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Virtual Laboratory as a Tool for Preparing Future Engineers for Professional Activity

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Abstract. One of the ways to strengthen the lecture materials in the study of electrical engineering and electronics in the technical direction is the experimental work of students, which consists of the demonstration of the studied process and phenomena. In this work, the creation of a virtual laboratory model for the "Electrical Engineering and Electronics" course, the content of the virtual laboratory work and the methodology of its use were discussed.

Key words: laboratory, virtual educational laboratory, virtual laboratory work, experiment, electrical engineering and electronics.

INTRODUCTION

Currently, issues of improving the content and quality of education are given special importance in our republic. Also, like the developed countries of the world, they are looking for ways to introduce modern information technologies to education, to develop education, to increase its effectiveness, to improve the research conducted in the direction of introducing information technologies to education, and to use the opportunities of modern information communication technology in the educational system. In the following years, a new term was formed in the field of application of information and communication technologies in education, i.e. the concept of virtual educational laboratory.

It corresponds to the principles of distance education and allows solving the problems related to the material and technical support of the educational process, albeit partially. Currently, there are very few scientific-methodical works on the topic of virtual educational laboratory, descriptions of virtual equipment and laboratory exercises performed using them [2,3,4,5,6]. In our opinion, the concept of a virtual learning laboratory in higher education has a much broader meaning from a methodological point of view.

It can integrate not only virtual equipment, but also constructions of technical objects, virtual classrooms, mathematical and simulation modeling systems, educational and industrial packages of practical programs, CALS-system components. Students can use the

virtual educational laboratory not only for laboratory exercises, but also for completing coursework and diploma projects.

From a methodological point of view, virtual educational laboratories can be classified into procedural, declarative and hybrid (procedural-declarative) types based on the typology of knowledge visualization models adopted in artificial intelligence systems. Practical program packages or industrial analogues designed to automate the work of a specialist form the basis of a procedural virtual training laboratory. In their creation, attention is mainly paid to the issues of mathematical modeling, implementation of calculations, and optimization of the studied objects and processes.

Sometimes, mathematical modeling is the only way to study complex engineering objects and processes. In such application packages, the subject of learning can be methods and tools of activity, for example, geometric modeling methods, optimization algorithms. However, it should be noted that despite the usefulness of automating the activities of engineers being trained in higher educational institutions, it does not always lead to an increase in the quality of professional training in the process of solving educational tasks.

Because, in most cases, the opportunities of application packages to study the properties of various objects and processes with the help of mathematical modeling and computational experiments are not realized. Most students do not have enough preparation in this regard. In such cases, a special didactic interface based on the following principles may come in handy: choosing a problem or problems that are interesting and easy to teach; use of a repetitive, closed form of guiding students' cognitive activities; solving problems heuristically and comparing the results with the computer solution option; to create a competition situation in order to increase the cognitive activity of students.

MATERIALS AND METHODS

Laboratory work in the field of electrical engineering and electronics is of great importance in the training of future engineers in technical higher education institutions. Of course, special classrooms are organized for this purpose. However, it is difficult to overestimate the role of such classrooms. Because their creation requires a long time, various expensive equipment and their careful maintenance, and most importantly, large material costs.

Modern educational laboratories of higher educational institutions can be organized with modern equipment, facilities, constructions mainly in large educational institutions at the expense of huge funds. Creating and working with such virtual learning labs is similar to creating and using e-textbooks. But their prototype is not the first sources on paper, but exhibits in kind.

In the virtual training laboratory, future engineers can learn the elements of electrical engineering and automation, as well as perform a number of other practical tasks. For example, future engineers can disassemble and assemble a lamp cartridge according to the instructions in the virtual training laboratory, connect the cord to the cartridge (practical work 1); disassembling and assembling the switch, connecting the cord to the switch (practical work 2); they learn independently the methods of disassembling and assembling the plug, connecting the cord to the plug (practical work 3).

In order to increase the effectiveness of learning material perception, it is advisable to use special technological methods, for example, flash-animation using a magnifying glass,

which allows you to see the object of study as a whole and get acquainted with its small details. At the end of the description of each learning object, it is appropriate to ask questions for self-control and training with short comments "hidden" under the hypertexts on the learned educational material. It allows to activate the process of mastering the learning material by integrating it and helps to prepare for the final tests.

Another promising direction of creating a hybrid virtual educational laboratory is to simulate model laboratory work on complex and unique equipment. During the performance of such laboratory work, all manipulations with the equipment are carried out by the employee in the laboratory, the teacher gives an explanation, and the students observe, further process the results of the experiment. In addition, the experiment is usually conducted for one set of initial parameters, and students are given ready-made results for other options.

Learners are supported at all stages of the learning process. A hybrid approach to the structure of a virtual learning laboratory is usually used in the preparation of virtual equipment. In addition, the control panel, visually, is adequately represented by its real analogue, and various operating modes are studied with the help of mathematical or simulation models.

