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THE EFFECTIVENESS OF USING VIRTUAL EXPERIMENTS ON ENHANCING STUDENTS' LEARNING AND CREATIVITY IN GENERAL PHYSICS LABORATORY

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Abstract:

This article is devoted to studying the problem of using virtual reality technologies when conducting physics lessons. The work shows the possibility of creating a demonstration physical laboratory using new technologies. An analysis of the use of virtual reality in education is carried out, the main advantages and disadvantages are highlighted. Arguments are given in favor of the use of multimedia technologies in the education system. Virtual reality is a convenient tool for conducting scientific experiments when studying certain subject areas of physics that are difficult to consider in reality.

Keywords: Information Technology, Virtual Laboratory, Traditional Experiment, Advantages And Disadvantages Of Virtual Laboratory Work, Organization Of Laboratory Workshops, Demonstration Devices, Laboratory Workshop, Models Of Measuring Instruments, Demonstration Laboratory Stands

INTRODUCTION

One of the problems of vocational training is the problem of teaching physical disciplines. Programs for studying physical disciplines are regularly improved and adjusted in accordance with the needs of practice. As a rule, a small number of academic hours are allocated for the study of some disciplines, during which teachers try to provide the maximum amount of material, mainly theoretical. This rarely leads to the formation of systematized knowledge; it comes down to primitive memorization and reproduction, and then complete forgetting of the material after certification [1]. Focused mainly on obtaining the knowledge necessary in their future profession, students do not show much diligence in studying general education disciplines, and as a result do not even possess generally known basic information and facts. In a certain sense, this problem can be solved by using modern educational technologies.

Practical classes in physics are an integral part of the discipline being studied. A clear and deep understanding of the basic laws of physics and its methods is impossible without working in a physics laboratory, as well as without performing home laboratory work. By conducting laboratory research, students not only confirm the known laws of physics, but also learn to work with physical instruments and master the skills of practical research. Interactive demonstration laboratory and practical work is a learning environment that, using computer interactive visualization, allows schoolchildren to simulate a real experiment and conduct educational research. This is an educational environment aimed at ensuring the development of the student's skills to independently generate new knowledge, formulate ideas, concepts, hypotheses about objects and phenomena, including previously unknown ones, recognize the deficits of their own knowledge and competencies, and plan their development.

1. Current state of conducting laboratory classes in physics

In modern vocational education, information and communication technologies are actively developing and increasingly being used [2], one of the most popular and promising areas is the introduction of new technologies. They allow you to use different forms of presenting information and make it possible to actively interact with it. The use of visual and auditory stimulation, activation of different channels of perception and processing of information makes the learning process more rich, varied, subjectively easier and more effective. Currently, students have stable skills to work in demonstration reality, which provides a wide range of opportunities for introducing new technologies into the educational process. In this regard, the creation and use of virtual laboratories in the educational process is promising. A demonstration laboratory is understood as an environment that simulates on the screen of a tablet, smartphone, computer or interactive panel the tools of an educational laboratory, computer programs that allow you to simulate chemical, physical and other processes, change the conditions and parameters of their occurrence [2].

Demonstration and augmented reality technologies will give students the opportunity to conduct a complex experiment, which in real life cannot be carried out for objective or subjective reasons, this

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could be a workshop in nuclear physics or the school may not have the necessary equipment to conduct a certain experiment. Physics is a natural science that must be studied through practical examples, and therefore it is important to think through practical and laboratory work in addition to theoretical materials. It is important to have close contact with the outside world, as this is very important when studying physical phenomena. To do this, it is necessary to perform physical experiments in laboratory classes related to the collection of various installations, to measure physical quantities by performing various experiments. Since laboratory work arouses great interest among students if they begin to contact the outside world. Performing laboratory work adds a scientific touch to school education. When performing laboratory work, a person develops his inner world, developing new knowledge, skills and abilities.

