

VIRTUAL LABORATORY WORK AS FORMATION METHOD OF SELF-EDUCATED COMPETENCE OF FUTURE ELECTRICAL TECHNICIAN

O. Bilyk

College of Kremenchuk Mykhailo Ostrohradskyi National University
vul. Chumatsky Shlyakh, 9 Kremenchug, 39601, Ukraine. E-mail: aleck.bilik@mail.ru

Purpose. The work covers the approaches to the definition of virtual laboratories and the didactic features of these learning tools. **Methodology.** Attention is paid to the problem of self-education of future technicians and electricians and it has been stated that professional self-education of electrical technicians is focused primarily on improving specialized training. In order to form self-educational competence, learning process should be organized as the students' research of certain processes and phenomena, which are carried out in cooperation between them, using Information and computer technology tools and providing training of creative research character. Virtual laboratories are replacing the standard, real, traditional laboratories. **Findings.** The use of these tools in the learning process is important due to the fact that working with them provides a real opportunity for students to perform tasks in less period of time than the time it takes to make a real research device. **Originally.** For this purpose, the virtual laboratory means of electrical engineering have been proposed to be used. The examples of laboratory studies with its use and methods of their implementation have been provided. Virtual laboratory work is considered as the forms, methods and means of training, during which the students conduct specific experiments, using only images that have the appearance and function of real objects. Also benefits of virtual laboratories in the classroom of Technical College have been marked and substantiated, namely the increasing of the motivation for the development of new material, providing self-study of the students, the possibility of their use during the distance learning. Attention is drawn to the need of attracting students to an independent choice of a programming product depending on the problem being solved. This approach facilitates the conscious use of information technologies in the solution of professionally oriented tasks, the formation of a scientific outlook, understanding the nature of relationships or phenomena in nature and society, allows comparative analysis of different approaches and methods of solution and increase the learning motivation of several disciplines simultaneously at the expense of interdisciplinary connections. **Practical value.** During the laboratory works in electrical engineering discipline it is necessary to appropriately use the spreadsheet systems, computer mathematics and software for special purposes. The students obtain basic abilities and skills during the learning process of the subject "Information Science", which learning should be carried out taking into account the professional orientation and training based on the formulation and solution of professionally oriented tasks. And along with that some certain shortcomings in the application of virtual laboratory facilities have been marked, where the main thing is the lack of direct contact with the object of study or research, tools and equipment.

Keywords: learning process, an electrician, virtual laboratories, virtual laboratory work.

ВІРТУАЛЬНА ЛАБОРАТОРНА РОБОТА ЯК ЗАСІБ ФОРМУВАННЯ САМООСВІТНЬОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ ТЕХНІКІВ-ЕЛЕКТРИКІВ

О. В. Білик

Коледж Кременчуцького національного університету імені Михайла Остроградського
вул. Чумацький шлях, 9, м. Кременчук, 39601, Україна. E-mail: aleck.bilik@mail.ru

Розглянуто підходи до визначення поняття віртуальної лабораторії та проблеми їх використання при проведенні віртуальних лабораторних робіт, наведено дидактичні особливості цих засобів навчання. Звернено увагу на проблеми самоосвіти майбутніх техніків-електриків та наголошено, що з метою формування самоосвітньої компетентності процес навчання необхідно організовувати як дослідження студентами певних процесів і явищ, що виконується у взаємодії між ними, використовуючи при цьому засоби ІКТ та надаючи навчальній діяльності творчого дослідницького характеру, для чого пропонується застосування віртуального лабораторного засобу з електротехніки. Наведено приклади лабораторних робіт з його використанням та методика їх проведення. Крім того, відмічені і обґрунтовано переваги застосування віртуальних лабораторних робіт в навчальному процесі технічного коледжу, а саме: підвищення мотивації до освоєння нового матеріалу, забезпечення самостійної підготовки студентів, можливість їх використання під час дистанційного навчання. Але разом із цим відмічені і певні недоліки при застосуванні віртуальних лабораторних засобів, головним з яких є відсутність безпосереднього контакту з об'єктом вивчення чи дослідження, приладами та обладнанням.

Ключові слова: процес навчання, техніки-електрики, віртуальні лабораторії, віртуальна лабораторна робота.

PROBLEM STATEMENT. Bologna system, which was adopted in most countries and is being implemented in Ukraine, requires considerable attention in the independent work of students and therefore the time of communication between the teacher and the students is reducing that may adversely affect the learning process, because a return call in the chain "a teacher-a student"

is breaking.