For example, in virtual educational laboratory modeling sessions create conditions for the development of students' technical thinking, spatial imagination, especially technical creativity, necessary professional qualities, and students strengthen and improve their previously acquired knowledge, skills and competences. However, this is not the main issue, but a task to be solved along the way. The structure of the lesson, the object of training, methodological tools - all this, first of all, belongs to the main didactic task and is directed to its fulfillment. At the same time, it is not allowed to create conditions that prevent the fulfillment of other educational tasks. The formation of students' professional skills in the virtual educational laboratory is a practical task, and this is achieved by performing professional actions.

It is known that most of the modern experimental devices used in higher education institutions consist of rather complex, large-scale and expensive complexes, which are somewhat complicated in terms of price, size, and conditions of use, and therefore many higher education institutions will not be able to perform many laboratory works at the required level during the educational process, and experiments are not conducted. Therefore, one of the ways to solve existing problems is the use of virtual laboratories and experimental devices.

The science of electrical engineering and electronics, which is taught in technical higher education institutions, is in a certain sense both a theoretical and a practical science. Therefore, in order to verify his theoretical conclusions in practice, in order to study the events and processes that occur in it, as well as the equipment, every future engineer must have the qualifications and skills to conduct experiments. For this, they have to do a series of laboratory work on electrical engineering and electronics.

However, in practice, there are a number of difficulties in performing many laboratory works: lack of equipment and the complexity of working with them; insufficient skills of students to work with measuring instruments; the fact that many physical processes cannot be seen with the naked eye. In order to eliminate these shortcomings, in this work, the main aspects of the virtual laboratory creation methodology model, the composition of virtual

laboratory work and the application methodology for the electrical engineering and electronics course taught in technical higher education institutions are presented.

RESULT AND DISCUSSION

Creation of virtual laboratory work includes the following steps: goal formation; choosing a virtual laboratory; determine the capabilities of the virtual simulator; determination of meaningful and didactic tasks; creating a scenario; testing; assessment and analysis of the reliability of the results of the virtual experiment.

The stage of goal formation is the process of selecting the goals of the planned laboratory work with the determination of permissible deviation limits in order to achieve the educational results with the most effective and suitable means, taking into account the material, technical, time, personnel resources, as well as the personality and age characteristics of the learners.

The stage of choosing a virtual laboratory is related to a number of factors: access to resources, financial conditions of their use, language and complexity of the interface, and, of course, the content of this laboratory, that is, the possibilities provided or not provided to the user to achieve the purpose of the planned laboratory work.

The stage of defining the tasks of the laboratory work being created can be considered as an important element of the process of designing student activities. Here, it is planned what kind of manipulations should be carried out and observed (meaningful tasks) within the framework of this laboratory work, what conclusions should be reached after its completion (didactic tasks), and on what basis skills are to be formed.

The difference between the proposed virtual laboratory works and other virtual laboratories is as follows: all virtual laboratories are based on a single concept and rely on a single methodology for their further use, that is, the methodology of using the developed virtual laboratories is taken as a basis; is a set of instructional programs based on virtual laboratories, with a priority on virtual experiments, which includes the necessary reference, calculation, test-taking and teaching components.

The following method of using virtual laboratories is proposed: it is possible to work with a virtual laboratory taking into account the psychological, intellectual, personal characteristics of learners, as well as the level of training. developed. In addition, in network versions there may be interaction within the group; the use of virtual laboratories in the teaching process usually significantly reduces the time required to complete individual laboratories, which allows to expand the laboratory practicum. In addition, virtual laboratories allow conducting the most expensive, life-threatening, but necessary for training experiments even in the absence of real laboratory equipment; in distance education, the specificity and general rules of using virtual laboratories, including network and offline versions, create great opportunities, because taking into account the possibilities, laboratory practicum can be carried out outside the educational institution during the semester using virtual laboratories obtained on external data carriers (for example, diskettes, laser disks) allows to perform; network technologies, for example, using the Internet, allow you to get help from the teacher during the virtual experiment.

CONCLUSION

Taking into account the above, the "Electrical Engineering" department of the "Electrical Engineering and Electronics" science included the following laboratory works: 1) Determining the error of the power measuring wattmeter; 2) Checking the parallel connected DC circuits; 3) Checking the chain of DC circuits connected in series; 4) Measurement of electrical energy consumed in a single-phase alternating current circuit; 5) Active and inductive resistance checking the alternating current circuit; 6) A set of virtual laboratory works was created for connecting consumers in parallel and series (resonance of currents and voltages) in an AC circuit with active, capacitive and inductive elements. The complex of virtual laboratory work is aimed at students' independent performance of laboratory work from the "Electrical Engineering" department of "Electrical Engineering and Electronics", acquisition of skills for practical performance of laboratory work, and strengthening of theoretical knowledge. Each laboratory work has a theoretical description of the subject under study, a description of the stand where measurements are performed, tasks and methods of their implementation, and a list of basic and additional literature. Each laboratory case has an animated model of the assembly and measurement process of the device of the laboratory case.

In conclusion, the effective aspects of using information technologies in the educational process are being proven every day. In this case, the teacher and the student are always forced to search, learn, and develop practical skills for independent expression of their opinion. This prepares the ground for them to become experts in their profession in the future.

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