Augmented Reality Technology as an Immersive Teaching Tool in the Middle School Biology Course

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Abstract. Based on the analysis of publications on the topic of digitalization of biological education, the article identifies four trends associated with the introduction of digital technologies and tools into the educational process: the formation of a blended learning model; transition to online learning; creation of an immersive educational environment; use of augmented reality technology. These trends are interconnected, and each of them affects the general biological education in Russia. On the one hand, digitalization contributes to an increase in the openness, flexibility of education, and an increase in the involvement of schoolchildren in the process of teaching biology in high school. On the other hand, it leads to the creation of a new educational situation, the inclusion of new factors in the system of biological education, which changes the nature of the relationship between its main participants. Digitalization introduces significant changes in the role of a biology teacher and a high school student in the process of teaching biology, which requires appropriate adaptation. The necessity of systematizing the educational and social effects of the introduction of immersive technologies in biological education and conducting longitudinal studies is substantiated. The design of the study was developed, which is based on the strategy of introducing immersive technologies in blended teaching of biology in high school.

1 Introduction

The development of informatization of education is characterized by the active and systematic use of digital technologies at all levels of the education system [8]. The demand for digital technologies in the sphere of education is obvious – their use allows solving multifunctional educational tasks in a short period of time: high-speed search for information, its visualization, graphic interpretation, modification, processing, formalization, production, including large volumes of structured and unstructured information; adaptation of information systems to new technical and technological

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conditions; modification of information systems without replacement of technical means; identification of the person of the student in the organization of his educational activities in the conditions of legitimate access to the relevant information sources; joint creation of an information educational resource; checking the text of written works of students for originality, adequacy of the subject, scientific character and literacy; simultaneous participation of a large number of subjects of the learning policy in web-conferences and other professional network communities; intellectualization of information activity and information interaction between the subjects of the learning policy, etc. Important for our study is the concept of “digital transformation of education”, proposed by I.V. Robert, as "the result of systemic significant changes that have occurred and are occurring in the field of education, in connection with the active and systematic use of digital technologies and the implementation in educational practice of the results of the achievements of scientific and technological progress of the modern information society of mass global communication" [4].

The digital transformation of education and, in particular, biological education is relevant, as it makes it possible to solve multifaceted educational tasks in a short time, in the context of the uncertainty of the duration [1].

The most popular in education are immersive educational technologies that provide full or partial immersion of students in a special educational space designed by interactive learning tools. Immersive technologies include, in particular, augmented reality (AR) technology – a technology that provides the introduction of 3D models into the physical environment in order to obtain additional information [2, 3]. The article discusses the teaching of biology in a modern school using digital technologies of augmented reality. The model of interactive interaction through AR technologies is shown in Figure 1.

![Model of interactive interaction through augmented reality technologies.](image)

AR-learning technologies are characterized by the use of different 3D models and applications in the learning policy in biology. Possible directions for using augmented reality technology in teaching biology at school are shown in Figure 2.
Fig. 2. Possible directions for using augmented reality technology in teaching biology at school.

Only the active involvement of students in joint cognitive, educational, research and project activities with the help of modern teaching aids will achieve high educational results.

2 Materials and Methods

When performing tasks, the sequent research methods were used:

– conceptual: inspection of data of the topic, subject and problem of research based on the methodology of a systematic approach, analysis of scientific literature and legal documents on the problem of forming the information culture of high school students using AR-learning technologies, comparison and synthesis, constructive modeling, design of the educational process;

– empirical (analysis and generalization of the results of educational activities of teachers and students of secondary school; construction of learning and methodological maintenance); questioning and diagnostic (longitudinal observation, questioning, and testing); experimental (stating, forming, control experiment), as well as processing empirical data using methods of mathematical statistics.

3 Results and Discussion

To include the means of AR technologies in the information activities of schoolchildren in teaching biology, methodological tools have been developed: a workshop on general biology using AR, AR quizzes, AR exposition, podcasts using AR applications, AR cases of biological content [5, 7]. As part of distance learning in 2020-2022, the educational independence of high school students in an immersive educational environment was organized using the developed AR course on the topic "Cytology", AR didactic materials on the topics "Genetics", "Evolutionary Teaching", "Ecology" on the platform and website and YouTube channel. Experimentally, the virtue of the tentative methodology for the organization of the information culture of university students of the digital generation in
teaching biology was tested (figure 3). The effectiveness of the experimental methodology for teaching biology using AR technologies can also be judged by the formation of the motivated need of the person, the level of education and information culture [6].

![Fig. 3. Dynamics of the current knowledge of students in the control and experimental classes in the course of experiments.]

Table 1 clearly shows the positive dynamics in the number of schoolchildren with a high level of intrinsic motivation for learning activities in biology classes using AR.

**Table 1.** Levels of internal motivation of students at the ascertaining and control stages of the educational experiment of the testing and experimental groups (in % of the total amount of respondents).

| Level of intrinsic motivation | Groups | | |
|------------------------------|--------|--------|--------|--------|
|                              | Experimental | Control | Experimental | Control |
|                              | Ascertaining point | Control point | Ascertaining point | Control point |
| High                         | 21,4 | 35,6 | 21,5 | 26,6 |
| Medium                       | 55,2 | 49,3 | 53,2 | 53,1 |
| Low                          | 23,4 | 15,1 | 25,3 | 20,3 |

Analysis of the control outcomings showed an increase in the level of the axiological foundations of information culture, focus on value-significant landmarks in the course of information activities using AR-learning technologies using the example of biological content in the testing group compared to the examining group. The result of the using of the experimental technique was an increase in the amount of choices for such motives for working with information as an independent search using additional AR resources, the same as the rate of biological knowledge. Internal diagnosis of the value bases of information culture, which was carried out through the Google-test mobile testing system, made it possible to identify an increase in the level of information culture of schoolchildren. The data presented in figure 4 clearly demonstrate that in the experimental group, where biology was taught using AR technologies, compared with the results of the testing group, the number of high school students with a high (critical) level of value bases of information culture increases by 21%, and with low (permissible) level – decreases by 37%.
4 Conclusion

1. During the study, the didactic potential of integrating AR technologies into the biology coursework in a secondary (complete) general education school was considered.

2. The outcome of the experimental work proved that the experimental methodology for teaching biology using AR is effective, because promotes an increase in the level of learning, motivation and information culture of schoolchildren.

3. The effectiveness and practical significance of the developed methodological means in the educational process in biology are shown: a workshop on general biology using AR expositions, podcasts using AR applications, an AR course on the topic "Cytology" in a virtual learning environment, didactic AR materials on the topics "Genetics", "Evolutionary doctrine", "Ecology on the platform, personal website and YouTube channel.

So, enriched reality technology, loading technologies have become a powerful and hopeful mean in education due to their extraordinary technological internals that differentiate them from other IT applications. A primary mission is seen as changing learning techniques, creating hopeful integrated learning systems, where the main role will be assigned to the immersive method - a set of advanced techniques implemented in basically new conditions. This shows an urgent need to form new strategies for teaching stuff for education, whose labor activity in the future will certainly be applied in completely different arrangements. Of course, the total supremacy of the immersive method in education should not be expected, still, the prospect of close cooperation with the new "imitative" world is a reality in the nearest years, motivating the development of adaptable information immersive environments.

References