Therefore, it is necessary to find the ways to improve the learning process, because the student must, within the allotted hour curriculum, assimilate the course material offered efficiently and creatively.

Today methods of teaching any subject, the content of educational material, mastering the solving practical

problems methods essentially depends on the teacher's ability and choice of different information and communication technologies (Information and Computer Technologies) and software as a general and special purpose in the pedagogical activity.

Recently new tools have been designed on the boundary of modern information and communication technologies to simulate laboratory work in a laboratory. Using these tools enables visualization and modeling the experiments and demonstrating the essence of complex processes and phenomena.

This is the virtual laboratory that has replaced the standard, real, traditional laboratory nowadays.

The necessity to use these tools in the educational process is caused by the fact that the work with them gives a real opportunity for the students to perform laboratory work for a shorter period of time than the time it takes to make a real research device.

Today the approaches to the virtual laboratories definition and problems of using virtual laboratories and stands at teaching different subjects are being analyzed in the works by Oleksyuk V.P., Pidgorny T.V., Popova I.V., Latynina O.V., Truhina O.V., Chernyi O.P. and others.

There is no single definition of "virtual laboratory". Different scientists have different interpretations of this concept and give different names for these tools, virtual laboratories, virtual laboratory stands, virtual laboratory facilities and others.

The goal of the article is the research and development of the "Theoretical basics of electrical engineering" system of virtual educational software using to form self-education competency in future electrical technicians.

EXPERIMENTAL PART AND RESULTS OBTAINED. It is impossible to train specialist of non-technical profile without the organization and carrying out laboratory-practical work during the educational process. To have better theoretical material and practical skills, the students perform a number of practical works of relevant disciplines.

Practical work reinforces the theoretical knowledge and enables students to study the method of applying this knowledge, to acquire the professional ability of intellectual-emergence in either natural or manufacturing processes.

In order to form self-educational competence process it is necessary to organize the process of studying as certain processes and phenomena which are carried out in cooperation between them, at the same time using the means of information computer technologies equipment and providing the educational process with the creative research work.

Taking into account technical colleges and technical schools, it is necessary to note that professional self-education of an electrician is aimed at the improvement of the special training.

Taking into consideration the professional competence and the results of studying of junior specialist listed in Educational Qualification Description according to the educational program "Maintenance and repair of electrical appliances", we have noted that the future

specialists can identify and refine the meaning of self-education and thus independently improve their professional competence. [1].

Self-education of the specialist on electrical equipment should be directed at the formation of professional meaningful and personal qualities of the future specialist, meeting his professional qualifications, constantly continuing his professional qualifications, which in turns has to provide a future electrician with success in further training and competitive capacity in the labor market.

In our research of self – education, the competency will be regarded as the ability to update the technical and operational part of their vocational awareness of the need to improve their professional level, self-development and self- education all life long.

Using virtual laboratory means, laboratories and stands, scientists consider the definition of these concepts. According to the definition by O.V. Truhina, P. C Kurganskaya, the virtual laboratory is a soft-hardware complex, which allows to conduct experiments without direct contact with real mounting or without it. [2]. A.A. Belohvostov considers it as the computer program that can simulate the process, change the conditions and the parameters of its fulfilment as a virtual laboratory. [3].

S.A. Chekhovskiy, S.M. Tsiryulnik, O.P. Chorniy and others study the use and basic principles of the virtual laboratory stands to train specialists of technical profile [4]. A virtual laboratory stand is considered as a computer program for research of certain processes and phenomena [5].

In the course of our research led by professor O. P. Chorniy conducted in Kremenchug Mikhailo Ostrohradskyi National University the "Theoretical Foundations of Electrical Engineering" virtual laboratory device was created which will be considered as an educational program tool to simulate laboratory work in the laboratory.

It is necessary to consider the concept of virtual laboratory work in order to develop the methods of the created device use.

A virtual laboratory, according to D.I. Troitskiy, is an information system that interactively designs real technical object and its essence to study the properties with application of computer visualization facilities. [6].

Technically Virtual Laboratory is a complex resource that includes: 1) the actual virtual laboratory as a computer program that simulates the main stages of the laboratory work; 2) a set of virtual items and equipment; 3) the guidelines of theoretical knowledge, specific tasks in the line of work, claims of the report [7].

