Laboratory Education: Meeting the Practical Needs

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***Abstract*—The paper summarizes the ways leading to modernization of engineering education in the area of electronic communications. In order to maximize the positive impact on quality, the considered methods are continuously optimized. We describe the fundamental elements and their integration into a brand-new concept of education.**

Keywords-electronic communications; project-based learning; university education; laboratory education

I. INTRODUCTION

The Department of Telecommunication Engineering has been involved in development and application of promising educational methods and related modern technologies for almost 25 years. Our team has been always seeking to harmonize the education with the real needs of the industry, especially small and medium enterprises (SME) that employ most of our graduates.

At present time we find ourselves on a crossroad: we have available almost unlimited pedagogical means including wide variety of modern procedures based on electronic support and distance education; on the other hand, there is still the traditional approach of contact education with its specific benefits; and, finally, we can rely on the conventional laboratory equipment, which, however, requires physical presence of students and teachers in the given place and in the determined time. [1]

II. KEY IDEA

With respect to the reasons described above we have been looking for an optimum arrangement of engineering education, with a clearly given objective – to effectively equip our students with knowledge that would be most useful for their professional career, focusing mainly on laboratory education.

We have identified five basic elements to define the general concept:

- Superior Laboratory of Networks and Electronic Communications,
- Modern topics,
- Project-based education,
- Project "from A to Z"
- Flexible education.

Practically, it means that we have proposed substantial innovation of complementary subjects (in terms of content and form). The principles of these innovations are described below.

III. THE FOUR ELEMENTS

A. *Laboratory of Networks and Electronic Communications*

The laboratory, which has been recently reconstructed and redesigned, belongs to the category of multipurpose classrooms with self-service operation. The reconstruction was concluded at the end of 2010; besides the increased space and complete rebuilding of the interior, it brought also new equipment (audio/video and didactic technology, networking technology, measuring devices, facilities for students), furniture, and logistic details (reflected in the design for optimized education process – see below).

Important details of the modern design include the electronic access system and the option of remote supervision thanks to the camera system (primarily intended for video conferencing and recording of lectures or seminars).

Thanks to its equipment the laboratory is predetermined for multipurpose use (basic modes include videoconference, lecturing, individual work, streaming, recording, laboratory education, project-based education, etc.), and it is suitable for application of the self-service mode.

The equipment of the laboratory is supplemented with a reservation system that allows its users to reserve a specific workplace (or the entire laboratory) and a time window (according to the defined rules).

B. *Project-based Laboratory Tasks*

The traditional laboratory tasks are designed to take approximately 90 minutes each; there is available an unambiguous assignment of partial tasks, a demand for controllable outputs, a list of measurement and diagnostic devices to be used (including the scheme), measurement method and procedure, and also detailed guidelines. This methodology helps the students to achieve the given objectives (learn, measure, diagnose), but it limits their active contribution to the process to almost nothing.

Project-based laboratory tasks, on the contrary, use completely different approach. Within the given subject (or its laboratory part) the students will be given only several (e.g. eight) general descriptions of available tasks, out of which they

will choose two most interesting ones and they will be dealing with them during the whole semester. With the remaining topics they will be made familiar during the lectures, but of course not so thoroughly.

The "general assignment" will contain only rough description of the problems that should be coped with, and the list of information sources (textbooks, operation manuals, previous measurements, etc.). Students will be also informed about the laboratory equipment available for their projects.

On the basis of this trivial set of information, the students *alone* should compose a proposal of specific tasks and objectives that they are about to achieve during the semester. These tasks, after their approval by a teacher, become obligatory criteria required for successful passing of the subject. Then, during the major part of the semester, students work on tasks defined by themselves.

C. Topics of the Laboratory Tasks

As for the appropriate topics of laboratory projects, we have been looking for them in the area of electronic communications. We have identified eight "general topics" that cover a wide range of current problems:

- Metallic data interfaces,
- Factors influencing the operation of high-speed data transmission systems,
- Data transmission over power distribution networks,
- Data transmission in CATV systems,
- IPTV,
- Data transmission in mobile networks,
- SDH/OTH technologies,
- UMTS/CDMA networks.

D. Project from A to Z

Another key idea is to prepare such subject that would equip our students with basic knowledge and skills needed for preparation of multimodal materials or applications (i.e. such that use a combination of several media – typically text, static or motion image, sound – for communication and interaction with users). The subject will consist in theoretical and practical introduction of technical, ergonomic, aesthetic and didactic aspects influencing the authoring process as well as the final products. The principal benefit should be better communication skills of our graduates, who will be able to apply the principles of efficient and comprehensible communication supported by modern technologies.

During the project period (i.e. major part of the semester) the students will individually choose topics of their projects and work on them. We expect that they will be able to formulate a script, prepare partial multimodal materials, integrate them, finalize the project and present it to the most critical group of their teachers and classmates.

IV. Concept of Flexible Education

The project-based education will be quite different from all conventional logistic schemes traditionally used at school. The most substantial change will consist in planning of education by the students.

The Laboratory of Networks and Electronic Communications will become the centre of this experiment, being capable of providing the background for laboratory tasks with "general topics" as well as for the projects "from A to Z" (see details above).

The reservation system will display time windows, for which the students may reserve the defined equipment of the laboratory for their individual work. This system will offer reservation of particular time periods during the whole semester, and the students themselves will define the necessary parameters, i.e.:

- The total time to be spent for the project tasks or for the "from A to Z" project,
- Arrangement of the total time (regular or irregular attendance of the laboratory),
- Specific dates and times.

This concept offers to students, on one hand, stunning time flexibility, but on the other hand, it notably educates them in responsibility, as it is solely up to them whether the tasks will be accumulated in some part of the semester or evenly distributed, whether long time periods (e.g. 6 hours) or just short ones should be needed for the laboratory work, etc.

It will be the students who should make the key decisions:

- What specific partial tasks will be performed,
- What measurement method will be used,
- What equipment will be needed,
- What the connection diagram will be,
- What the interpretation of measured values will be.

Teachers will be present in the laboratory, but rather as opponents or consultants prepared to discuss the proposed solutions than guides offering detailed help with all possible difficulties that students may encounter. We can also envisage an advanced model – i.e. that teachers will not be present all the time of students' measurements, but only on demand. The presented concept leads up to the desired final condition, which should be the self-service operation of the whole multipurpose laboratory.

Such type of education brings the students closer to the real conditions in the industry: there emerges a technical problem, and the expert (student) has to propose an appropriate solution, implement it and vindicate it – with the means and possibilities that are currently available. It is only up to him (or her) whether and to what extent the proposed solution is successful. This way, we want to support independent and responsible thinking and doing of our students.

V. Conclusion

The application of the introduced model means a fundamental change in the approach to education based on laboratory tasks. With the new concept of education, the conventional laboratory measurements will be transformed to individual laboratory projects.

Within our faculty this is a pilot project that will reveal the realistic possibilities for innovation of education with respect to the novel concept of laboratory education and to the time flexibility of laboratory projects. Besides the new methodology, we must not forget about the contribution of newly conceived laboratory projects and tasks.

After the conclusion of the pilot phase (winter semester 2011/2012) we will make a survey among our students with the objective to evaluate how they perceive (and receive) the innovated concept of education.

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