ELECTRONICS AND ELECTRICAL ENGINEERING
ISSN 1392 – 1215 2010. No. 6(102)
ELEKTRONIKA IR ELEKTROTECHNIKA

ELECTRONICS SCIENCES
ELEKTRONIKOS MOKSLAI

Effectiveness and Quality of Education: Methodology, Organization and Technical Means

V. Juška, A. Chaziachmetovas, R. Jaruševičius
Department of Signal Processing, Kaunas University of Technology,
Studentų str. 50, LT-51368, Kaunas, Lithuania, phone: +370 37 300533, e-mail: vladas.juska@ktu.lt

Introduction

Our experience has shown the shortcomings of traditional teaching and learning approach at the technical university:

- The lack of systematic student's learning during the entire semester.
- Too formal evaluation of student's learning during the semester.
- The poor compatibility in time of learning topics in the classroom (lecture, tutorials) and laboratory.
- Low effectiveness of team work in the laboratory. Very often not all members of the team are actively involved in the work.
- The learning process does not correspond to the actual work course, where assignment, information retrieval, simulation, experiment and assessment have to be concentrated in time.

All mentioned disadvantages bring typical habit of "rush" – all tasks will be completed in the end of session.

In addition to methodological disadvantages the training process has the low economical - technical efficiency. There is very low intensiveness of the laboratory and equipment use. There are laboratories, which are in use only for three-four months per year. It is inappropriate but unfortunately widely used the laboratory working strategy, where the tasks do not encourage thinking and understanding, but points a performance measurement (verify the Ohm's law). Students waste much of time and energy for calculations, data collection and presentation but their understanding of the topic remains low. After all they get tables, charts, etc. and use they to fill the reports of the laboratory. During the defense time tired of the routine instructor gives the questions to the students and those questions are typical, in this way the students get possibilities to answer the typical responses. Obvious and paradoxical case – the more detailed brief description of the work is proposed to the student, the less students are thinking.

Individual work assures effective learning of new knowledge, especially when laboratory work steps and assessment means stimulates student's thinking. In this case the very important point is evaluation algorithm of the knowledge and theory understanding. When quizzes or question sets are used, it is not correct to give from several answers only one correct answer. We propose to give some different "correctness" answers with corresponding grades – we avoid the lottery effect. When the answer with lower "correctness" level is chosen the special PC application shows the theory page that describes this question. After that the questions is given again. The process is repeated until the student gets the right answer. Number of repetitions influences the final grade.

The recognized educational pyramid [1] clearly shows the ineffectiveness of passive forms of training and what prompted us to explore new methods of active development expertise.

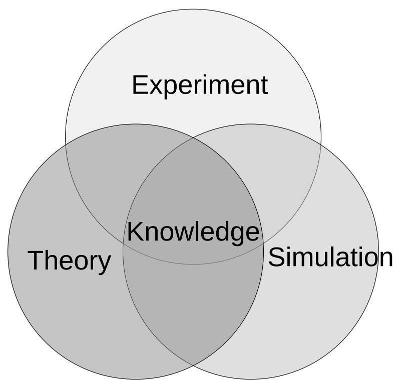

Fig. 1. Knowledge base

In engineering education it is necessary to focus on the basic disciplines that make up the knowledge base. If these subjects have not fully mastered, the study leads to fragmentation of knowledge, which is very difficult to remove in subsequent courses. These courses are the theory of circuits and electronic in our case. The knowledge base consists from theory, simulation and experimental parts (Fig. 1).

Modern technologies allow to realize on a new level historically supported and generally recognized training "teacher - student – teacher“, where teacher is a creator of a program and students, who are sited in workplaces with the PC. An instructor is in full control of the situation. Data for each student and students‘performance are stored on instructor‘s computer. On the basis of collected statistics, an instructor constantly adjusts needful learning material and its presentation form. This is an on-line and reliable feedback between teacher and student. In such a situation an instructor is able to devote more time for problem learning and individual work of students. Therefore an effectiveness of working time is increased substantially. Moreover, in this case, laboratory work may be supervised by low-skilled laboratory assistant, who performs only the technical functions.

Work structure

It is expected to realize three levels of activities in the laboratory see fig 2. The first one, zero or students' level will be available via web access and oriented to students interested in electronics, as well as to the future students. The second level - engineering – for the work in the hands-on laboratory. Following the work of this level, students present report for the final assessment. Third level - advanced engineering. For a student additional assignments are given, and different research methods are offered. All material is illustrated by multimedia - video clips, animated pictures, diagrams, contributing to better understanding on all activity levels.