From a didactic point of view the virtual laboratory operation is considered as a form, methods and means of training, during which students conduct some experiments, using only images that have the appearance and function of real items. [8] Virtual didactic opportunities of laboratory work should be considered as the possible forms of remote entities (or subjects with remote resources) cooperation between them, which are provided for one or other computer communication technology in the education activity during the implementation of a

pedagogical problem [9].

Using virtual laboratory works towards the real ones can be demonstrational, resumptive and experimental [8]. Demonstration type is used before the real work and gives the lecturer an opportunity to show the sequence of actual laboratory work; Resumptive type is used after real work and gives the teacher the possibility not only to demonstrate but also to clarify certain issues or phases of research and draw conclusions as to consolidate the acquired knowledge. Experimental type provides individual or group assignments without performing real works, conducting computer experiment.

Analyzing all variants of virtual work and taking into consideration the definition of Virtual Laboratory, we can say that the most appropriate for our research is experimental use of virtual laboratory work instead of the actual laboratory work.

Thus, virtual laboratory works are generally used to achieve the same didactic goals that are real and have research nature. Let us consider the application created by the virtual laboratory tool in details.

Example 1. Determination of power losses in the wires of electric lines.

The aim of the laboratory work is to study and determine by the students the dependence on voltage and power loss in the wires from the length of network and the load on the network.

In order to form self-educational competence the laboratory work is to be done in three stages.

1. Stage 1. The main field work program consists of the elements of the circuit which forms electric circuit. General view of the laboratory is presented at picture 1.

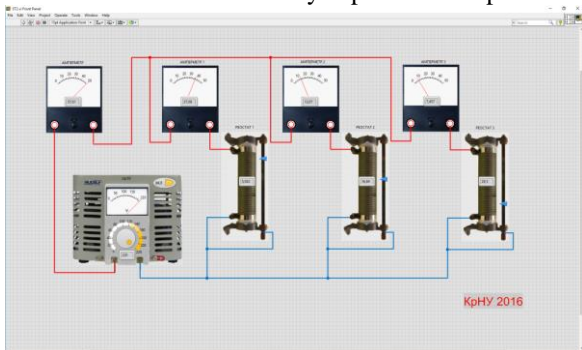


Figure 1 – General view of the laboratory work

The source of electricity in the circle is a laboratory automatic transformer. An ammeter and three rheostats are connected to it in series. A voltmeter is connected simultaneously to the last rheostat.

At an input voltage press the "ON", set 220 V and conduct measurements with minimal resistance range. For this purpose the first and second rheostat set to minimum position. The value of the last resistor is necessary to establish to the maximum position

In this case, the ammeter will fix the value of the force of the current flowing in a circle, and voltmeter will display the voltage supplied to the third resistor. Since the resistance of the rheostats is minimum, then the voltage drop will be minimum too. This can be determined by comparing the input of the voltage indicators (for a laboratory automatic transformer) and output voltage (on the voltmeter).

Stage 2: Task implementation.

1. To conduct four experiments with minimal voltage drop, changing the value of resistance at one of the rheostats. The values that have been received (current, voltage) should be written down into the table. A sample of the first experiment are shown in Pic. 2.



Figure 2 – The "minimum voltage drop" experiment.

2. To achieve maximum voltage drop, for which it is necessary to set resistance in rheostat of 38 Ohm (maximum). In this case, the difference between the voltage on indicators of a laboratory automatic transformer and voltmeter will be essential, and the ammeter will display the current value of the current in a circle. Gradually reducing the value of resistance at one of the rheostats, it is necessary to perform four experiments. Obtained parameters values of amperage and voltage should be written down into the table.

Upon the completion of the program, the "OFF" button should be pressed which switches off power supply and breaks the electric circuit. In carrying out these tasks the teacher should question the students aiming to create students' self-education competency.

- 1) What will happen if the voltage exceeds maximum value?
- 2) How does the voltage affect the operation of electrical devices?
- 3) Explain why the electricity transmission through the wires the voltage drop should be considered.
- 4) Explain how to fight with voltage drop.
- 5) If the circle has one element, what will voltage drop be?
- 6) What is the difference between voltage and voltage drop?
- 7) If there are nonlinear elements circle, how the voltage drop should be determined?
- 8) What causes the voltage drop and why does this phenomenon occur?
- 9) What are the prerequisites for voltage drop and what are the reasons for this phenomenon?

