USE OF AUGMENTED REALITY TECHNOLOGIES IN TEACHING COMPUTER SCIENCE

Yunusov Azizbek Fazilovich
Acting Associate Professor of Andijan State Pedagogical Institute
Yunusov Fozil Mirzamamirovich
Associate Professor of the "University of Economics and Pedagogy" Ph.D.
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Abstract. This article describes the issues of using augmented reality technologies in the process of teaching computer science and information and communication technologies to university students and the results obtained through experimental verification of their effectiveness.

Keywords: informatics; information and communication technologies; augmented reality; technology; experiment; efficiency.

In modern society, new technologies are emerging every year, and their role in human life is increasingly increasing. These technologies are increasing the efficiency of various processes. Education is no exception.

One of the promising technologies that can be used in education is augmented reality, which can be viewed as a hardware and software system designed to enhance reality with virtual objects. This technology represents a new way of accessing information, and its impact on society can be justified by the emergence of the Internet [1,2].

The global network has made information more sensitive to the context determined by environmental conditions. When a large amount of information becomes publicly available, its availability is no longer important, but it is important to obtain the necessary information about the object at a given time.

The introduction of new technologies always raises a number of questions and difficulties related to an objective assessment of their effectiveness. Research is being conducted to develop a number of approaches to the use of augmented reality technologies in teaching computer science in higher educational institutions. Part of this research requires proving the effectiveness of using such technologies in teaching computer science to 2nd-year students of the 2nd-year Pedagogical Faculty, "Pedagogy" major, through an experiment. Since augmented reality technology serves as both an object of study and a teaching tool in the computer science course, it is necessary to conduct two experiments to study its effectiveness.

The first experiment tested the hypothesis that the use of augmented reality technology in teaching students of higher education institutions would increase the effectiveness of learning about this technology, rather than simply providing an understanding of it. The second experiment tested the hypothesis that the use of augmented reality technology in teaching could increase the effectiveness of learning specific topics in the computer science curriculum.

These experiments were conducted in the 2024-2025 academic year with the participation of 2nd-year students of the "Pedagogy" educational direction of the pedagogical faculty of the Andijan State Pedagogical Institute. The first experiment assessed the students' skills in using augmented reality technology while performing tasks. The final data were

collected during the experiment and classified according to five indicators (Table 1). The following symbols are used in this table:

N– control group, T – experimental group.

Table 1

The final level of knowledge and skills in studying augmented reality technologies among 2nd year students

o.	Knowledge and skills in learning augmented reality technologies	Low level (1–2 points)		Adequate level (3–4 points)		High level (5 points)	
		Groups					
		N	T	N	T	N	T
		Student	Student	Student	Student	Student	Student
		%	%	%	%	%	%
1.	Skills in creating models for augmented reality systems	33	9	22	36	12	21
		48,8%	13,1%	32,5%	56,0%	18,8%	31,0%
2.	Know the components required for an augmented reality system	36	3	18	45	13	18
		53,8%	4,8%	26,3%	68,0%	20,0%	27,4%
3.	Learn the features of working with an augmented reality marker	25	7	26	36	16	23
		37,5%	10,7%	38,7%	54,8%	23,8%	34,5%
4	Know the algorithm for adapting an augmented reality model to real objects	28	4	27	35	12	27
		41,3%	5,9%	40,0%	53,6%	18,8%	40,5%
5	Skills in working with augmented reality devices	31	7	22	35	14	24
		46,3%	10,7%	32,5%	52,4%	21,3%	37,0%

At this stage of the experimental work, the average score for each indicator was determined (Table 2) and a diagram was drawn up (Figure 1).

Table 2

Average scores determined during the experimental testing of knowledge and skills in the field of studying augmented reality technologies for 2nd-year students

Knowledge and skills in the field of studying augmented reality technologies	Control group	Experiment group
1. Skills in creating models for augmented reality systems	2,9	4,0
2. Know the components required for an augmented reality system	2,6	3,8
3. Know the features of working with an augmented reality marker	2,8	3,9

4. Know the algorithm for adapting an augmented reality model to real objects	2,95	4,1
5. Skills in working with augmented reality devices	3,1	3,1
Overall average score	2.87	4.02

If we conclude based on the overall average score determined after the end of the test based on the experimental results, the augmented reality technology training system developed during the research is effective, since it showed a difference of 1.15 points between the average scores in the control and experimental groups. Thus, the level of overall knowledge and skills of students in the experimental group on augmented reality technologies increased by 23.1% compared to the control group.

