Some thoughts and suggestions for the revision of the laboratory instruction at the Electronic Engineering Departments of the Technological Educational Institutions (TEI) of Greece

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Abstract:
The experience accumulated in the Electronic Engineering Department of the Technological Educational Institution (TEI) of Athens indicates that laboratory instruction although is planned to complement theoretical instruction, with practical applications, in practice it doesn't seem to respond successfully to its specifications and meet the existing needs. This aspect has been proved by a thorough study related to the evaluation of the students' performance. A packet of measures are suggested for the development of a new spirit in laboratory instruction including a curriculum reform to ensure that students have opportunities to develop the knowledge, skills, and attitudes to conceive and design complex systems and products.

Key Words: - electronics engineering education, laboratories, evaluation curriculum.

1 Introduction

The planning and creation of a modern well-structured curriculum of studies of Engineering Education taking into account the determination of subjects and of the scientific units that will be supported by laboratory training which faces a number of difficulties of various origins [1]. The power of technology, its pervasiveness, and its continual advances demand a rigorous curriculum and the commitment of educators to understand it, promote its responsible use, and enable students to become problem solvers who are self-sufficient, entrepreneurial, and technologically literate. Students must acquire the technological skills and knowledge required to participate in a competitive, global economy. They must become critical and innovative thinkers, able to question, understand, and respond to the implications of technological innovation, as well as to find solutions and develop products.

The overall goal of engineering education is to prepare students to practice engineering. Thus, from the earliest days of engineering education, instructional laboratories have been an essential part of undergraduate and, in some cases, graduate programs [2]. Indeed, prior to the emphasis on engineering science, it could be said that most engineering instruction took place in the laboratory. While much attention has been paid to curriculum and teaching methods, relatively little has been written about laboratory instruction.

Research works published in periodicals related to engineering education during the past decade show that papers using «laboratory» as a keyword were far below 10% [3]. One reason for the limited research done in laboratory instruction is the idea that it performs the role of a complementary part in the process of teaching a specific subject in a curriculum of studies. So, while research in laboratory instruction topics was not in the centre of interest during the past few years, various factors contribute now in resurgence of the interest in this subject [4,5]. Laboratory instruction has acquired a lot of interest due to the appearance and extended utilization of personal microcomputers together with distance learning systems and the Internet [6,7]. The personal computer has introduced new possibilities in lab work including simulation, automated data acquisition, remote control of instruments, and rapid data analysis and presentation. On the other hand, the reality of offering undergraduate engineering education via distance learning has caused educators to consider and discuss just what the fundamental objectives of instructional laboratories are [8].

These discussions have led to new understandings of laboratories and have created new challenges for engineering educators as they design the education system for the next generation of engineers.

In the present study, after a thorough research work with respect to the evaluation of the performance of students, a packet of measures are suggested for the development of a new concept in laboratory instruction within the School of Engineering in general and the Department of Electrical and Electronic Engineering of the Technological Educational Institutions (TEI) of Greece in particular.

2 Review of the existing situation

An important questioning has arisen in the academic community during the past few years regarding both the quality and the efficiency of the provided laboratory education in the Schools of Engineering of the Technological Educational Institutions (TEI) of Greece. Discussions tend to conclude that laboratory education has been reduced to a formalized endless process prohibiting and making impossible to realize any attempt of going deep into the notions of the scientific unit corresponding to the orientation of each department. In particular, in the Departments of the Schools of Engineering of the TEI of Greece there are additional peculiarities that enhance the above mentioned unfavourable findings. More precisely, during the past years the number of registered students has greatly increased. An idea of this can be got from the diagram depicted in Fig. 1 where one may see the increasing trend of students enrolled in the Department of Electronics of the TEI of Athens from the year 1997 and forward.

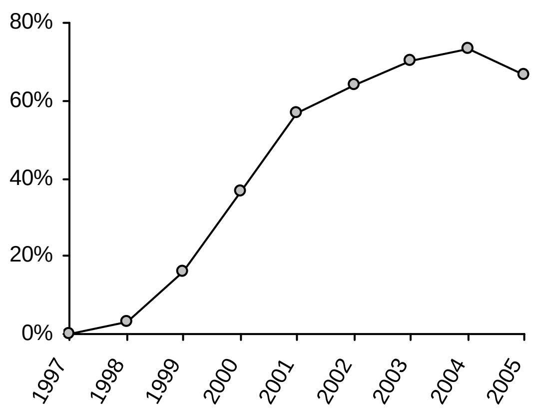

Fig. 1: The student enrolment percentage at the Dept. of Electronics of the TEI of Athens during the past decade.

