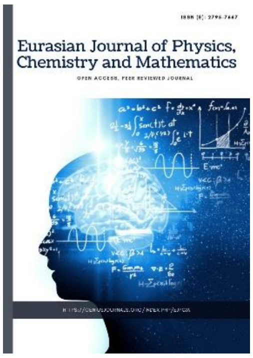

Information Technology in Laboratory Lessons of The General Physics Course

Saydayev Obid Bahodir o'g'li
Jizzakh State Pedagogical University, Sharof Rashidov-4, 100130, Uzbekistan,
Email: obidsaydayev@gmail.com

ABSTRACT

The paper describes an approach to organizing laboratory workshops on electromagnetism, which consists in using the "Virtual Laboratory". 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.

Keywords: *organization of laboratory workshops, virtual instruments, laboratory workshop, models of measuring instruments, virtual laboratory stands*

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].

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 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.

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.

4. 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’ literacy 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	2

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 3, we can see that students' use of online database and power point increased. The reason is that during the course, students used an electronic database for independent work and a Power Point program for preparing presentations. 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 information and communication skills increased by 10-15%.

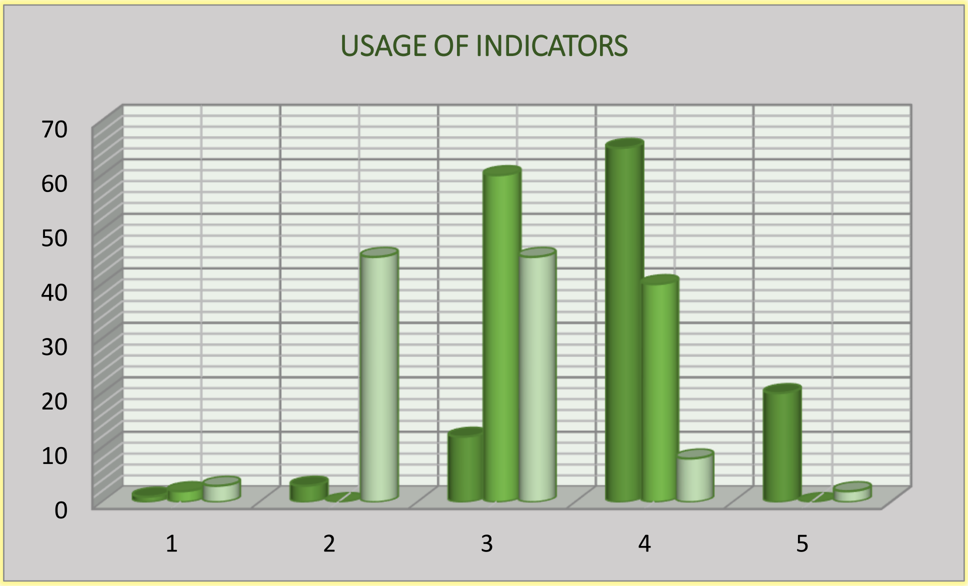

Figure 2 - Schedule for improving students' information and communication skills.

Therefore, the use of electronic textbooks, electronic whiteboards and virtual laboratory programs during the lesson plays a key role in improving the information and communication skills of students. Modern information technologies speed up all stages of the educational process. Based on the use of information technology, we can observe an increase in the quality and efficiency of the educational process, and an increase in the cognitive activity of students.

This, virtual 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 strengthen the practical skills of students, but also to transfer part of the fund of assessment tools to virtual 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.

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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