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Some aspects of using mixed reality technologies in the training of physics teachers

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Abstract. The introduction of modern technologies in the learning process at school is an important task, both for the education system as a whole and for an individual teacher. The ability to work with new teaching aids allows the teacher to interest students in their subject. One of these tools is virtual and mixed reality headsets. The emphasis is on mixed reality, although the two are often closely related. The article provides a brief overview of works devoted to the use of mixed reality in teaching physics, a study of the readiness of students of a pedagogical university to use this technology in their future professional activities is carried out. The questionnaire for expert assessment of mixed reality developments has been modified, and a survey of experts in this field has been conducted. The results of the research may be of interest to teachers of various specialties, senior students and graduate students in the field of physics teaching methods.

1. Introduction

Training of teachers in modern realities in Russia is an important and difficult task [1-3]. General problems [2] are especially acute in the field of engineering and technical education [1]. This is directly related to the basic science disciplines at school, in particular, physics. The authors of works [1-3] point to the problems of Russian education, which leads to a slowdown in the economy and other unfavorable economic consequences. This is how the ineffectiveness of teacher education is highlighted, as a result of the low economic and social status of teachers, problems with employment after training, the lack of innovative research conducted at universities, and much more [2]. Undoubtedly, the identified problems are relevant to one degree or another for different regions and levels of education. The purpose of this work is to consider the possibilities and prospects of using modern technical means using the example of mixed reality (MR) technology in the preparation of physics teachers. We also see the expediency of this topic in the fact that students of a pedagogical university will not only gain knowledge using mixed reality, but also in the long run embed MR elements into their lessons and events. The relevance of the



introduction of such technologies in the form of fragments of lessons or full-fledged lessons in a virtual environment has increased with the introduction of elements of distance learning.

Next, we will consider the main trends in this area. In one of the early works [4], dealing with mixed reality issues, variants of the classification of technological devices of the late XX century are given. Despite the fact that technology has made great strides forward, let us note one of the approaches, which is based on the degree of knowledge of the world, fidelity and immersion. This approach also corresponds to virtual reality in general. As emphasized in work [5], mixed reality is one of the branches of virtual reality.

Traditionally, the most developed area of application of virtual technologies is natural sciences [6-18]. Most of the works come to the conclusion about the success of using VR and MR technologies in teaching. The study of the implementation of virtual reality technologies in the educational process of schools in the study of natural sciences showed a number of features. In [19] it is emphasized that all teachers reacted positively to the implementation, but highlighted a number of difficulties. In particular, it was noted that for high-quality integration, ready-made content and methodological support are required. These results show the need for an earlier acquaintance of teachers with these technologies when studying the methodology of the corresponding disciplines.

2. Methods and means

Technically, the study was based on the use of classvr virtual and mixed reality headsets [20] with basic software and a web interface. This equipment allows you to use the developed content, which is extremely important when considering standard tasks. The portal has ready-made developments that can be applied in the classroom in a wide range of disciplines, both the school curriculum and higher education.

At the first stage, meta-analysis was used as a research tool, providing the study of literary sources on the research topic [21, 22]. More than 50 works were analyzed, touching upon both general issues of the application of modern teaching technologies, and some particular aspects in the preparation of teachers and the study of physics. As a result, the most closely related works to our topic are discussed here.

Further, a survey of students of the Shukshin Altai State University for Humanities and Pedagogy, (Biysk, Russia) from 1 to 5 courses. The total number of respondents was 54. The content of the survey and its results are discussed below.

The final stage of the research was an expert assessment of a number of our developments for mixed reality [23, 24]. The credibility and reliability of the results depends on the competence of the experts [25]. That is, the opinion of a highly qualified group of experts may well turn out to be reasonable and reliable. This method is simple from the point of view of its organization, in comparison with the survey of a large number of students, however, the subjective factor of the respondents is not excluded. It is advisable to apply both methods simultaneously, using both objective development trends and expert opinions. Also, in order to obtain an accurate forecast, experts must have the ability to adequately reflect the development trend of the object under study, experience in the area under consideration.

