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APPLICATION OF INFORMATION TECHNOLOGY IN LABORATORY LESSONS IN THE
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Abstract: The paper describes an approach to organizing laboratory workshops on electromagnetism, which consists in using the “Virtual Laboratory”. This approach made it possible to implement part of the educational process in a remote or front-line mode, reduce the costs of implementing laboratory workshops, reduce the risks of expensive equipment being damaged due to unskilled use, and implement new forms of work that are difficult to implement within a traditional laboratory (such as, for example, the introduction and troubleshooting). 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 virtual 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.

INTRODUCTION

For physical and engineering fields of training, laboratory work is an integral part of the educational process, aimed at the formation and development of the necessary professional competencies. Currently, most educational institutions are equipped with computer equipment, so one of the current directions for solving this problem is the implementation of laboratory workshops using specialized virtual laboratory stands [2]. A virtual laboratory bench is a software that allows you to simulate real processes and reflect as closely as possible the principles, modes and operating procedures of the corresponding equipment. The implementation of such software allows laboratory work to be carried out without the need to use real equipment [3, 4]. It seems appropriate to create and implement into the material and technical base of universities providing training in engineering specialties a "Virtual Laboratory" integrated educational solution (virtual laboratory environment) for conducting laboratory and practical classes for students, advanced training of specialists, and conducting control activities. The use of such an environment will allow a student, teacher, student of additional education courses to complete assigned tasks without time limits (both completely in virtual form and in the form of training before working with real equipment), independently experiment with laboratory equipment and various electronic components (which will undoubtedly increase student interest). Thus, an increase in the efficiency of the educational process is achieved by expanding its capabilities and ensuring accessibility to a larger number of students [5].

As we noted above, here we will describe the approach to organizing laboratory workshops on electronic physical measurements, using the "Virtual Laboratory" allows you to implement the educational process in a remote or frontal mode, reduce the costs of implementing laboratory workshops, and reduce the risks of failure of expensive equipment due to unskilled use, to implement new forms of work that are difficult to implement within a traditional laboratory. To solve these problems, a laboratory environment modeling method based on LabVIEW software was used. Using built-in and specially designed programming tools and mathematical libraries, visual images and functionality of various elements of the virtual laboratory bench equipment are implemented:

instrumentation , auxiliary equipment, connecting cables, and the interaction between them. The developed virtual models are visually almost identical to the corresponding real prototypes in terms of the set and arrangement of controls (buttons, switches, indicators, panels), which makes it possible to expand and complement the set of competencies acquired by students when using a traditional laboratory: key skills in working with modern control and measuring equipment, including the formation of test sequences, performing measurements, processing and presenting their results, with an emphasis on automating all stages of working with measurement information through the development and use of professional software.

1. Equipment of laboratory stands

Currently, various approaches are used to organize and conduct laboratory work on electrical and radio measurements [2]. An example of such a solution for educational institutions is the “Electrical Measurements” stand. The stand is a set of modules with many possible assembly combinations, which significantly expands its capabilities. Using this stand, teachers can conduct about 10 different laboratory works that help students become familiar with the use of electrical measuring instruments and consolidate theoretical knowledge in practice. The stand includes: a power module, a functional generator, an autotransformer, a measuring unit, a wattmeter, electromechanical measuring instruments, a current and voltage transformer, a DC potentiometer circuit, a resistance store, etc. The laboratory stand has a modular construction principle and can be assembled in various configurations to carry out the corresponding work. The peculiarity of this solution is that the theoretical basis of the course is issues of data collection technology. The focus is not on students working with ready-made devices, but on implementing a project approach. As part of the workshop, students themselves build software components to solve measurement problems based on the ELVIS platform and the multifunctional data acquisition equipment built into it.

2. Virtual educational solutions

One of the popular domestic educational and methodological complexes is the virtual workshop “LabVIEW. Workshop on the basics of measurement technologies” [3]. The workshop includes a set of software-implemented virtual laboratory stands and a training manual, including methodological instructions for them. This complex has proven itself well in the educational process and has helped many teachers in conducting classes, however, its functionality and flexibility are somewhat limited and do not provide students with the opportunity to fully become familiar with the functions, appearance and behavior of modern electrical measuring instruments. In addition, the software code is closed, the

stands are delivered in the form of complete executable applications, and virtual instruments can only be used within the framework of the proposed laboratory work.

