Empirical Aspect of Scientific Research in the Discipline "Electronics and Circuit Design"

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Abstract—**The innovation of elements of scientific research into the educational process using hybrid laboratories is considered. The experimentation methodology of a laboratory workshop in a computerized laboratory on the theory of electric and electronic circuits, which uses problem situations, is proposed. At the same time, the effectiveness of the educational process increases and the attainments of scientific research of phenomena and processes are developed.**

Index Terms—**education; didactic; laboratory practice; hybrid laboratory; virtual experiment**

I. Introduction

The development of science is associated with an analysis of the influence on the processes of various factors, the identification of the interaction between these factors. The goal is a thorough study based on the developed principles and methods. An important role in this is given to the cognitive task of the empirical and theoretical direction. We distinguish only one aspect – the empirical, which is based on the experiment.

The development of modern teaching technologies requires new methodological approaches to conducting a laboratory workshop in the study of electrical engineering disciplines that would provide the appropriate level of knowledge. To do this, in the educational process, it is necessary to implement a methodology for problem learning, which provides the implementation of elements of scientific research. Unfortunately, this technique is almost not used in high school, and especially in the environment of the study of electrical engineering disciplines.

The problem of the innovation of elements of scientific research in the educational process has always been and remains relevant. This is due to the diversity of methods and forms of learning process, the introduction of new learning technologies, as noted in the article [1]. As one of the factors, the use of elements of problem learning [3] or the organization of a laboratory workshop [4] is noted. A more significant analysis of the importance of a laboratory practice in student research was conducted in [2], but only from the point of view of traditional laboratory work. In [5] already accentes the fact that scientific work affects the quality of the learning process and its effectiveness depends on the use of integrated laboratories.

II. Formulation of the Problem

Modern computerized teaching methods and the latest technologies also require wider use of the virtual laboratory workshop as the main component of the learning process and put new demands on it. These requirements are specified with the introduction into the structure of the laboratory practice elements of problem education, which, at the same time, requires the student basic scientific research skills. Symptom of problem learning is the creation of a problem situation, which is solved on the basis of acquired or new knowledge. In this paper, the issue of developing the structure and implementation of such a laboratory practice in the discipline "Electronics and Circuitry" is being addressed to implement the empirical aspects of scientific research.

III. Problem Solving

Laboratory workshop is the main component of the didactics of electrical engineering disciplines, which is important for the formation of students of engineering thinking. This workshop, as you know, solves the following didactic tasks:

- Acquiring practical skills while carrying out experimental tasks;
- Development of methods of measuring electric quantities;
- Verification of the theoretical positions.

At the same time, the use of modern learning technologies can significantly expand the didactics of a laboratory practice in the direction of studying a phenomenon or process.

To implement these principles of problem learning, some tools are needed. Creation of a specialized hybrid laboratory, which ensures both natural and virtual experiments on disciplines of the electrical engineering profile. Using the USB measuring device DISCO2 allows you to realize the functions of the oscilloscope, electronic voltmeter, logic analyzer and spectrum analyzer. Modeling an experiment in a virtual environment is provided by software complexes (Laboratory Virtual Instrument Engineering) and OrCAD [6].

Actually, the combination of the whole experiment and its virtual reproduction at the laboratory practice solves the problem of adaptation of students of the first years of study to virtual simulation. This is very important, because it actually provides the basis for the analysis of processes in electrical and electronic devices, that is, it connects their reality with the virtual reproduction. This approach provides the basis for the introduction of elements of scientific research, namely its empirical aspect, during the conduct of a laboratory workshop. However, the last aspect has an important role in the training of a specialist.

Preferably, a laboratory practice on electrical disciplines is carried out on the physical (laboratory) model of an object or element. This approach does not form a student with a complete understanding of the processes under study, and also complicates the combination of the educational process with scientific research. The use of such a laboratory workshop in a computerized intellectual lab allows to improve the quality of laboratory research by introducing into its program elements of problem learning – the creation of problematic (emergency) situations. These problem situations are focused on cognitive directions that characterize phenomena or processes.

Such an approach corresponds to the structural scheme of conducting laboratory work on discipline "Electronics and Circuit Design" on the study of a number of electronic circuits (Fig. 1), in particular the transistor amplifier. The basic is the block "Scientific task", where the student receives a problem solving task for scientific research by creating an appropriate problem. Such problem situations may include violations of normal operating modes of devices or emergency situations in them or the effect of element parameters on the characteristics of devices.

In more detail, we focus on conducting a virtual component of the laboratory work on the study of a virtual model of a transistor amplifier in the OrCAD environment. During the virtual experiment the problem – to investigate the influence of the capacitive elements of the circuit on the frequency response, for the student is posed. To do this, he needs to find out what capacities affect the characteristic at low and high frequencies, as well as how to improve the gain.

CONCLUSIONS

The proposed approach to the implementation of a hybrid laboratory practice with elements of scientific research in the intellectual lab, firstly, greatly enhances the effectiveness of the educational process, forcing the student to seek approaches to solving the problem by obtaining new knowledge. Secondly, in the process of learning, the student receives scientific research skills. Considering that such a laboratory workshop is used for I-II courses of study, this approach is of practical importance for future specialists in electrical engineering and electronics.

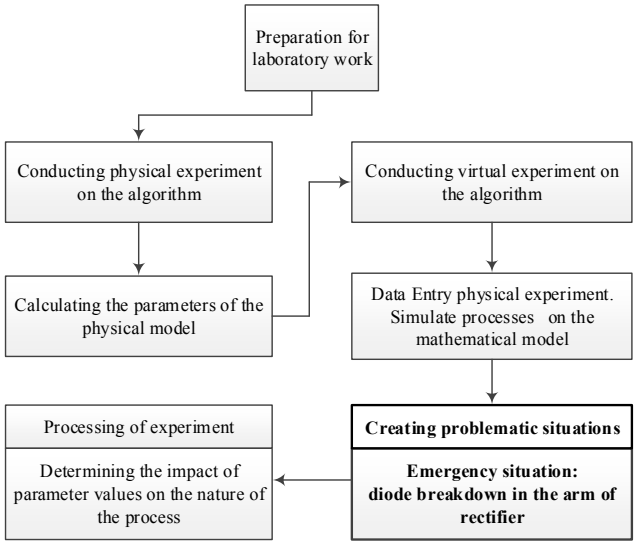

Fig. 1. Structural scheme of problem-oriented learning

In addition, such a hybrid laboratory practice requires radical changes in the teaching methodology of electrical and electronic disciplines and, accordingly, the qualifications of the teacher himself.

Thus, working out of a laboratory workshop on such an algorithm gives the student confidence in further study, producing scientific thinking in it. In addition, such a technique produces cognitive motivation in the student, which in turn leads to a stimulating interest in learning. However, this is the main goal of higher education, which should prepare motivated professionals in the modern world.

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