3. Results and discussion

Consider the results of an Internet survey of students. The questionnaire for students included the following seven questions:

- “Have you used VR or MR solutions in teaching or in another area?”;
- “Do you think the use of VR and MR technologies in education is effective?”;
- “In your opinion, is the assimilation of material with the help of VR and MR technologies different from the traditional presentation of information in the classroom?”;
- “Do you think that the degree of visibility of traditional means of demonstration is higher than that of VR and MR technologies?”;
- “Can VR and MR technologies replace traditional teaching?”;

- “Would you like VR or MR technologies to be used in the classroom?”;
- “Do you plan to use VR or MR technologies in your future professional activities?” There were three possible answers: “Yes”, “No”, “Difficult to answer”.

The structure of the distribution of students by course is shown in figure 1. More than 50% of the respondents were second and third year students, due to the greater activity in learning and less employment in other areas.

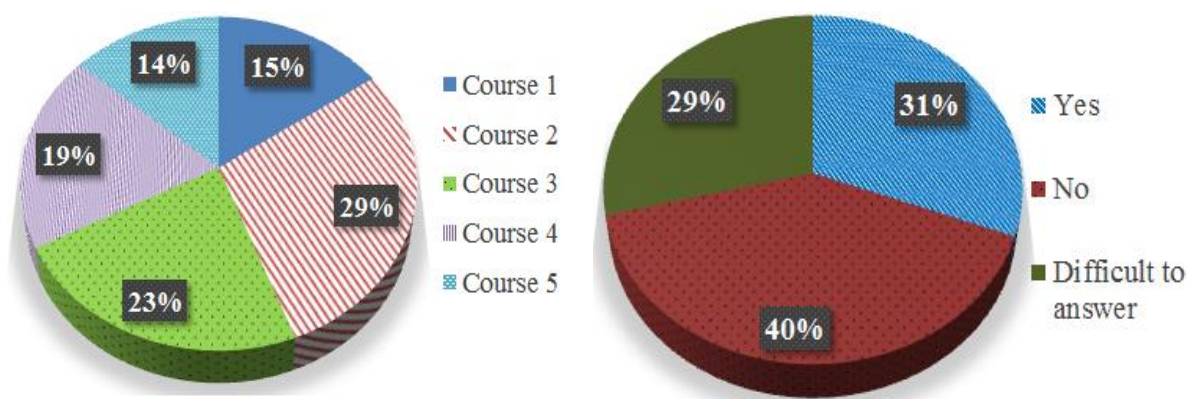


Figure 1. Distribution of respondents by training course.

Figure 2. Students using MR and VR technologies.

Figure 2 shows a diagram for a question about the use of these technologies in a particular field of activity. Note that many students have not encountered mixed and virtual reality technologies, not only in the educational sphere, but also in others, such as entertainment and games. Only about a third of the participants answered unequivocally positively. Slightly fewer respondents found it difficult to answer whether they had encountered these technologies. This confirms the need to include information in training courses.

When answering the question about the effectiveness of the use of VR and MR, students of the two senior courses answered positively, or found it difficult to answer. So 86% of fifth-year students are confident in the effectiveness of these technologies, in the fourth year 80%, the rest of the students found it difficult to answer. While from 1 to 3 years of study there are negative answers. Obviously, this is due to the fact that methodological disciplines begin to be studied from the fourth year of study.