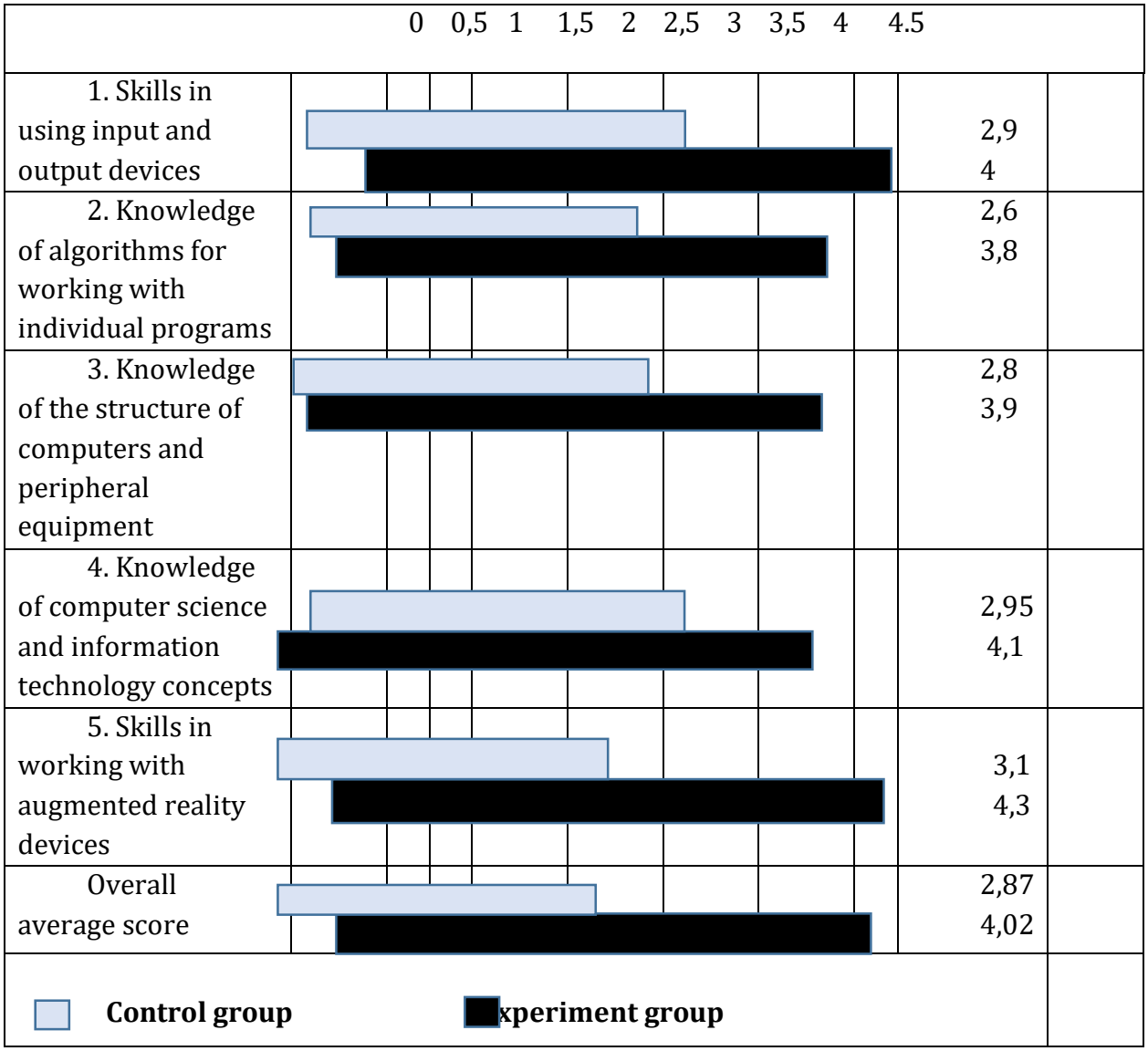

Figure 1. Results of an experiment to test the effectiveness of learning augmented reality technology

The second experiment aimed at testing the effectiveness of using a computer hard drive as a model as a teaching tool for augmented reality technologies was conducted by the author of the article with the participation of 2nd-year students of the Pedagogical Faculty of Andijan State Pedagogical Institute, "Pedagogy". A total of 105 students participated in the experiment. During the experiment, students' understanding of the structure and principles of operation of a computer hard drive was assessed using a four-point assessment system. The training used specially developed three-dimensional models of a computer hard drive and markers that form the basis of the use of augmented reality technologies.

The results of the study of a computer hard drive in the control and experimental groups, obtained by processing data using the experiment and the Microsoft Excel spreadsheet, are presented in Table 3 and shown in the diagram in Figure 2. During the experiment, for comparison, a relative coefficient K was introduced for the mastery of computer science knowledge by students in the same group. This coefficient is equal to the average indicator, taking into account the number of points received and the correspondence of each point to the level of knowledge received by students.

Table 3

Results of the experimental study of the effectiveness of using augmented reality technologies as a means of teaching computer science in higher education institutions

Groups	Number of students	Number of students by grades				K
		5	4	3	2	
Experience	92	31	39	17	5	0,85
Control	95	11	35	33	16	0,71

