the elements of electrical circuits and analog measuring instruments of different designs (Fig. 6). On the basis of which students can determine the price of the division, the limits of measurement of devices, to understand the consequences of exceeding them (Fig. 7).+

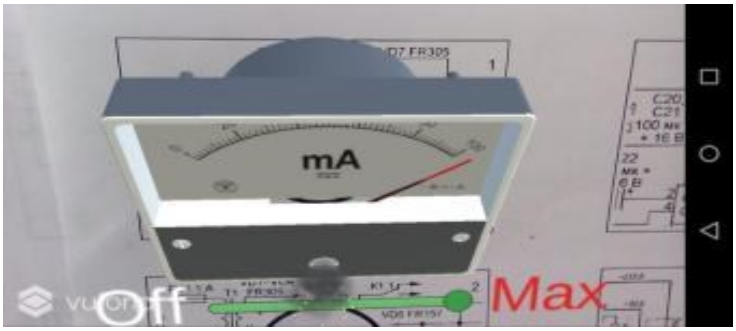


Fig. 7. *Visualization of the condition of exceeding the measurement limits of the microammeter in Electricity AR* (Electronic application with key images Cg-physics AR, n.d.)

We use the Cg-physics AR program (Electronic application with augmented reality technology Cg-physics AR, n.d.) to form students' general ideas about the magnetic field. The sequence of work with the mobile application (Mobile application with augmented reality technology Cg-physics AR, n.d.) is similar to that for Electricity AR *(Electronic application with key images Electricity AR, n.d.)*. The program is downloaded using the service https://play.google.com/store/apps/details?id=com.cg_physics.cg_physics AR. Key images can be downloaded from http://www.cg-physics.org/index.php/de/ar and printed or displayed on the screen (Fig. 4).

Cg-physics AR makes it possible to visualize with the help of augmented reality the lines of induction of the magnetic field of a permanent magnet (strip and horseshoe) and a conductor with current (direct and circular).

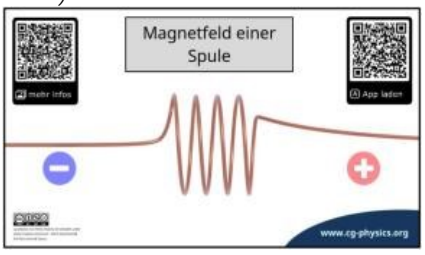


Fig. 8. *Key image for studying the lines of induction of the magnetic field of circular current* (Electronic application with key images Electricity AR, n.d.)



Fig. 9. *Visualization of magnetic field induction lines of each turn of circular current in Cg-physics AR* (Mobile application with augmented reality technology Cg-physics AR, n.d.)

For example, consideration of power lines of induction of a magnetic field of a circular current is visualized step by step: at first the picture of power lines of each turn separately (fig. 9), then - coils as a whole (fig. 10) and the picture for definition of magnetic poles of the coil with current is offered. 11).

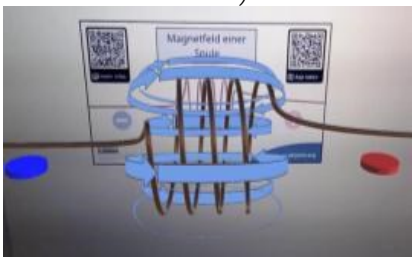


Fig. 10. *Visualization of magnetic field induction lines of a coil with current in Cg-physics AR* (Mobile application with augmented reality technology Cg-physics AR, n.d.).



Fig. 11. *Visualization to determine the magnetic poles of a current coil in Cg-physics AR* (Mobile application with augmented reality technology Cg-physics AR, n.d.)

In our opinion, the most expedient is the use of augmented reality technologies for the implementation of students' activities during laboratory work, especially in quarantine.

During the laboratory classes it is possible to use the mobile application Physics Lab AR (Mobile application with augmented reality technology Physics Lab AR, n.d.) on the iOS 9 platform for iPhone and iPad (Fig. 12).



Fig. 12. *Physical application Physics Lab AR (*Mobile application with augmented reality technology Physics Lab AR, n.d.)

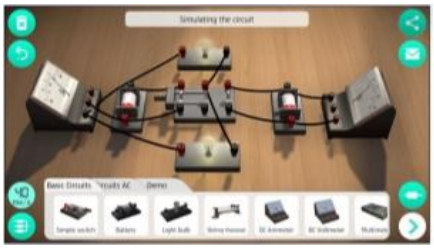


Fig. 13. *Assembly of electrical circuits in Physics Lab AR* (*Mobile application with augmented reality technology Physics Lab AR,* n.d.)

Using Physics Lab AR it is possible to work with different components of electrical schemes based on reading circuits, make electrical

circuits and explore how they work in real time (Fig. 13). This tool is suitable for teachers to demonstrate experiments in physics in the classroom, students to work in the classroom and outside it. In the classroom, teachers can explain in more detail to students the structure of the internal elements of devices and installations, which ensures the effectiveness of training of future professionals.



Fig. 14. *Methodical recommendations for laboratory work in physics using augmented reality* (Modlo, Yechkalo, Semerikov, & Tkachuk, 2017)

The authors describe the possibilities of using guidelines (Fig. 14) and laboratory facilities (Fig. 15), which can be an environment for working with augmented reality.