After all the experiments have been made, the students ought to come to the conclusion that a negative voltage drop hardly affects the operation of the circuit, and at the device that is connected to this circle. Therefore, there are certain methods to combat this phenomenon, which can be used in the preparation of the electric circuit. 288/5000

Stage 3: Independent Research. In order to form self-educational competence it is advisable to involve students to the independent research activities using information computer technology tools. In carrying out a laboratory work, it is advisable to choose any software tool to build these graphs of dependence at the current

strength of the input power with the required voltage drop and current on the input and output at the maximum sense voltage drop independently.

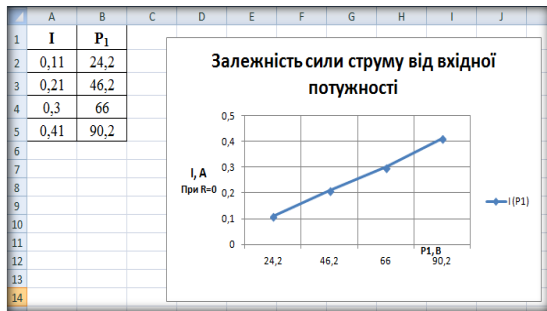


Figure 3 – Example of the current strength dependence graph on the input power

It is also advisable to propose to build a serial connection circuitry elementary with the software environment Electronics Workbench. Software Environment Electronics Workbench is a tool software development and simulate electrical circuits, which include a large number of models of electronic devices of best known manufacturers, it has a simple and easy interface, it does not require deep knowledge of computer technologies, provides possible work with a large number of computer peripherals and simulate its work. In carrying out these tasks, the students can be sure in the scheme, and to realize the real impact of voltage drop across the circuit work, and perform calculations of voltage drop. Examples of the given graphs are shown in Pic. 4, 5.

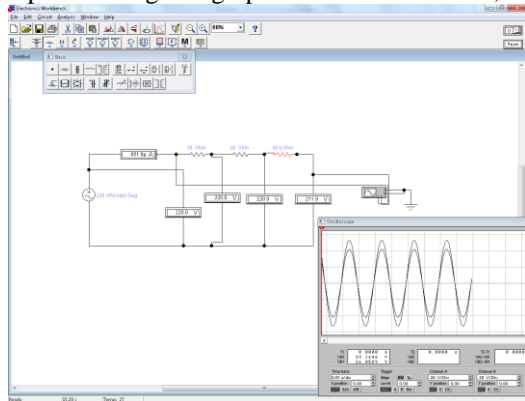


Figure 4 – Example of scheme with minimum voltage.

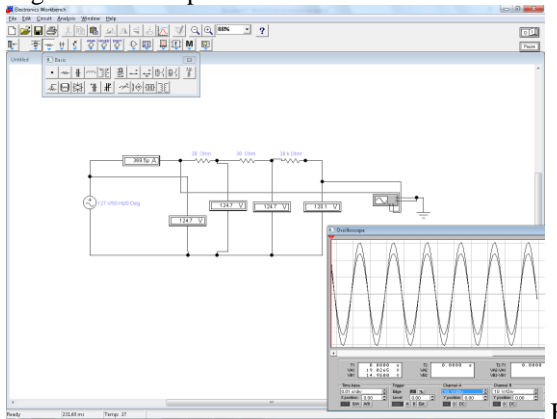


Figure 5 – Example of circuit with max voltage drop

It is necessary to pay attention to the necessity of attracting the students for independent choice of a software tool based on the problem being solved. This ap-

proach helps use the information technology in the process of solving the professionally oriented tasks consciously, the formation of a scientific outlook, understanding the essence of the relationships of phenomena in nature and society, allows comparative analysis of different approaches and methods and also increase learning motivation simultaneously of several disciplines at the expense of cross-curriculum connections. During the laboratory works in electro-technical disciplines it is necessary to apply spreadsheet, computer mathematics systems and also software of special purpose appropriately. Basic abilities and skills of work with the following software are being obtained by the students while studying the "Informatics" subject which should be trained being oriented at the professionally orientated tasks and using the devices of information and computer technology.

Example 2. Types of connections elements. The aim of the laboratory work is to research the types of connections of the circuit elements.

Stage 1: The Main Material Presentation.

The main field work program consists of elements of the circuit, which forms closed electric circuit. In the circuit there are the following elements: a laboratory automatic transformer, a rheostat, an ammeter, a voltmeter. The location of elements at the parallel and also their connection is shown in Pic. 6.

