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Research article

## Virtual reality: educational and methodological aspects

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**Problem and goal.** Virtual reality in education is used as the information space, in which the student can not only obtain the necessary information, but also enter into the contact with the fictitious objects. Sinking (immersion) into the educational medium helps students to acquire the habits of interaction with the virtual objects, to develop methods of collective collaboration and to find confidence in the course presentation of its own projects. The process of creating the resources with the elements of interactivity, and also the selection of the necessary instrument means is a technological and a systematic problem for the teachers, who are mastering new information technologies. The purpose of the article is construction and substantiation of the effectiveness of the model of the use of technologies of virtual reality in the course of the instruction of schoolchildren in the system of additional formation.

**Methodology.** The development of the model of the use of technologies of virtual reality in the instruction of students in the extra-curriculum activity was accomplished on the basis of the complex data analysis, obtained in the course of conducting the approval developed educational methods materials in the system of additional formation, structuring of information, generalization of the results of a study.

**Results.** The didactic possibilities of the technologies of virtual reality were identified in the course of the instruction of students in the system of additional formation. The theoretical substantiation is given the need of applying the virtual reality as a means of the development of creative thinking in students and an effective tool of the creation of the immersive training medium. On the basis of a study working program has been prepared, as well as teaching aid and systematic recommendations for the teachers, who use technologies of virtual reality for conducting the training exercises.

**Conclusion.** The results of the conducted investigation made it possible to make a conclusion about the effectiveness of the use of technologies of virtual reality in the system of additional formation. It is ensured by the goal-directed application of the corresponding model of instruction and system of instrumental and teaching aids. The application of virtual reality,

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different technologies of imitation simulation not only contributes to the development of the algorithmic and creative thinking of students, but also to the maximum disclosure of their intellectual potential.

**Key words:** virtual reality; the immersive training medium; imitation and mathematical simulation; the computer program “Scratch”; the computer program “Unity”; the project “Moscow Electronic School”

**Problem statement.** Virtual reality has become an essential attribute of contemporary life. It intensively penetrates all spheres of the vital activity of man. This occurs because of the swiftly developing information technologies, which create the new quality of the perception of objective reality.

The virtual reality presents the special space, in which the exchange of diverse information becomes possible. It is one of the highest manifestations of information civilizations, its necessary condition and strategic expression. With the development of civilization occurs the improvement of all its institutes, including educational ones. The use of computer virtual analogs in the instruction, the training and the development of personality became one of the most important achievements in the world educational practice of last decade.

Teaching with the use of technologies of the virtual and augmented reality has a number of advantages in comparison with the traditional curricula. They consist of the following:

- the complete recreation of the motion of the real situations of different technological and natural processes in the regime of real time and finalizing of the algorithms of actions during them;
- an increase in the effectiveness in the instruction of schoolchildren because of the new highly technological procedures of the within the framework practiced procedures;
- the complex evaluation of the level of the obtained knowledge and acquired habits because of the continuous feedback;
- the prognostication of the results of fulfilling the real technological operations of trainees;
- the virtualization of the process of the forthcoming technological operations of the real executor and the fastening of the algorithm of the fulfillment of procedure taking into account the sudden unforeseen situations, which appear in the course of real activity.

The problem of a study consists in the substantiation of the systematic bases of the design of training exercises with the use of technologies of imitation simulation, virtual and augmented reality.

The object of a study – the process of the instruction of students with the use of technologies of the virtual and augmented reality.

The subject of experiment – the procedure of instruction in imitation simulation with the use of technologies of virtual reality in the system of school additional formation.

The purpose of a study consists of the substantiation of the application of technologies of virtual reality in the extracurricular training activity.

The hypothesis of the study: if we in the process of the instruction of students in imitation simulation use technologies of virtual reality, and also specially designed system of training exercises, filled with the corresponding content, then this will make it possible to increase the effectiveness of instruction, and also the level of the integrative knowledge of students, their interest in the special courses.

For the realization of this investigation, it is necessary to solve the following tasks:

- to analyze the possibilities of using the ecosystems of specialized lingual and software means for the instruction in the basics of the design of the virtual and augmented reality, and also of the instrument means of the creation of the virtual and augmented reality, oriented to the use in the general formation (including the comparative analysis of the instrument means, utilized in schools and institutions of the additional education of children of Moscow within the framework pilot projects) with the use of Moscow Electronic School (MESH) resources;

- to develop the models of the use augmented reality (AR) and virtual reality (VR) equipment in the course of the instruction of students;

- to prepare educational methods materials for the future teachers for the instruction of the students of secondary school the creation of the elements of the augmented, virtual reality and the principles of the imitation simulation within the framework of scientific and technical-engineering extra-fixed activity (working the program of discipline in the selection “the instruction in bases of design AR/VR, to the bases of the mathematical and imitation simulation the students of secondary schools”), electronic teaching aid, systematic recommendations for the trainers, systematic recommendations for the instructors;

- to conduct the pilot approval of the developed educational methods materials in the system of additional formation;

- to organize and to conduct webinar for the teachers on the theme “the application AR/VR also of bases of mathematical and imitation simulation in the instruction of the students of secondary schools”;

- to develop the scenarios of lessons on the theme of a study in the Moscow Electronic School.