One of the problems is that a more and more diverse and inhomogeneous – regarding their background - student population are registered. This fact forces the instructors to pay particular attention to those of the student requiring personal assistance. On the other hand, the existing hardware substructure is insufficient to meet the increasing demands and -in many cases- defective. Finally, the increasing teacher workloads threaten the quality of education and mostly the laboratory training giving priority to lecturing.

According to the official curricula of studies at the departments of the Schools of Engineering of the TEI of Greece, the laboratory instruction is only realized in the frame of teaching subject units that include laboratory exercises for the students. Such subjects are called «composite subjects» (CS) because a number of the programmed teaching hours per week are devoted to lab exercises while a larger number of hours are devoted to lectures. The students are evaluated separately for their performance in laboratory exercises and for their performance in the theoretical part of the composite subject. The final grade is the average of the two independent evaluation marks.

In the curricula there are some clearly theoretical (TS) and some clearly laboratory subjects (LS) which are not supported by any theoretical lectures. Their contributions to the curriculum of studies are: 48%, 48%, and 4% respectively.

3 Statistics of composite subjects

Here is presented some statistical information concerning the performance of Electronics students in the category of composite subjects. Three basic parameters will be discussed thoroughly:

- The percentage of students that abandon i.e. stop attending lectures or participating in the final examination of the subject.
- The percentage of students that pass the subject as a result of successful attendance.
- The average grading of students that have completed attendance successfully (grade greater than 5 on a 0 - 10 scale).

The above parameters are checked for both the theoretical and the laboratory part of the composite subject and the results presented are the average of the recorded grades in the composite subjects included in the curriculum of each semester for the past three years.

Although a considerable number of students register in the beginning of the semester for the attendance of a subject, they usually abandon in the middle or about the end of the semester.

As far as the theoretical part of a composite subject is concerned, the abandonment proportion is calculated with respect to the absence at the final examination, while for the respective laboratory part the abandonment proportion is calculated with respect to the number of students that do not do the required minimum laboratory experiments.

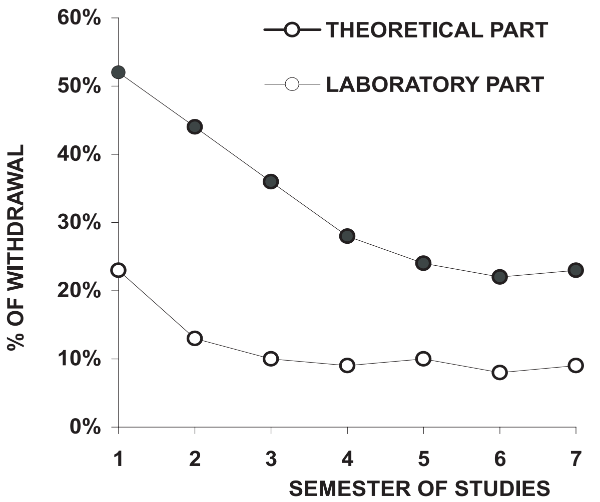

Fig. 2: Proportion of students abandoning theoretical and laboratory parts of a composite subject with respect to study semesters.

The results are presented in Fig. 2 where it is evident that the laboratory part of a composite subject is done successfully by a considerable number of the students that choose it and register to attend. It is particularly rare (10%) for students of advanced semesters to be unsuccessful in the lab part. On the contrary, the proportion of absence from the final exams is much greater.

Before getting to conclusions from the above serious differentiation one should read the success proportions for the theoretical and for the laboratory parts of the composite subject, which are depicted in Fig.3. Successful are 80% to 90% of the total registered students. On the contrary the respective proportion related to the examinations of the theoretical part marginally reaches 60%. As far as the average grading parameter of the performance of the students who finish successfully either the theoretical or the laboratory part of the CS at different semesters, the latter is clearly higher. (See Fig.4)

From the above it becomes evident that students are more willing to attend and finish both successfully and with high grades the laboratory than the theoretical part. Although in a Technological and Engineering Education curriculum, one of the aims of the laboratory is giving students the opportunity to develop their knowledge and capabilities in order to design complex systems and products, it seems that this is hardly achieved. The main reason is – as is found in the present work – that the students have not had the time needed or are completely indifferent to assimilate the required knowledge which is a critical prerequisite to do the laboratory work.