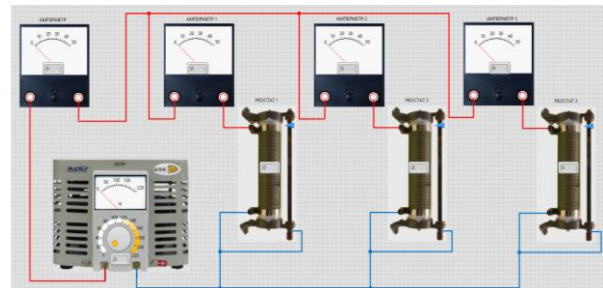


Figure 6 – Location of circuit with parallel connection

The source of electricity in the circuit is a laboratory automatic transformer. Three resistors are parallel connected to it and ammeters are connected to each of them in series.

By clicking the "ON" button, the voltage of 220V is energizing, then with the help of the slider each rheostat must be given a certain value. Each ampere meter will display the strength of the current, which flows through a resistor. Thus, we can find out how much current is distributed at each rheostat in parallel connection.

Stage 2: Execution phase.

By clicking "ON", the input voltage source voltage is applied in 2 stages: the assignment. Conduct three experiments, changing the value of all the resistance in rheostat. The values that are received must be noted down into the table.

After all the experiments have been made, the students must come to the conclusion that each type of connection in the electrical circuit is characterized by its value of amperage and voltage and each connection has its advantages and disadvantages. For example, when using a parallel connection a greater number of connecting wires are used, but this scheme is more reliable in use of a serial connection.

Stage 3: Independent Research.

In carrying out the laboratory work students are invited to build a circuit diagram of a mixed-connection elements, which includes a set of serial and parallel connections and performs calculations of equivalent resistance in this connection. Construction scheme is implemented in the Electronics Workbench software environment.

After making a circuit, the students must come to conclusion that each part in the electrical circuit with mixed joining is characterized by its value of amperage and voltage. To determine the equivalent resistance of the elements in the mixed joining it is necessary to use the method of consequent shortening of the scheme. This method is to replace some multiple resistances by one resistance with general meaning. Thus, the circuit diagram can be greatly simplified, making the calculation of the equivalent resistance easier.

CONCLUSIONS. Based on the proposed system, the usage of a virtual laboratory tool for training future technicians-electricians maximum simplifies the process of the studies, increases its effectiveness, there are opportunities to create self-educated competence and improve professional skills of the future professionals.

The virtual laboratory work contributes to the development of creative abilities of students, education activity, initiative, intellectual curiosity, which will ensure success in future careers of students and will be necessary in further study at higher education institutions. In addition, the benefits of the use of virtual laboratory works in the educational process of technical college should be noted, namely the increasing of the motivation to get new knowledge, to ensure independent study of students, the possibility to use it during the distance learning, the possibility to carry out a significant amounts of experiments with different input parameters. With the time released, much attention is given to the comparative analysis of the results, diverse approaches and methods of solution, the possibility of modeling such processes which impossible to reproduce in laboratory conditions and their visualization. It is also necessary to note the lack of necessary-intensive purchase of expensive equipment and the possibility of safe work when it concerns the work with high voltage.

It is also necessary to note the disadvantages of using the laboratory devices, the main thing of which is the lack of direct contact with the unit of the study or research, instruments and equipment.

In our view, it is necessary for the future technicians to have an experience to work with real equipment and laboratory work must be like a real experiment on the modern equipment, scientifically reasonable proportion that will provide the most effective training in relation to financial expenditure and rapidly develop the structure and methodology of teaching electrical engineering disciplines.

REFERENCES

1. Osvitno-kvalifikatsiyna charakteristika. [Educa-

tional qualification characteristic] Spetsiainist #141 «Elektroenergetika, elektro-tehnika, elektromehanika» za osvitoynu progra-moyu «Obslugovuvannya i remont elektropobutovoi tehniki». – Kvalifikatsiya «Tehnik-elektrik». - K., 2010. - 35 c. [In Ukrainian].

2. Truhin, A. V. (2003), Vidy virtualnykh kompyuternykh laboratoriy : [Types of virtual computer laboratories], [Otkryitoe i distantsionnoe obrazovanie] / A. V. Truhin. - T., 67 c. [In Russian].

3. Belohvostov, A. A., Arshanskiy, E. Y. (2012), Elekt-ronnyie sredstva obucheniya himii; razrabotka i metodika ispolzovaniya [Electronics means of learning chemistry and the method of development] / A. A. Belohvostov. – Minsk : Aversev. - 206 c. [In Belorussia].

