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## VIRTUAL LABORATORIES IN TEACHING AND EDUCATION

**Abstract:** E-learning implemented by educational institutions should include not only educational-methodical complexes on disciplines (modules), but also software aimed at the development of professional competencies. The best way to build competences is a virtual laboratory, simulated in an e-learning environment onto real world objects. Creating a virtual laboratory allows, on the one hand, to experiment with the equipment and materials that correspond to the real lab, on the other, to get acquainted with the computer model for the development of practical skills in professional activities. Note that not every educational institution can afford to purchase expensive equipment, which is costly in maintenance, purchase supplies, and most importantly, the replacement at its improvement. The versatility of virtual laboratories compensates these shortcomings. Virtual Lab provides students with the complex problems of various do-mains, virtual instruments to formalize the process conditions, the means to solve the problem; teachers are able to monitor, diagnose the process of mastering the material. Thus, students can independently form practical skills in the time convenient for them, not limiting themselves to the times and the territorial remoteness of the educational organization.

**Key words:** laboratory, exercise machine, virtual laboratory, electronic training, technique.

**Language:** English

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### Introduction

The modern stage of human development is called the period of building the information society. Today, graduates of higher schools must not only possess fundamental and professional knowledge, but also be able to navigate in the modern information society. In this regard, the processes of informatization of education are accompanied by the search for new methods of organizing the educational process, focused on self-organization and self-development of the individual.

Teachers of the British Joint Information Systems Committee disclose the content of the concept of “e-learning” as training using information and communication technologies [6]. In other words, the authors mean e-learning as a set of IT services (IT is an information technology management system) used to organize and conduct distance learning. Therefore, the term “e-learning” includes the content of the concept of “distance learning”, implemented through means of communication (A. Khutorskoy

[15]. Recall that e-learning provides students with the opportunity to choose the pace of study, content and time of development, regardless of the territory of residence. This training is an independent form, consistent and reflects the laws of science, didactics, educational psychology, pedagogy and other techniques. Recall that e-learning has developed in several stages:

- teacher - several students (used e-mail, personal computer, telephone);
- the emergence of local networks, the improvement of communications (training computer programs, disks);
- the use of global networks (Internet learning, distance learning platforms, creating an information and educational environment).

The basic principles of e-learning are modularity, continuity, openness, dynamism, adaptability, creativity. Of course, in e-learning, a special role is given to electronic educational resources that are responsible for the quality of

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education. The term “electronic educational resources” is understood as an electronic educational tool that provides students with information on the methodological features of studying modules (disciplines) online and offline interaction between a teacher and a student; regulation of independent work, educational and methodological complex (content), automated control aimed at mastering competencies in accordance with the federal state educational standard. OV Nass interprets the content of the concept of “electronic educational resources” as computer tools that are used by a teacher to achieve learning objectives [11].

### Literature review.

According to the authors M.P. Lapchik, V.R. Mayer, D.Sh. Sailor, the means of information technology are: electronic textbooks, virtual laboratories, testing systems, digital educational resources that allow not only to increase the degree of students' independence, but also to form their professional competencies [4]. Achievement of learning objectives is carried out through the development of electronic techniques focused on the formation of competencies. However, not all educational institutions can provide full-fledged practical training of students, including those based on the virtual reality system. E-learning is limited to video lectures and educational resources in the form of content, there are no practical classes, which raises doubts about the development of the educational program and standard [13]. In laboratory classes, workshops, according to E. V. Dozorov and V. A. Dozorov, students are trained in computer games that create microworlds of the studied modules (disciplines) and contribute to the development of competencies [5]. Microworlds are created through virtual laboratories [1]. S. M. Vishnyakova considers the content of the concept of “laboratory” as an institution conducting scientific and technical experiments, and “virtual” - real, real [3]. Thus, the term “virtual laboratory” is understood by the author as an institution conducting real experiments. A. Ch. Khatagov associates the concepts of “virtual simulator” and “virtual laboratory”, characterizing them as a software package focused on computer lab work [7]. S. Golovin discloses the content of the term “simulator” as a technical training tool, “virtual simulator” as a system of program elements. However, according to the opinion of E.O. Kozlovsky and G.M. Kravtsov, a “virtual laboratory” is, first of all, a software environment in which the opportunity to study objects detailed in relation to real processes in the field of one type of knowledge or activity is organized [8]. V.V. Trukhina reveals the content of the concept of “virtual laboratories” as a software and hardware complex focused on the formation of practical skills through a laboratory installation with remote access, based on software and hardware for

controlling the installation and processing of data, including communication tools [14].

S. A. Yampolskaya, V. P. Zhivoglyadov - as software and hardware tools for research [2]. A virtual laboratory is an information source that provides students with the development of practical knowledge, skills and abilities, which allows modeling objects and processes of the surrounding world [9]. Virtual laboratories should provide students with practical tasks for the development of modules (disciplines) of the main professional educational program containing virtual tools and means for solving them. Analysis of Internet resources allows us to conclude that the majority of authors use the term “virtual laboratory” to mean Internet sites, texts (tasks) of laboratory work, and media files. The creation of virtual laboratories allows, on the one hand, to conduct experiments with equipment and materials corresponding to a real laboratory, on the other hand, to get acquainted with a computer model for the development of practical skills in professional activities. In other words, a virtual laboratory is a simulated object of the real world in an electronic educational environment. Of course, virtual laboratories can and should be used in educational organizations, because the market for educational services does not keep pace with the development of engineering and technology. Not every institution can afford to purchase expensive equipment that requires maintenance costs, the purchase of consumables, and most importantly, replacement when improving it. The versatility of virtual laboratories is compensated by these shortcomings. Summarizing the above, we note that the virtual laboratory is a hardware-software complex that allows you to organize laboratory and practical classes without the lack of real equipment, direct contact with it, replaces the lesson laboratory workshops. Students are given the opportunity to independently and independently of location perform tasks using information and communication technologies and the Internet. According to V.V. Trukhin, there are two types of hardware and software systems: remote laboratories, virtual laboratories. Virtual laboratories include software simulating laboratory experiments, and remote laboratories include a laboratory facility with remote access [14]. One of the goals of creating virtual laboratories is the desire for a comprehensive visualization of the studied processes, tasks - providing students with the most complete perception, understanding of the studied processes. Virtual laboratories make it possible in real production conditions to observe processes that are difficult to distinguish due to the small size of devices or particles, not to depend on time and resources, to change the parameters of experiments without fear of violation of security measures, to form competencies outside of an educational organization. You can use laboratories both offline and online. Virtual experiments, namely interactive laboratory work, can