For the solution of the problems presented there the following methods were used: the analysis of the principles of the use of technologies of virtual reality in the instruction of the students of different age groups; the study of the scientific literature, dedicated to the methods of creation and of using the virtual objects in the educational practice; the questioning of teachers on the development of the degree of the information about the new technologies, pedagogical experiment and the estimation of empirical work.

A comparative analysis of software environments for teaching students simulation modeling, design of virtual and augmented reality has been done. Currently, the use of “Scratch” in virtual and augmented reality is not possible due to the lack of a mixed reality system that supports projects implemented in “Scratch”. Since

there are online and offline versions of the program, it is possible to use it on interactive panels of MESH, as well as on tablets of students and teachers. The interface of the environment is convenient for working with touch screens. Due to the fact that system is based on the HTML5 environment, applications implemented in the “Scratch” environment can be loaded into the MESH library as an application, with its subsequent use in the scenarios of lessons devoted to simulation and mathematical modeling.

With the help of the “Unity” computer program, it is possible to develop augmented and virtual reality environments owing to full-featured built-in tools and cross-platform. Studying the “Unity” 3D program at school allows you to teach 3D and 2D graphics, lay the foundations of programming. Due to the multiplatform and web version, ready-made applications developed in “Unity” can be downloaded to the MESH learning materials library.

Demonstration of virtual reality objects is impossible without appropriate equipment. The features that should be taken into account when using virtual and augmented reality equipment during classes (regardless of the type of equipment—virtual reality helmet or glasses) may include:

- the need for sufficient free space for each student, who will use the equipment during the class, due to the fact that this equipment involves motor activity;
- distribution of time for distribution and connection of equipment during the lesson;
- mandatory accounting and implementation of hygienic requirements to the condition of the equipment (wiping with antibacterial wipes before and after using the equipment);
- charge control of charging and the possibility of rapid replacement of autonomous batteries (batteries or accumulators) of virtual and augmented reality equipment.

Virtual reality, like any technology, needs to use its own tools. Without the appropriate equipment, it is impossible to create and reproduce high-quality virtual lessons. Existing virtual reality applications used in education, so far cannot fully realize the full potential of this unique educational tool.

**Method of research.** As part of the study, educational materials on the creation of virtual objects were tested. The purpose of testing the work program and methodological manual and recommendations was to verify the substantive and methodological validity of the developed materials on mathematical and simulation modeling, the basics of augmented and virtual reality for high school students.

The tasks of testing consisted of identifying the compliance of the complexity of the content of the discipline with the characteristics of the students; in finalizing the developed educational and methodological materials, taking into account the identified comments accumulated during the practical classes.

Testing of the developed training program for the basics of mathematical and simulation modeling, virtual and augmented reality was carried out in Moscow A.P. Gaidar Palace of Creativity of Children and Youth.



For the practical part of the training, practical tasks were used to create a mathematical model using the “Scratch” program and virtual reality elements using the “HP Reveal” program.

When transmitting material on the subject “Fundamentals of Mathematics and Simulation Modeling”, the age characteristics of students were taken into account. Classes were held for students to create a mathematical model of a cannon shot, modeled using the “Scratch” programming environment, taking into account the minimum input and output parameters (figure 1).

During testing on the topic “Fundamentals of AR/VR means of their creation”, lessons were held on the formation of the structure of the virtual reality object by students. In addition, students independently developed augmented reality content, represented by a 3D model developed in the “Blender 3D” program.

During the classes for constructing virtual and augmented reality, the following didactic conditions for the implementation of the training course were identified:

- use of a systematic approach to analyze the objectives of the course;
- synthetic assessment of the role of mathematics and simulation modeling to create an immersion learning environment;
- practical orientation of the course;
- integration of interdisciplinary knowledge.

The most preferred methods were the following: problematic, search, inductive, deductive, interactive, multimedia. As for the teaching aids that can be used during the course, it’s required to pay attention to teaching aids, educational resources of the Internet, multimedia presentations, training videos, computer programs, Internet services and mobile applications.