4. Tsurulnik, S. M. (2010), Komp'yuterizovaniy laboratorniy virtualniy stand [Computerized laboratory virtual stand], [Visnik Vinnitsko-go politechnichnogo institutu] / S. M. Tsurulnik, V. I. Roptanov. – Vinnitsya . 98 c. [In Ukrainian].

5. Chorniy, O. P., Rodkin, D.Y. (2010), Virtualni kom-pleksi i trenazheri – tehnologiya yakisnoi pidgotovki fahivtsiv u galuzi elektromehaniki, avtomatizatsii ta upravlinnya [Virtual complex and trainers - quality technology training in the field of electromechanics, automation and control] , [Osvitni tehnologii] / O. P. Chorniy. – Kremenchuk. 34 c. [In Ukrainian].

6. Troitskiy, D. I. (2008), Virtualnyie laborator-nyie raboty v inzhenernom obrazovanii [Virtual laboratory work in engineering education] , [Elektronnyiy resurs] / D. I. Troitskiy. 73 s. – Rezhim dostupa k zhurn.: <http://www.qualityjournal.ru/data/article/375/files/Binder13.pdf>. [In Ukrainian].

7. Novyie vozmozhnosti internet-obucheniya. Metody i sredstva interaktivnogo vzaimo-deystviya [New opportunities of Internet-education. Methods and means of interactive relationship] , [Elektronnyiy resurs] / P. S. Kurganskaya, L. A. Peskova . – 2004. 130 s. Rezhim dostupa k zhurn. : http://elib.library.isu.ru/docs/psycholog/p1297-3_E8_6783.pdf. [In Ukrainian].

8. Polozhennya pro organizatsiyu navchalnogo protsessu v Koledzhi Kremenchutskogo natsionalnogo universitetu imeni Mihayla Ostrogradskogo. [The provisions on the organization of educational process in the College of Kremenchuk Mykhailo Ostrogradskyi National University] – Kremenchuk: Vid-vo KKrNU, 2015. – 16 s. [In Ukrainian].

9. Vasilchenko, L. V., (2010), Didaktichni mozhlivosti komp'yuternih komunikatsiy – osnova didaktichnoi modeli pidvischennya kvalifikatsii pedagogiv za distantsiynoyu formoyu [Didactic possibilities of computer communications - the basis of didactic models teachers' qualification mastering for remote form] , [Elektronnyiy resurs] / L. V. Vasilchenko. – 11 s. Rezhim dostupu: http://www.nbu.gov.ua/portal/soc_gum/ppmb/texts/2010_4/10valvtrf.pdf. [In Ukrainian].

**ВИРТУАЛЬНАЯ ЛАБОРАТОРНАЯ РАБОТА КАК СПОСОБ ФОРМИРОВАНИЯ
САМООБРАЗОВАТЕЛЬНОЙ КОМПЕТЕНТНОСТИ БУДУЩИХ ТЕХНИКОВ-ЭЛЕКТРИКОВ**

Билык А. В.

Колледж Кременчугского национального университета имени Михаила Остроградского
ул. Чумацький шлях, 9, г. Кременчуг, 39601, Украина. E-mail: aleck.bilik@mail.ru

В работе рассмотрены подходы к определению понятия виртуальной лаборатории и проблемы использования этих средств при проведении виртуальных лабораторных работ, приводятся их дидактические особенности. Обращено внимание на проблемы самообразования будущих техников-электриков и отмечено, что с целью формирования самообразовательной компетентности процесс обучения необходимо организовывать как исследование студентами определенных процессов и явлений, что выполняется во взаимодействии между ними, используя при этом средства ИКТ и предоставляя учебной деятельности творческого исследовательского характера, для чего предлагается применение виртуального лабораторного средства по электротехнике. Приведены примеры лабораторных работ с его использованием и методика их проведения. Кроме того, отмечены и обоснованы преимущества применения виртуальных лабораторных работ в учебном процессе технического колледжа, а именно: повышение мотивации к освоению нового материала, обеспечение самостоятельной подготовки студентов, возможность их использования при дистанционном обучении. Но вместе с этим отмечены и определенные недостатки при применении виртуальных лабораторных средств, главным из которых является отсутствие непосредственного контакта с объектом изучения или исследования, приборами и оборудованием.

Ключевые слова: процесс обучения, техники-электрики, виртуальные лаборатории, виртуальная лабораторная работа.

Стаття надійшла 10.02.2017 .