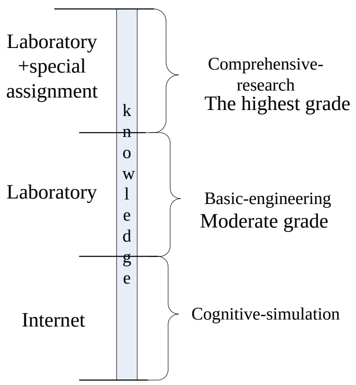

Fig. 2. Structure of laboratory experiment

To that end, a set of methodical, technical and organizational measures are developed.

Methodical means:

1. Integration of learning, tutorial and laboratory experiment in the workplace, and at the same time. No incompatibility in time - stages of the learning process fully meet the real working conditions (Fig. 1.)
2. Full and final assessment - the computer assesses the work performed and student‘s answers by preliminary grade, reflecting students' knowledge.
3. There is a possibility to avoid the very human psychological effect - now to listen to instructor (lecture), to calculate something (exercise), something to measure (laboratory), and assessment will be later, and then – time to contemplate. Learning is a complex process, and in order to get a higher assessment some individual steps can be repeated several times.
4. Huge educative effect - no attacks (exams, tests, defenses of reports, etc.) - the result is achieved by means of consistent daily work.
5. It is intended to give special attention to the formulation of the laboratory tasks.

Technical means:

1. The main idea - the laboratory equipment should not be a goal. The experiments are carried on by first-year students - the measuring instruments are not familiar enough. Often experiments are not finished in time because it is difficult for students to absorb a lot of new things – control of instruments, presentation of results, etc.
2. The universal instrumentation unit transfers measurement data to the PC, and the screen displays real-time panoramic characteristics – magnitude and phase. The objects for experiments are realistic, fully prepared for investigation. The student‘s task – understanding of causal relationships, and comparison of simulation and experimental results.
3. Many simple circuit boards are prepared for both courses. All students can consistently perform all assignments of the course [2].

Organization:

1. At the beginning of the course an instructor delivers a few lectures about course contents and structure, basic knowledge, presents the procedures and other general matters. It is important to introduce the module and the structure so as to make clear what will be taught and how. In these lectures some features of the course are introduced as well. Later a workshop may be carried on, as the second feedback element, in which a student may ascertain some theoretical difficulties.
2. In the workplace only one student. He performs a custom task. Workplaces are separated by screens, thus the environment is non distracting, and favorable for independent work.
3. Semi-open type of laboratory - provides sessions according to the timetable, and a workplace for a student is guaranteed. The student can attend the laboratory the other time, but in such a case an online pre-registration is required.
4. Learning process is constantly monitored, and monthly assignments have to be performed. Students, who are behind the schedule, should agree a timetable online.

Description of laboratory workplace

The structure of a workplace is presented in Fig. 3, and picture of a workplace is presented in Fig. 4, 5. The workplace consists of three main hardware components: a computer, a universal measurement and signal formation unit and a kit of specific circuit boards.

1. The computer controls means of the experiment, receives, processes and displays the experimental data, delivers questions and evaluates responses, presents all relevant theoretical material;

2. The interface is used to connect a PC to the universal measurement and signal formation unit which forms the appropriate signals and performs measurements.
3. Specific circuit board - the student changes the parameters of the circuit, performs the necessary switchings, monitors and interprets changes, and responses to control questions.