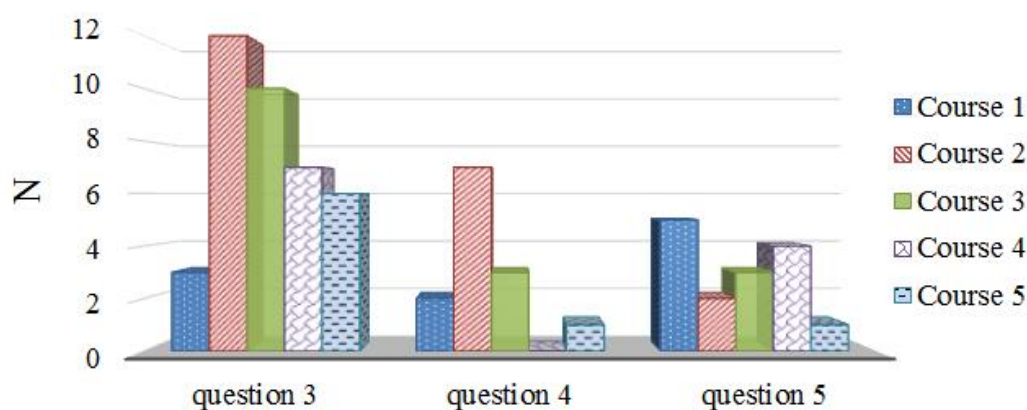


Figure 3. Histogram of positive answers of respondents to questions 3, 4 and 5, where N is the number of students.

Questions affecting the methodological prospects for the use of VR and MR are reflected in the form of a histogram in figure 3. Summarizing the results, it should be noted that the majority of respondents see the use of these technologies in physics lessons as promising. At the same time, it is noted that these technologies should be used in conjunction with others. Virtual reality provides greater visibility and accessibility in the classroom.

Further, 67% of students spoke in favor of using these technologies in the classroom, 6% believe that such technologies are not needed. At the same time, when discussing their future professional activities, the majority of 58% found it difficult to answer whether they would use VR and MR. The same 6% would not like to use these technologies in their work. 36% answered positively to the final question.

For an expert assessment, the technological map attached in [26] has been modified. For the assessment, the experts were asked to evaluate the developments discussed by us in the works [23, 24]. The results are shown in table 1.

Table 1. Expert assessment of methodological developments for mixed reality.

	Criteria	Assessment levels	Points / Experts				
			a	b	c	d	e
1	The quality of using VR and MR technologies and methodological support	1 point - elements of VR and MR technologies are used in the development (sensors, VR gloves, etc.).					1
		2 points - the use of elements of VR and MR technologies is methodologically substantiated.	2	2	2	2	
		3 points - the development uses a set of elements united by common educational goals.					
		Overall score:			9		
2	The quality of the used educational content	1 point - the library of VR and MR technologies is widely used in the development.					
		2 points - borrowed content is methodologically used in the development.					2
		3 points - the development uses methodologically grounded content made in Paint 3D, Blender 3D, etc.	3	3	3	3	
		Overall score:			14		
3	Creation of health-preserving conditions for educational activities	1 point - the development provides for dynamic pauses.	1	1		1	
		2 points - in development, health-preserving conditions, in addition to dynamic pauses, are achieved due to the diversity of students' cognitive activity.				2	2
		3 points - the development traces the physical culture of a person, the responsibility of choice.					
		Overall score:			7		
The sum of points for the entire sample: 30							

The expert assessment showed a score typical of the average statistical assessments of multimedia resources [26, 27]. Perhaps this result is due to the fact that experts did not apply these technologies in practice, but rely on the experience of using other multimedia interactive technologies. The experts put a low score in the item of health-preserving conditions. This is due to the presence of studies showing that virtual reality headsets can cause dizziness and headaches.

4. Conclusions

The article analyzes the literature on the use of mixed and virtual reality technologies in the preparation of physics teachers. A survey was conducted among students from 1 to 5 years of study. The results of the survey indicate that these technologies are of interest to students of a pedagogical university, both in their training and as a methodological tool in their future professional activities. However, there are skeptical students, about 6%, who plan to adhere to traditional teaching methods. Expert assessment of developments with mixed reality elements showed that they are considered by experts as other

multimedia means. According to the results of the study, the introduction of mixed and virtual reality systems into the training of physics teachers seems to be expedient along with other innovative technical teaching aids.

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