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be carried out in online resources, or can be through a series of specialized discs. Students' activities in a virtual laboratory are useful for the formation of research competencies, an experiment is the result (automatic processing of the results).

A visual demonstration of experiments is carried out by software that creates a visual effect of the intervention of students in the process. The depth of the student's interaction with the computer program is characterized by interactivity, therefore, at the initial stage, interactivity will be insignificant compared to the final stage. The creation of virtual laboratories is based on 3D graphics, animation and video clips. Virtual measuring instruments allow you to monitor the results and progress of the experiment. Students can independently form practical skills at a convenient time, without limiting themselves to time. Note that there are software without ready-made scripts, that is, practical tasks for testing hypotheses.

Virtual laboratories can include virtual classrooms, mathematical modeling, application software packages, components of CALS - systems and can be used in practice, laboratory studies, course and diploma design, research activities.

Of course, virtual laboratories also have a drawback, as well as e-learning in general - this is the lack of direct contact with the object of study, research. However, virtual laboratories expand the range of services provided, provide the opportunity for interaction of all participants in the pedagogical community. And the current trend of the network interaction of educational institutions, the widespread dissemination of communication channels, a variety of programming tools allows the joint efforts to create virtual laboratories in the form of -services.

### Discussion.

Virtual laboratories in terms of methodology can be classified according to the typology of models for the provision of knowledge, namely: hybrid, procedural and declarative types [12]. The hybrid type is used for the development of virtual devices, the external attributes and the control panel are identical to the existing devices. The operating mode of these devices is built on mathematical and simulation models. A promising direction of this type is the imitation of laboratory work, in other words, a traditional lesson is organized, which is commented by the teacher. A minus of this type: an experiment for one set of source data, when they change, students receive processed results without participating in the experiment.

The procedural type is characterized by the presence of applied labor automation programs based on mathematical modeling, which limits the possibility of scenario schemes according to the principle of intelligent simulators.

The declarative type is similar to the preparation and operation of electronic textbooks, but their substantial prototypes are exhibits of real laboratories.

In the didactic plan, an integrated approach to choosing the typology of a model is effective, providing all stages of students' cognitive activity: perception, comprehension, consolidation, formation of competencies, research activities. Consequently, the multimedia complex of the virtual laboratory should include guidelines, electronic textbooks, test materials, visual laboratories, mathematical (simulation), simulators, etc.

Therefore, to create a virtual laboratory, it is necessary to form a computer base, namely: video clips of laboratory tests, various initial data (parameters), choose a model, develop a computational algorithm and software taking into account the specifics of mathematical modeling and the process. The work of the virtual laboratory should fully reproduce the traditional scenario of the lesson. Thus, the program shell of the virtual laboratory reproduces the scenario of the lesson, which includes four stages, namely: the preliminary stage (theoretical basis, instructions for performing laboratory or practical work), the stage of the work (test, assembly of the work scenario, execution), report generation, protection work.

A.O. Matlin, S.A. Fomenkov offer the author's methodology for constructing virtual laboratories, based on the following algorithm:

- 1) creating a virtual laboratory step;
- 2) selection of a graphic image (background) of a virtual laboratory step;
- 3) selection of active areas for virtual laboratory tools;
- 4) selection of a graphical toolkit; 5) correlation of active areas and tools;
- 6) definition of a set of tools;
- 7) the assignment of penalty points for the wrong choice of tools and the wrong action [10].

The authors of the methodology propose creating virtual laboratories on their own without the direct participation of technical specialists. The only limitation of the technique is the presence of pre-prepared 2D images of the background of steps, tools.

Recall that a virtual laboratory requires an expanded amount of disk space and RAM, however, given the fact that the student does not need all the work at the same time, one job can be loaded into the shell system to master a specific module and theoretical section. Of course, in e-learning, teaching and learning tools are an integral part of the learning process, which is ignored by many educational organizations when implementing training using distance learning technologies. Software products for e-learning should have mechanisms: creating a model (structure), transforming (editing) a model, and making calculations.

The advantages of using virtual laboratories are:

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1. reduction of the same type of equipment, lack of personnel for its maintenance;
2. automation of the performed actions (operations);
3. availability;
4. Continuous improvement of equipment in accordance with the development of the economy and methods.

### Conclusion.

The virtual laboratory provides students with a set of tasks of various subject areas, virtual tools for

formalizing the process conditions, means for solving the problem; teachers - continuous monitoring, diagnostics of the development of the material.

The creation of virtual laboratories is an urgent topic for the education of Russia, supplements the material and technical base of institutions, expands the circle of users of equipment, ensures the development of competencies and the implementation of the Federal educational standard.

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