Conclusion. 3D graphics allows you to convey accurately the volume and the depth of space, and the materials attached to the objects add realism to the environment, which allows you to recreate accurately the subject-spatial environment.

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APPLICATION OF AUGMENTED REALITY FOR IMPROVING EDUCATION EFFECTIVITY

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Keywords: augmented reality, AR, mobile application, web application.

The article discusses the advantages of using augmented reality in the process of teaching students and schoolchildren. The description of a mobile application and a web application for visualization of educational materials on the pages of textbooks is presented.

The relevance of the work. To date, augmented reality technologies are actively developing and are being used in various spheres of activity-news. As for the field of education, augmented reality technologies are a fundamentally new approach to accompany educational materials with visual images.

The aim of the work is to develop a mobile application that complements any textbook with digital materials using augmented reality technology, as well as a web application for the management of augmented reality objects.

Material and methods. The research material is the creation of a qualitatively new level of information and subject environment for students due to their "immersion" in three-dimensional augmented reality, which gives the student the opportunity to simulate the feeling of direct contact with objects, contactless control of them, simulate reality by actualizing the effect of personal presence and participation in processes occurring on the screen of a smartphone or tablet, interaction with objects or processes that are reflected on the screen, the implementation of which is impossible in reality[3].

The paper uses experimental-theoretical research methods: analysis and synthesis, abstraction, formalization, modeling.

Findings and their discussion. The information saturation of the modern world requires special preparation of educational material before its presentation to students. One of the effective technologies for activating learning is the method of visualization of educational information, which has firmly taken its place in the educational process. The use of visual forms of assimilation of educational information allows you to change the nature of learning: accelerate percep-

tion, understanding and generalization, develop the ability to analyze concepts, structure information [1].

Augmented reality (AR) technology is one of the key directions of informatization of society, a fundamentally new approach to the accompaniment of educational materials with visual images.

One of the most objective criteria for the success of using augmented reality in education is to improve the quality of students' knowledge on the subject. We conducted a study based on teaching biology using augmented reality. The students were divided into three groups: schoolchildren studying the subject using AR under the guidance of a teacher; children using AR in the form of independent work, and a control group - students studying using traditional methods. The groups were compared according to the results of training and emotional state. As a result, the study showed that students studying the subject using AR under the guidance of a teacher achieved better results, while students studying independently received more positive emotions from the subject (Illustration 1).
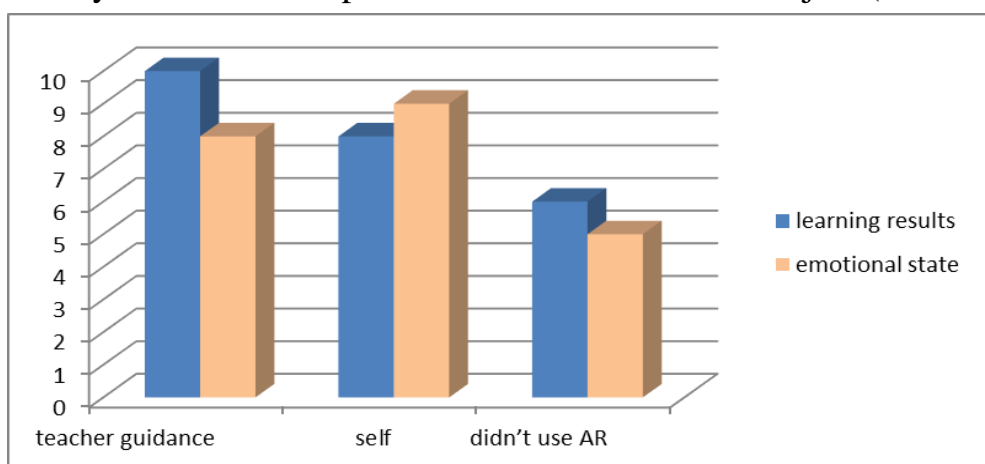

Illustration 1. The impact of AR on learning outcomes and emotional well-being.

One of the key solutions to improve the effectiveness of training is the development of an AR application using the Vuforia platform and the Unity 3D environment integrated with it, which allows you to recognize the necessary images when displaying various media materials, such as 3d models and gif animations.

This application is used in the textbook "Human life safety" (I.M. Prishchepa, V.A. Klyuev, A.N. Dudarev) [2] with elements of augmented reality, which was published in 2020 and received the Seal of the Ministry of Education of the Republic ofBelarus.

We have developed a web application for managing augmented reality objects, the main task of which is to store and display a catalog of objects, as well as to ensure effective interaction with the user through a user-friendly interface. The application is implemented in the JavaScript programming language using React and Redux libraries, the Atom code editor was used as the development

environment, Node.JS technologies were used to manage packages, in particular: NPM [3].

The mobile application created by us has the following advantages:

· a qualitatively new level of information-subject environment (absence of restrictions of the real environment and the possibility of its addition);

· universality (the ability to use augmented reality images to create images in any textbooks);

· the prospect of long-term maintenance of the product (the possibility of replacing the contents without changing the printed textbook);

· accessibility (nothing is required for our technology except a phone with a camera).

The economic significance of the project lies in the fact that three-dimensional graphics make it possible to demonstrate the model more effectively without referring to real objects that may be inaccessible (volcano, coral reef) or dangerous (nuclear reactor, forest fire, shark), may be far away or expensive.

The social significance of the project lies in the development and optimization of students' education processes through the visualization of images from textbooks using augmented reality technologies. The project is at the stage of creating a server part of the application that will download data from the network, and users will be able to add their photos, 3d models, gif animations and video files there.

Vitebsk State University after P.M. Masherov is already actively using augmented reality when conducting classes. The results of using AR tools for teaching Chinese show that it is much faster for average and weak students to learn the subject with its help [4].

Conclusion. The result of the work is the development of a mobile application that complements any textbook with digital materials using augmented reality technology, as well as a web application for the management of augmented reality objects.

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