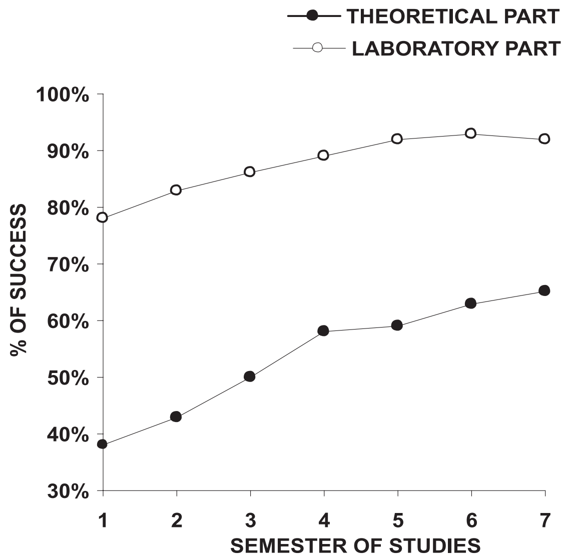

Fig.3: Proportion of students passing the theoretical and the laboratory part of a composite subject with respect to semesters of study.

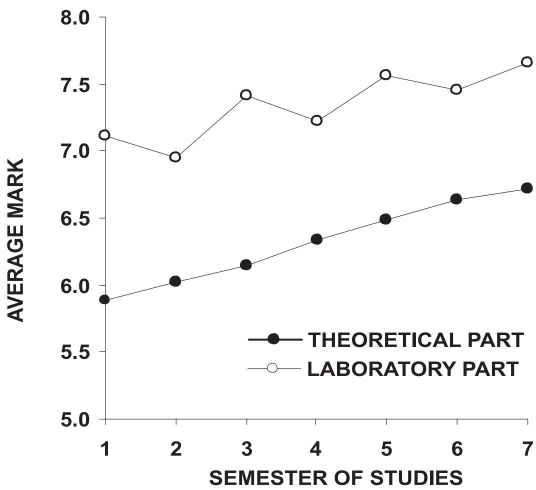

Fig.4: Average grading of theoretical and laboratory parts of composite subjects with respect to semester of study.

As a matter of fact, the C.S. in the curricula of several Departments of the Schools of Engineering of the Technological Educational Institutions (TEI) of Greece needs to be reconsidered.

4 Conclusions - Suggestions

The parallel instruction of various subjects belonging to different scientific units through C.S. as was proved above seems to mislead the students and drag the whole curriculum away from the desired educational targets and ultimately to failure at least in the Dept. of Electronics of the TEI of Athens.

Laboratory work although designed so as to be in a sequence and coherence with the theoretical instruction, in practice, it doesn't seem to respond to its role.

The narrowness as well as the strict focusing of an experiment on the contents of the theoretical part of e.g. a chapter of a C.S. deprives the laboratory of its power to communicate with various theoretical notions – not necessarily being parts of a C.S. - and diffuse the know-how among the young experimenters. With the existing organization of studies and the described way of attending the students don't take their laboratory exercise seriously enough. Many of them wish to finish their laboratory work as soon as possible without being interested in getting the most of the theoretical part of the subject.

The Studies Curriculum Design Committee must take over as soon as possible in order to intervene with a new improving proposal.

From this point we can only make the following suggestions:

a) Considerable reduction of composite subjects (C.S.) to an acceptable minimum in the curriculum. The C.S.'s that will survive the reduction must be in the last semesters, not in the early semesters.
b) Introduction of independent laboratory subjects (L.S.) in all semesters at a proportion 1:2 with respect to theoretical subjects (T.S.).
c) In the first two semesters the laboratory subjects will mainly aim in getting the students acquainted with computers. Computer studies will be concerned with how computers represent objects (e.g., a list of names, a graphical image, an electronic circuit) and how they receive and process instructions to manipulate these objects. On the other hand, students will be familiar with handling basic electronic instrumentation and metrology.
d) During the following semesters the L.S. will focus on topics that have been taught in previous semesters. In some cases, students may not be allowed to proceed to a L.S. if their marks in the corresponding T.S. are considered unsatisfactory.
e) Redesigning of laboratory experiments and coverage of basic scientific and technological units as the following: Electronic Circuit Experiments, Electronic Circuits Design, Electronic Circuits Design Automation, Microprocessor Theory and Experiments, Communication Theory and Applications, Microwave and Antenna Design and Experiments.
f) Enrichment of the existing laboratory experiments and design of new ones to give the opportunity to implement new courses in virtual instrument measurement, a new course in electronic instrument measurement automation and a new and comprehensive design course that brings the virtual instrument measurement and electronic instrument measurement automation into the areas of electronic circuit design, communication theory and applications, microwave and antenna experiments [9,10]. With the new lab and new courses, the students will have hands-on design experience with the most advanced instruments and technology [11].

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