Demonstration laboratories can be used in classroom lessons with a teacher or independently, on the Internet or on a local computer, individually or in a group. In a demonstration physics laboratory, it is permissible to perform both individual experiments to demonstrate a specific property or phenomenon, and laboratory work on certain topics. The equipment of the physical laboratory is visualized; the student can observe physical processes or independently conduct research by manipulating laboratory instruments. Most often, a virtual laboratory is presented in the form of sections - tabs - theoretical material, description of work, procedure for performing work, laboratory setup, report. The use of virtual programs makes it possible to make the study of physics more accessible and complete. For example, physics curricula do not include experiments with harmful substances, although some of them are of great importance, since they form the basis of historical discoveries and are necessary to obtain a complete understanding of the nature and evolution of this knowledge. The virtual laboratory allows for experiments that are not possible in a real physical laboratory. In the demonstration laboratory, the necessary skills for studying real processes are developed, and it is possible to prevent possible errors in setting up and conducting experiments.

2 . Methodology for conducting demonstration experiments.

The pedagogical effect of any demonstration experiment, i.e. the most complete perception and understanding of it by students can be achieved only with a certain method of demonstrating experience.
The methodology of a demonstration experiment is a set of methods, techniques and means that ensure the effective inclusion of demonstration experience in the learning process. The method of demonstration experiment involves determining the place of the experiment in the lesson, its didactic capabilities and the sequence of implementation together with the teacher's explanation, finding the optimal combination of the demonstration experiment with other means of visualization, selecting questions for students when discussing the results of the experiment, etc. Using a demonstration laboratory in teaching physics as remotely and in regular classes allows you to increase the efficiency of completing homework and diversify it in form and content. Computer models of the physics laboratory encourage students to experiment and gain satisfaction from their own discoveries. The predominance of one's own activity when performing practical work increases the cognitive interest of students [5]. Demonstration laboratories stimulate active interaction of students not only with the teacher, but also with each other, making them full-fledged subjects of educational and professional activities [6].
Thus, a review of available electronic resources and an analysis of the advantages of using virtual laboratories in physics showed that a promising direction for optimizing the teaching of physics as a non-core discipline is the use of these technologies. At the same time, the teacher can use existing materials, integrating them into the educational environment without significant processing. Carrying out practical work in physics in virtual laboratories will help develop interest in this discipline, stimulate the development of students' intelligence and cognitive activity in general.

The use of information and computer technologies in the educational process plays an important role in the development of observation, attention, speech, and thinking of students. Unlike conventional technical teaching aids, information technologies make it possible not only to saturate the student with a large amount of ready-made, strictly selected, appropriately organized knowledge, but also to develop intellectual and creative abilities [1,2]. It has been established that the clarity of the material increases its assimilation, because All channels of perception are involved - visual, mechanical, auditory and emotional. It should be noted that the stage of motivation in this case increases and carries a cognitive load.

3. Features and forms of demonstration experiments in physics

In many cases, when the essence of various physical laws is revealed, a demonstration experiment is carried out after its theoretical explanation. In this case, it acts as a qualitative illustration of the stated pattern. Finally, in some cases, it is pedagogically advisable to show the same demonstration experience twice in a lesson: once