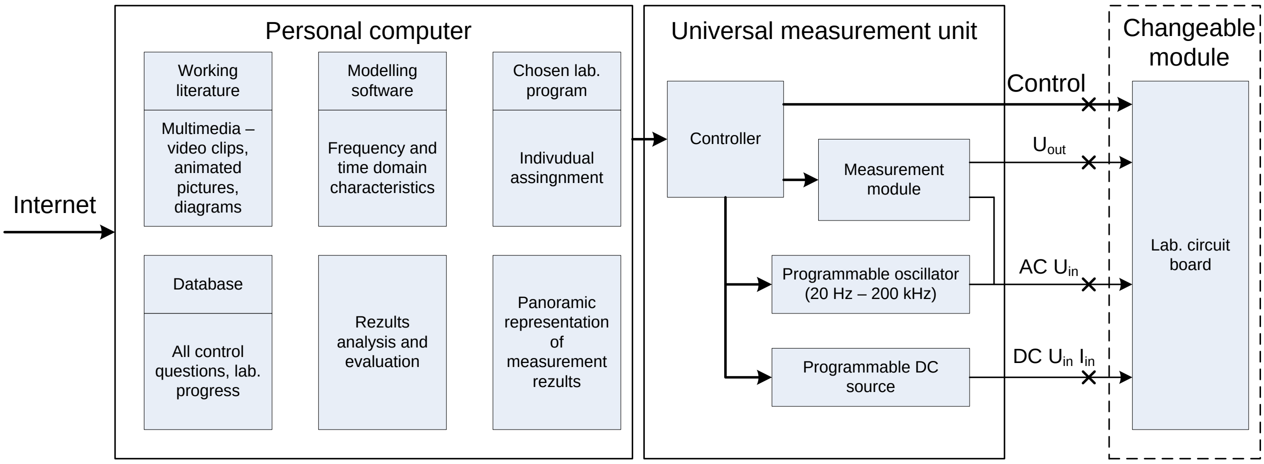

Fig. 3. Structure of laboratory workplace

The universal measuring unit forms signals for lab panels. It consists of program controlled sine wave frequency generator (DDS chip – AD9832) and a programmable voltage source. Frequency response of magnitude and phase of investigated circuit is measured, and all data are transferred online to PC. The experiment results are processed and displayed on the screen in LabVIEW environment [3, 4] (Fig. 6). The circuit simulation is performed simultaneously (Fig. 7).

Fig. 4. Laboratory workplace - big picture

Example of a complex task in the workplace – to compare experimental and simulation results in order to find out the reason why the phase frequency response for the low frequencies differs significantly from the theoretical characteristic. By changing the parameters of the model student must determine the parameters which has influences to mentioned difference and determine their real values in the real circuit.

During the laboratory work student uses the theoretical material and video clips that explains the analyzed processes. For our example - the mechanical equivalent of resonant circuit with spring (inductance) and weight (capacitance). This model visually explains the process how the electric field energy is transformed into magnetic field energy and vice versa. The main goal of the laboratory experiment is not only a circuit performance measurement but investigation of characteristics and influence factors.