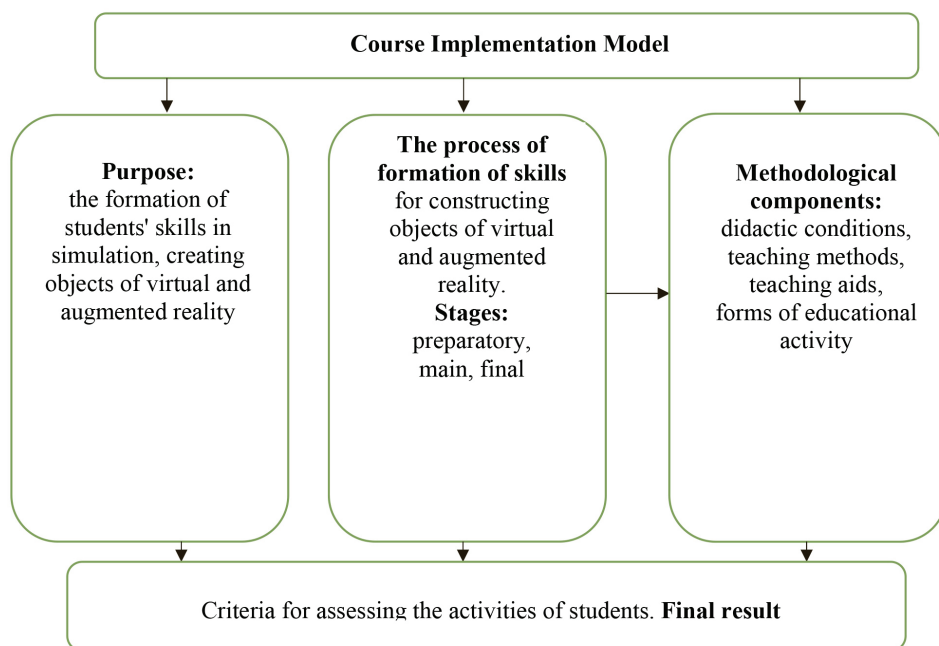


Figure 2. Model of training course

During the course, the training model was used, which included various interconnected components. Among them: the purpose and planned learning outcomes, the process of forming the skills of simulation and mathematical modeling, the form of training, as well as criteria for evaluating students’ activities in mastering the content of the discipline and the final result of course. All of these components are shown in figure 2.

**Results and discussion.** The experimental work was carried out in the Moscow A.P. Gaidar Palace of Creativity of Children and Youth by the students of the Institute of Digital Education (Moscow State University). The number of students trained in the basics of mathematical and simulation modeling, virtual and augmented reality in the framework of testing, included more than 200 people.

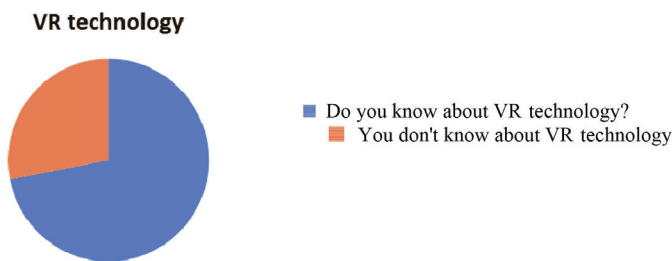
The content of the classes covered the following topics: “Fundamentals of Mathematical Modeling”; “Fundamentals of AR/VR”; “Creating AR/VR Elements.” During testing, students were offered theoretical material, which is presented in the first section of the manual, in particular, the basics of mathematical and simulation modeling, virtual and augmented reality, and AR/VR creation tools. According to the results of classes with students, a survey was conducted.

The questionnaire contained the following questions:

1. Name the class that you finished.
2. Define the mathematical model.
3. Where are mathematical models used?
4. Are you familiar with virtual reality technology?
5. What programs are used to develop mathematical models?
6. Using which programs you can create: a) virtual reality; b) augmented reality?
7. Did you enjoy the classes conducted by students? (Yes/No)
8. Was the material presented in the lessons clear? (Yes/No)
9. What topics would you like to study in a computer science course?
10. What are your perspectives on virtual and augmented reality?

The questionnaire showed that students studied with great interest in new material that is not included in the school computer science course. Many of them developed objects of virtual and augmented reality for the first time.

Answering question 4 of the questionnaire, the students stated that they were familiar with virtual reality, but they did not know with the help of which program it could be created (figures 3, 4).