Fig. 15. *The use of augmented reality during execution laboratory work in physics* (Modlo, Yechkalo, Semerikov, & Tkachuk, 2017)

Laboratory installations or measuring instruments are used as markers, in particular in order to supplement them with instructions for use. Augmented reality provides a solution to the urgent problem of encouraging students to research and motivates them to experiment.

In turn, Martin-Gutierrez, Guinters, & Perez-Lopez (2012) note that augmented reality can be used for joint work of students. This is especially

true when performing laboratory work with potentially dangerous equipment that requires constant monitoring of student activities. Real laboratory work is preceded by augmented reality work by placing markers on laboratory installations. Using markers, students can use a mobile device to visualize the instructions or learning materials needed to properly use and configure the equipment.

So, working with augmented reality objects is to simulate different pieces of learning material using the necessary markers. In an augmented reality system, the user can control the laboratory installation by changing the position of the switch, combining different elements, etc., by simple decomposition, rearrangement and rotation of the markers.

Any augmented reality tool can be a learning object if it is controlled and facilitates user interaction with real objects in order to study their properties during experimental research. If these requirements are met, cognitive and emotional experiences can provide a complete understanding of what students are learning. Therefore, we agree with that the use of augmented reality:

– provides an opportunity to increase the realism of the study;

– provides emotional and cognitive experience that helps to involve students in systematic learning;

– provides correct information about the system in the process of experimenting with it;

– creates new ways of presenting real objects in the learning process.

We share the opinion of Cieutat, Hughes, & Guayel (2012), who, considering the possibilities of using augmented reality to enhance learning, outline the main directions of its use:

– modeling environments, which combine the possibilities of teaching, learning, communication with game elements;

– support for research and experimental approach;

– checking the model for adequacy;

– acquisition of technical skills, etc.

Based on it, it can be argued that the use of augmented reality in the education system contributes to:

- gaining experience in project activities;

- collective implementation of information projects;

- creation, editing, design, storage, transmission of information objects of various types with the help of modern software;

- information activities in various fields in demand in the labor market;

- development of algorithmic thinking, abilities to formalize,

elements of system thinking;

- mastering the skills to use information and communication tools and customize them for user needs.

We also emphasize that augmented reality technology develops spatial imagination and thinking and promotes a more harmonious development of personality.

Conclusions

The article describes and substantiates the relevance of the application of augmented reality technology, considers possible uses of this technology in the educational process, in particular in terms of mobile distance learning. Examples of mobile applications aimed at practice-oriented learning using augmented reality technology are described. Examples of real educational systems that allow to study the disciplines of physical orientation on the basis of this technology are considered.

It was found that augmented reality technologies stimulate the educational process and provide the opportunity to implement knowledge in both humanities and natural sciences. This technology expands the educational process towards clarity and motivates the student to further study the material. Visual education is the best thing that can be offered to modern students, which will contribute to the development of scientific and technological progress.

Introduction of modern teaching aids into the system is the most important condition for strengthening the educational process, which is the interactivity of 3D modeling and the use of augmented reality technology. This is, in particular, important for future teachers of physics and mathematics.

The necessity in the development of educational classes on the basis of the introduction of augmented reality technology is substantiated, which will allow to transfer the educational activity of students of pedagogical free economic zones to the plane of real time. It can be argued that augmented reality technology is a tool of the future that has fundamentally new visualization capabilities and will be useful for teaching students in free economic education. In particular, it will promote the development and self-education of each student, provide opportunities for them to obtain the latest knowledge, practical training for professional activities.

Thus, the introduction of augmented reality technology provides an opportunity to improve the quality of education by motivating students to self-study, increasing audience interest in educational material, developing a

desire to use modern interactive technical capabilities and technologies, replacing textbooks and laboratory equipment with multimedia computer models under distance learning conditions.

Recently, in foreign countries, augmented reality is actively included in many areas of human life, including education. In our country, the issue of modernization of education in terms of the use of these technologies still remains open. The use of augmented reality has a positive effect on the educational process - that's for sure. Among the advantages and disadvantages of augmented reality technology AR, we include the following (Table 1)

Table1. *Advantages and disadvantages of using augmented reality in the educational process*

Positive sides	**Unresolved issues and shortcomings**
1. Increased interest in education material, self-study and learning new things 2. Visibility of training increases it quality and efficiency 3. There is a development of spatial imagination and thinking 4. Interactive learning prevails 5. Attracts ease of use applications 6. Ability to study a large amount of information in less time 7. Using the effect of student enthusiasm (as you know, when you connect the emotions of memorization is better)	1. The need to develop special applications 2. Some restrictions on use related to technical aspects, such as the mandatory availability of appropriate technical means (smartphones, tablets, etc.) 3. The success of marker recognition depends on the lighting, the angle at which the user points the camera and the quality of the camera itself 4. The variety of applications complicates the formation of a universal tool for reading information 5. Lack of a single educational platform

The prospects for further research include testing the effectiveness of the use of augmented reality technology during classes in higher education in physics of various kinds: lectures, practical and laboratory.

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