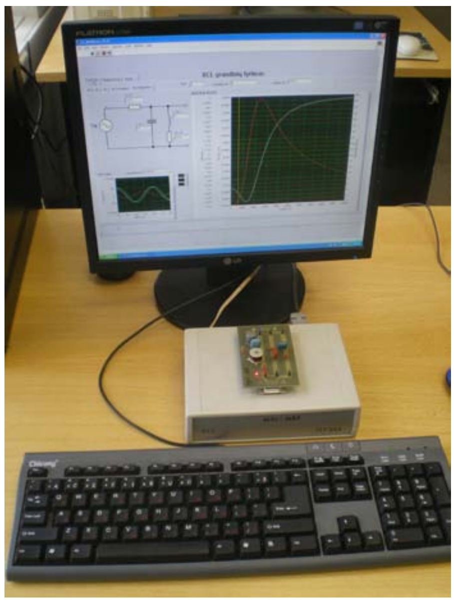

Fig. 5. Laboratory workplace

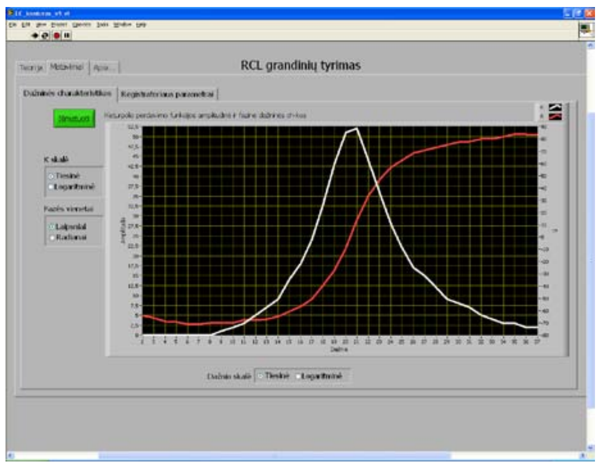

Fig. 6. Program dialog window in real experiment mode

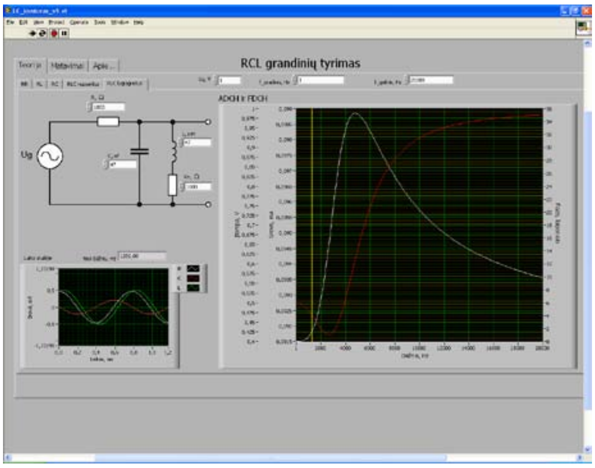

Fig. 7. Program dialog window in simulation mode

Acknowledgement

The authors would like to thank Prof. Romanas Krivickas for his advices and support.

Conclusions

1. The universal measurement unit and circuit boards are developed and made in the laboratory. Students took active part in design of hardware and software of the project.
2. Similar job structure is described in the reference [1]. The main difference between our versions – fully prepared circuit boards.
3. The relatively low equipment cost and size will allow the installation of laboratory with 15 workplaces in near future.
4. A workplace is fully prepared for testing in real learning environment. The idea that significantly changed the students' motivation – "everything in our hands, we are not passive observers; we are beginning to work and finish it completely".

References

1. **Dale E.** Audio–visual methods in teaching (Revised edition). – New York: The Dryden Press, 1954. – 534 p
2. **Filipkowski A., et. al.** Computer–aided design and computer–aided engineering in electronic engineering education. – Publishing House of the Warsaw University of Technology, 1996. – 383 p.
3. **Clark C. L.** LabVIEW Digital Signal Processing. – McGraw–Hill, 2005. – 205p.
4. **Kehtarnavaz N., Kim N.** Digital Signal Processing System–Level Design Using LabVIEW. – Newnes, 2005. – 304 p.

Received 2010 04 29

V. Juška, A. Chaziachmetovas, R. Jaruševičius. Effectiveness and Quality of Education: Methodology, Organization and Technical Means // Electronics and Electrical Engineering. – Kaunas: Technologija, 2010. – No. 6(102). – P. 103–106.

The paper presents an active learning method, which is applied in electronics and basic circuit theory. An essential feature of this methodology - theory, simulation and hands-on laboratory combined in a fully computerized workplace. The objective of training methodology provides the student with more freedom to increase personal responsibility and motivation. Ill. 7, bibl. 4 (in English; abstracts in English, Russian and Lithuanian).

В. Юшка, А. Хазеэхметов, Р. Ярушевичюс. Эффективность и качество образования: методология, организационные и технические средства // Электроника и электротехника. – Каунас: Технология, 2010. – № 6(102). – С. 103–106.

Представлен метод активного обучения, который применяется в обучении электроники и основ теории цепей. Важная особенность методики – теория, моделирование и лабораторные работы объединены в полностью компьютеризированных рабочих местах. Представленая методология дает студентам больше свободы для повышения личной ответственности и мотивации.. Ил. 7, библ. 4 (на английском языке; рефераты на английском, русском и литовском яз.).

V. Juška, A. Chaziachmetovas, R. Jaruševičius. Mokomojo proceso efektyvumo didinimas ir kokybės gerinimas metodinėmis, techninėmis ir organizacinėmis priemonėmis // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2010. – Nr. 6(102). – P. 103–106.

Pranešime pristatoma aktyvaus mokymo metodika, kurios tikslas – iš esmės padidinti bazinių elektronikos disciplinų įsisavinimo efektyvumą. Esminė šios metodikos savybė ta, kad teorija, modeliavimas (pratybos), laboratoriniai darbai (praktinis mokymas) ir galutinis atsiskaitymas pateikti vienoje visiškai kompiuterizuotoje darbo vietoje. Ši objektyvi mokymo metodika suteikia studentui daugiau laisvės, daugiau personalinės atsakomybės ir papildomai jį motyvuoja. Esame įsitikinę, kad mūsų sąlygomis ši mokymo metodika leis pasiekti gerų rezultatų ir efektyviai naudoti žmogiškuosius išteklius, patalpas ir įrangą. Il. 7, bibl. 4 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).