**Figure 3.** Student insights on VR technology

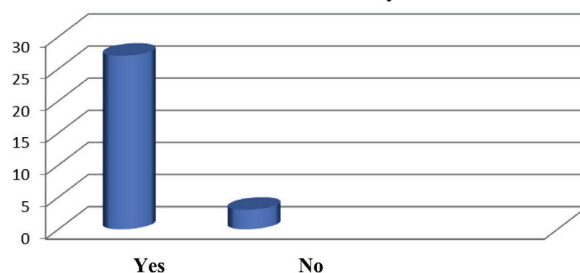
**Are programs for creating VR / AR known?**



**Figure 4.** Students' views on VR creation programs

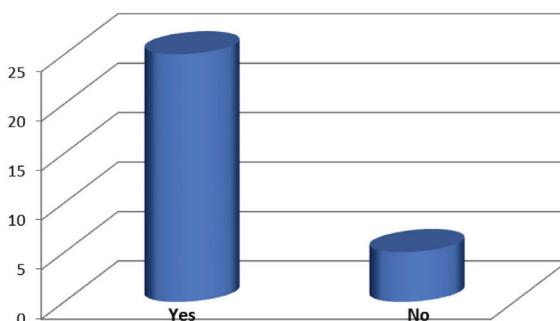
Most school students liked the classes they were taught. Students would like to study materials related to mathematical and simulation modeling, virtual and augmented reality. The data on the answers to questions 7, 8 of the questionnaire are presented in figures 5, 6.

**Results for answers to question 7**



**Figure 5.** Data on the answers to question 7 of the questionnaire

**Results for answers to question 8**



**Figure 6.** Data on the answers to question 8 of the questionnaire

Based on the results of testing the course, the following conclusions were obtained.

1. It is possible to start the study of mathematical and simulation modeling from grades 5 and 6 with the help of various illustrative material that modern software products offer.



2. The disadvantage may be poor mathematical (natural) training of students. To eliminate this, it is necessary to include in the current course the natural-scientific concepts and examples related to modeling problems.

3. It is necessary to use an integrated approach in teaching mathematical and simulation modeling, when conducting lessons to demonstrate intrasubject communications of the main content of the discipline with mathematics, physics, chemistry, geography. To do this, you need to coordinate the topics of modeling projects with related disciplines.

4. It is quite possible and advisable to use AR/VR in lessons and teach augmented and virtual reality technologies.

5. During the training, it is important to adapt the theoretical and practical materials related to the AR/VR basis in accordance with the potential of students.

**Conclusion.** As a result of the study, a training course was prepared on “Teaching the Basics of Designing AR/VR, Mathematical and Simulation Modeling of Secondary School Students”, as well as methodological recommendations for teachers on its implementation of the system of additional education and the work program of the course. A series of lesson scenarios was developed for the Moscow Electronic School.

The research demonstrated the relevance of the study, the extreme interest in its continuation among pupils, students, teachers and pedagogical workers of Moscow and other regions of Russia.

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Научная статья

## **Виртуальная реальность: учебно-методические аспекты**

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**Проблема и цель.** Виртуальная реальность в образовательной сфере используется в качестве информационного пространства, в котором ученик может не только получать необходимые сведения, но и вступать в контакт с вымышленными объектами. Погружение (иммерсия) в образовательную среду помогает школьникам приобретать навыки взаимодействия с виртуальными объектами, развивать приемы коллективного сотрудничества и обретать уверенность в ходе представления собственных проектов. Процесс создания ресурсов с элементами интерактивности, а также отбор необходимых инструментальных средств представляют собой технологическую и методическую проблему для педагогов, осваивающих новые информационные технологии. Целью настоящей статьи является построение и обоснование эффективности модели использования технологий виртуальной реальности в ходе обучения школьников в системе дополнительного образования.

**Методология.** Разработка модели использования технологий виртуальной реальности в обучении школьников во внеурочной деятельности осуществлялась на основе комплексного анализа данных, полученных в ходе проведения апробации разработанных учебно-методических материалов в системе дополнительного образования, структуризации информационных баз, обобщения результатов исследования.

**Результаты.** Выявлены дидактические возможности технологий виртуальной реальности в ходе обучения школьников в системе дополнительного образования. Дано теоретическое обоснование необходимости применения виртуальной реальности как средства развития креативного мышления школьников, эффективного инструмента создания иммерсивной обучающей среды. На основе исследования подготовлена рабочая программа, учебное пособие и методические рекомендации для учителей, использующих технологии виртуальной реальности для проведения учебных занятий.

**Заключение.** Результаты проведенного исследования позволили сделать вывод об эффективности использования технологий виртуальной реальности в системе дополнительного образования. Она обеспечивается целенаправленным применением соответствующей модели обучения и системы инструментальных и методических средств. При-

менение виртуальной реальности, различных технологий имитационного моделирования способствует не только развитию алгоритмического и творческого мышления учащихся, но и максимальному раскрытию их интеллектуального потенциала.

**Ключевые слова:** виртуальная реальность; иммерсивная обучающая среда; имитационное и математическое моделирование; компьютерная программа Scratch; компьютерная программа Unity; проект «Московская электронная школа»

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