Based on the results of the analysis, a list of the most frequently encountered modules (devices) of laboratory stands, as well as laboratory work that can be implemented based on the identified modules, was compiled. To solve the problem of developing Virtual Laboratory software, various tools can be used. In particular, it is possible to use:

- universal text programming languages;
- specialized graphic programming tools.

Due to the availability of developed visual programming tools and mathematical libraries, the implementation of visual images and algorithms for the operation of various elements of a virtual laboratory desktop is simplified: instrumentation, electronic components, breadboards, connecting cables, coaxial connectors, and the interaction between them as part of the work. When developing the project idea, several main options for implementing the “Virtual Laboratory” were studied:

- creating a set of complete stands, each of which is implemented as a large application window with a complete stand configuration;
- use of a stand window with the possibility of “filling” with devices; formation of a stand on the desktop from devices called up in separate “floating” windows.

The main selection criteria were flexibility in terms of creating various stands and their modification, as well as convenience and low resource requirements for use on various computer equipment. Based on these criteria, the third approach was chosen as the main one. The model is intended for performing laboratory work on metrology. For educational purposes, the device model is supplemented with a set of test panels to emulate the use of the device in various modes, as well as the ability to automatically record measurement results for subsequent processing.



Fig.1. Equipment model of the “Virtual Laboratory”

Several virtual stands have been created from the fleet of equipment models of the “Virtual Laboratory”. An example is the virtual stand developed during this work for laboratory work on measuring DC power (Fig. 1). The stand includes a window with a menu for selecting device models. To call a particular device, the user must click on the corresponding button in the menu. All device subroutines operate synchronously; interaction and data transfer between models is carried out through global variables. This stand contains four virtual devices: a power supply, a resistance store, a multimeter that acts as an ammeter, and a multimeter that acts as a voltmeter. The virtual bench program is launched through an executable *.exe file, to run which you must have the free RunTime Engine software installed on your computer. Each virtual device is launched from a menu in its own window, thereby providing the opportunity to arrange programs on the screen in a user-friendly manner and reducing the minimum screen size requirements.



Rice. 2. Stand for studying initial laboratory work of a classical workshop

The subroutines simulate connecting devices with wires; next to each connector for the device contacts, when pressed, a number is displayed, which means the number of the wire that is used to “connect” the devices. Enumeration of numbers to select a wire is carried out by repeatedly pressing the contact. To monitor the correct connection of devices, a special subroutine is used. Within the framework of the “Virtual Laboratory”, several stands were also created using the traditional “one window” format. As an example in Fig. 2 presents a stand for studying the initial laboratory work of a classic workshop on electrical and radio measurements. The models of a voltammeter, digital universal voltmeter and voltage test source created for this stand are implemented as separate applications, with the main

functionality included in subroutines. Thus, an approach has been tested here that allows the use of instrument models for constructing stands both in the form of a set of “floating windows” and in the traditional “single window” format, which can be more convenient and understandable for students when performing work at the very beginning of the workshop. The “Virtual Laboratory” also includes virtual laboratory stands for measuring direct voltage and alternating voltage parameters, and oscillographic measurements.

3. 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 clarity, selecting questions for students when discussing the results of the experiment, etc.

Methodological requirements for demonstration experiments

1. The basic methodological requirements for demonstration experiments determine the rules for their conduct, which the teacher must always adhere to. One of the first methodological requirements is an organic connection between the demonstration experience and the presentation of educational material in the lesson. That is why the overwhelming majority of demonstration experiments are qualitative in nature. Despite their short duration, demonstration experiments must be convincing and clear. These important qualities of demonstration experiments are largely determined by the technique used to stage them.