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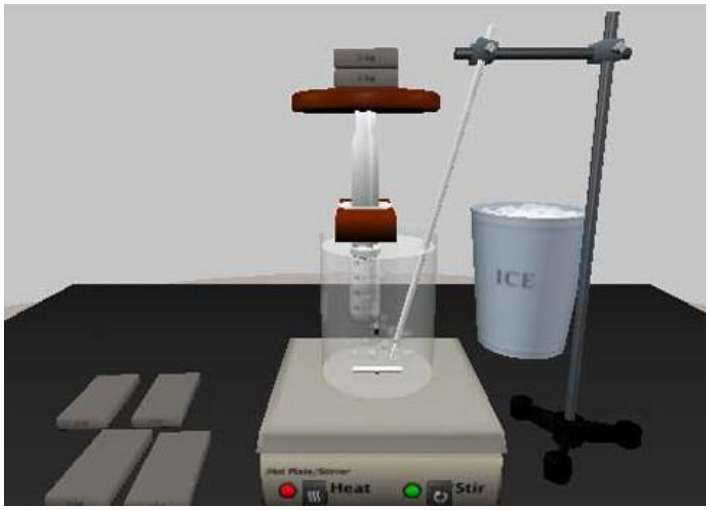
at the beginning of the lesson, in order to create a problem situation, and then a second time after the teacher has explained this phenomenon. Processes and experiments that in school physics are considered the most difficult to directly observe and study (this includes, first of all, processes hazardous to health associated with radioactive radiation, changes in strong electric and magnetic fields, etc.) can be studied on material or computer models. Computer modeling is also used for more accessible processes, such as the propagation of light (as well as reflection, refraction, diffraction, interference, etc.), the movement of bodies in the Earth's gravitational field, etc. Modeling is justified by the fact that it allows one to escape from attachment process to time: experiments can be repeated an unlimited number of times, they can be paused at any convenient place. It is difficult to imagine how it would be possible to slow down the light a little so that students have time to notice what is happening in thousandths, millionths, and sometimes billionths (nano) of a second. This is where computer models can be used. The main advantage of computer simulation programs is that they reflect the model of a real physical experiment. The actions performed by the student correspond to the actions during a real experiment. At the same time, historical experiments are not yet being modeled so actively, although the significance of these experiments for obtaining initial, basic knowledge in physics is significant. We have created a virtual laboratory for the study of historical experiments in the subject of physics (Fig. 1). The software product is a virtual laboratory in which it is possible to carry out in model form some fundamental experiments that laid the foundations of classical physics.

4. Illustrative examples of demonstration experiments in the "Molecular Physics" section of the general physics course

This topic is related to the study of the section " Melting processes of crystalline and amorphous bodies " of the 8th grade physics course. During the demo, students are asked to complete three experiments and a general quiz on the topic. This *experience* shows differences in the melting processes of crystalline and amorphous bodies, which is due to the fact that, unlike amorphous bodies, when melting crystalline bodies it is necessary to expend a certain energy on melting the crystalline structure. In this case, it is important to show through measurements that a change in its structure (the transition of ice into water) occurs at a certain temperature (melting point) in the case of melting of a crystalline substance. In the case of amorphous bodies, the graph of temperature versus time is significantly different. There are six different processes by which matter changes from one state of matter to another. To become familiar with all of these processes, students are encouraged to study the interactive diagram with examples of the processes of melting, crystallization, evaporation (evaporation and boiling), condensation, sublimation, and desublimation. After reviewing the interactive diagram, students are presented with a quiz asking them to answer five questions to reinforce their knowledge of each process, from simple to complex. It is recommended to take the quiz yourself at home when preparing for a general lesson on the subject, as well as when preparing for the state exam in this subject.



Picture 1 . Melting processes of crystalline and amorphous bodies

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The development of a demonstration laboratory for broadband systems will make it possible in the future to provide services for modeling and creating virtual specialized laboratories, stands and unique installations. Expanding the list of virtual multimedia services will allow for specialized training of qualified specialists to work on unique installations, instruments, machines and machines. An interesting example of this approach is the development of a demonstration laboratory demonstrating the operation of a scanning microscope in various modes [11]. This example demonstrates the rather complex principles of atomic force and tunneling microscopy in various modes. However, even in this option, the assimilation of the material occurs much easier and at a deeper level than with theoretical knowledge alone.

A similar example is the solar system demonstration laboratory [12,13], which demonstrates the position of the planets, as well as their motion relative to each other. In our opinion, controls could be added to the model, such as setting the date and displaying the planets at the desired location, as well as demonstrating eclipses and displaying some interesting physical data, such as the orbital period, etc. In the field of molecular physics and optics, models have been created to study isobaric, isochoric, isothermal and adiabatic processes in an ideal gas, study the diffusion process, as well as calculate work for an ideal gas.