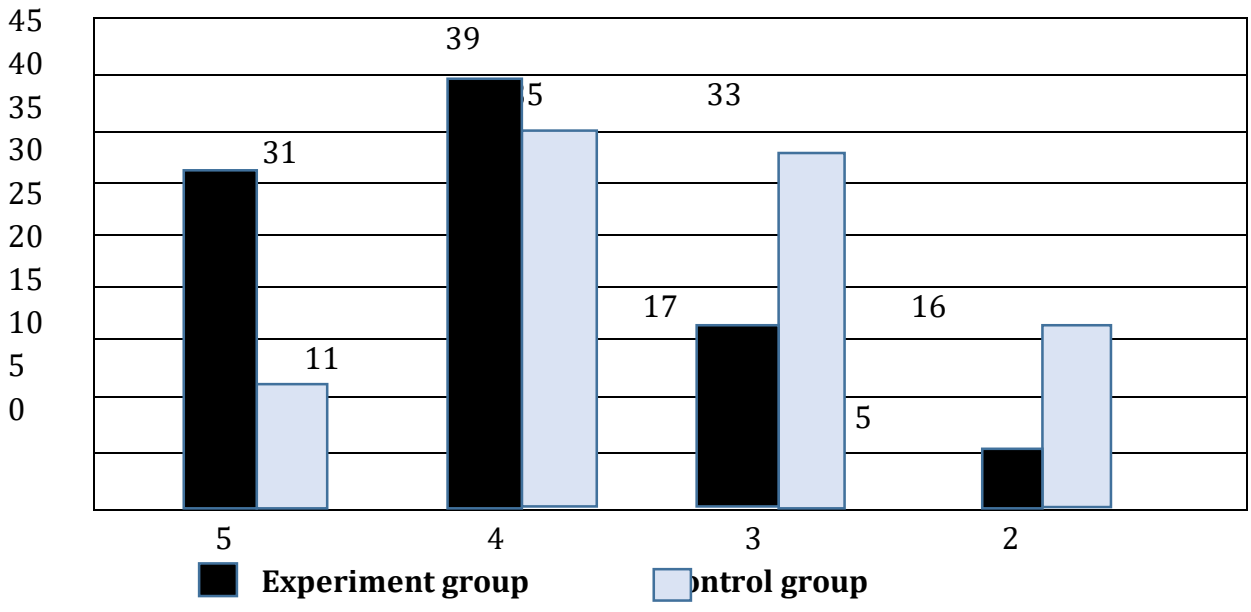

Figure 2. Distribution of students' results by level of preparation in determining the effectiveness of using augmented reality as a teaching tool for computer science

The tables, figures and the analysis of the coefficient K depicted in the diagram (Figure 3) show the superiority of the experimental group over the control group. This means that

studying the characteristics of a computer hard drive using augmented reality technology ultimately has a positive effect on the mastering of the material in the relevant section of the computer science curriculum in higher educational institutions.

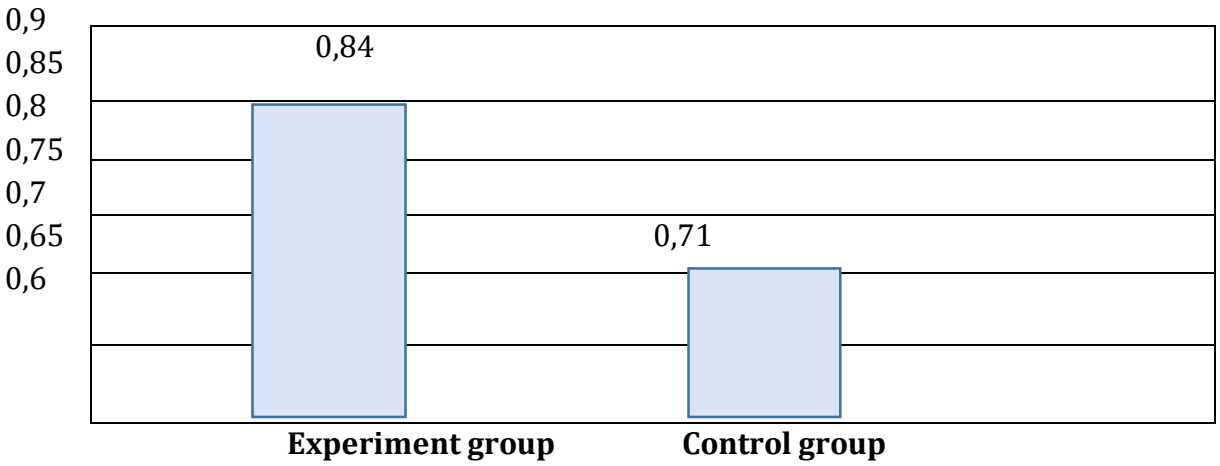

Figure 3. Comparison of the relative coefficients of general knowledge acquisition K by university students in the control and experimental groups

Conclusion

The data presented in the tables and figures, as well as the results obtained experimentally, confirmed the hypothesis about the pedagogical effectiveness of the approach developed based on the use of augmented reality technology in teaching computer science.

It should be noted that students at all stages of studying computer science showed interest in the proposed form of teaching. The unconventional approach to learning new material and its visualization through the integration of virtual and real objects were of particular interest.

Based on the above, the experimental verification process led to the conclusion that the hypothesis that the development and use of augmented reality technologies in teaching computer science to university students enhances the visualization of learning and increases the effectiveness of studying computer science topics that are traditionally difficult for students of higher educational institutions was substantiated. In addition, it was substantiated that the increased efficiency of considering augmented reality technology as an object of study by students was increased.

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