2. Organically merging with the content of the lesson, demonstration experiments should capture the attention of students for a time necessary and sufficient to solve a local educational problem; this time should not be long so that the students’ attention does not wander. In other words, the psychological basis for the effectiveness of the demonstration experiment lies in the interconnection of the first and second signaling systems, which is externally expressed in the combination of clarity with the teacher’s word. When demonstrating experiments, the teacher plays a decisive role, since he acts as an active mediator between students and the phenomena being demonstrated; The success of the demonstration

depends on his methodological skill and technical literacy. In addition, schoolchildren's ideas that arise when observing experiments must be brought to generalizations, and only a teacher can do this.

3. The overwhelming number of physical phenomena, concepts, and patterns being studied cannot be well mastered by students without a carefully developed system of experiments that meets the requirements of the methodology and technology of demonstration. It is important that the number of demonstrations be respected here, and that the selected experiences together form a logically connected system in which each subsequent experience develops and builds on the previous one, and students must see and understand the interconnection of the experiences. This is achieved by the fact that the demonstration setup for each subsequent experiment basically remained the same, and a new effect is achieved by slightly changing or supplementing it.

4. Of particular importance is the preparation of students to perceive experience. Any experience evokes involuntary attention of students, however, it is unstable, and with the help of words it must be translated into voluntary attention, that is, to arouse interest in the experience by clarifying its purpose [5-9]. We have already emphasized that the result of each experiment is nature's answer to the question posed to it. Therefore, it is necessary to bring this question to the students' attention so that they expect the answer and understand it. Demonstrating an experience without specifying its purpose is not effective. Usually, before an experiment, the teacher clarifies its purpose and indicates ways to achieve the goal, usually accompanied by an explanation with a drawing on the board. Once students understand the idea of the experiment and the design of the demonstration setup, he begins to design it. If the demonstration experience is complex (requiring several actions or sequential achievement of several results), then to increase its effectiveness it is better to divide it into separate stages, defining the purpose of each of them [10-14].

5. The pace of the demonstration should correspond to the pace of oral presentation and the speed of perception by students. In many manuals, until recently, this quality of demonstration was not quite accurately called short-termism, meaning its optimal mode. If a phenomenon occurs faster than schoolchildren can perceive it, the experiment should be repeated (for example, observing a spark discharge), if possible, at a slower pace. At the same time, it must be remembered that an unreasonably extended demonstration reduces students' interest in it and leads to loss of learning time. Thus, when they talk about the short duration of an experiment, they do not mean reducing the time for observing a phenomenon (although it should be spent sparingly), but reducing to a minimum the time for preparing the experiment in the lesson. This implies the need to prepare all equipment for the experiment in advance. So, if it is supposed to boil water during a lesson, then it is heated to a boil before

that; all distances, volumes of bodies, instrument readings, etc. are determined in advance [15-20]. When preparing a demonstration, it is necessary to establish how long the experiment takes in order to properly plan the elements of the lesson.

6. An important methodological issue is the place of demonstration experience in the lesson, which is determined by the teacher's chosen methodology for presenting new educational material and the logic of development of its content. With the heuristic method of teaching a lesson, in most cases the teacher's conversation should lead students to pose a question, the answer to which is provided by the intended experience. But in some cases, a demonstration of experience may precede a conversation in order to pose a problem to students, which is resolved during the lesson. This methodological technique, which activates the mental activity of students, has recently become increasingly widespread.

CONCLUSION

The results of the work make it possible to conduct practical classes in disciplines related to measurement technologies in a frontal or remote format without the need to purchase and use real laboratory equipment, and also help to develop software and methodological support for the educational process.

In addition, the creation and implementation of new educational technologies, including digital ones, is one of the most important components of the development program of leading universities. Digitalization of education stands out as an important factor in increasing the efficiency of the educational process. Further development and implementation of the "Virtual Laboratory" will achieve the following results:

- implementation of a full-fledged educational process in engineering educational
- programs in a distance format, expanding the range of additional education programs, obtaining a competitive educational product;
- efficient use of laboratory resources, active implementation of digital educational technologies, development of educational and methodological support;
- increasing the interactivity of laboratory and practical classes for better student engagement, obtaining a flexible software tool to simplify the organization and conduct of classes in a distance format;

- full development of educational competencies, correspondence of experience with virtual models to the use of real equipment.

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