6. Results of assessing the use of virtual models in teaching.

Today, virtual existence is used in various spheres of human cultural activity. A virtual entity is primarily used in the field in which it was created, in science, including physics, when modeling the dynamics of liquids and gases. In education, digital literacy of teachers plays an important role, who can freely use a personal computer, communicate with the community and students; in education they update their resources with the help of electronic technologies, which implement a system of tasks performed by students in electronic form. At the end of the course, we conducted a survey to test students' competence in the field of information and communication technologies; the results of the study are presented in Table 1.

Table 1. Indicators of the use of information and communication technologies by students at the end of the course.

Name of ICT	Usage indicators			
	Constantly, %	Often, %	Rarely, %	Habitually
Online classes	3	12	65	20
Virtual laboratory	0	60	40	0
Power Point program	45	45	8.5	1.5

The table shows that the use of electronic whiteboards, electronic textbooks, as well as the use of virtual laboratories when performing laboratory work created the opportunity to increase the competence of students in the field of information and communication technologies. From Table 1, we can see that students' use of online database and power point has increased. The reason is that during the course, students used an electronic database for independent work and a Power Point program for preparing presentations.

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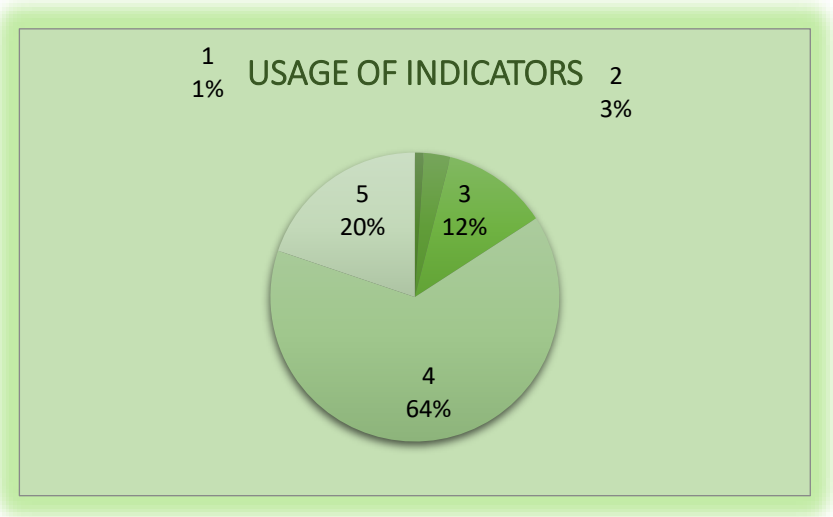

Fig.1. Indicators of students' use of information and communication technologies at the end of the course

The results of the study show that according to the survey conducted at the beginning of the course, we see that by the end of the course, students' use of ICT increased by 10-15%.

Thus, demonstration laboratories are organically integrated into the modern educational process, occupying their unique niche in the wide variety of didactic tools offered within the framework of the educational technologies used. Analysis of the implementation of virtual systems in our experience allows us to draw the following conclusions. The use of virtual laboratory work has made it possible to reduce the time allocated for them, as well as transfer some aspects of it into an independent mode of operation. The use of virtual laboratory work allows not only to consolidate the practical skills of students, but also to transfer part of the fund of assessment funds to demonstration situational tasks. This allows not only to assess the student's practical skills, but also to track his readiness to pass the qualifying exam in the professional module.

CONCLUSIONS

Thus, the work shows the possibility of creating a demonstration physical laboratory using new technologies. A significant difference of the developed laboratory is the ability to conduct experiments with changing parameters that affect the course of the experiment. This technique allows you to intuitively understand the essence of a physical phenomenon and helps students develop independent work skills. Demonstration experience can have pedagogical value only if the achieved effect of the demonstration is clearly visible to the entire audience of students. Here one cannot but agree with the opinion of those who believe that no matter how perfect the demonstration may be in all other respects, it will be unsuitable if the students do not so much see the phenomenon as guess about it from the words of the teacher.

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