Learning Centered Computer Aided Circuit Design Course

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***Abstract*—** In this study, improvements made to the Computer Aided Circuit Design Course given in the Marmara University Electronic and Communication Education Program is presented. Curriculum of the course has been redesigned by considering the new paradigms of education, and developed with student centered learning techniques. A learning environment, where students realize the circuit design, computer simulation and laboratory practices by taking part in the center of learning, has been established. With motivating ambience of the learning medium, it is aimed that students would develop skills and habits to solve open-end problems, learn individually, work in a group, and think critically. At the end of the semester, students evaluated the course and a positive feedback is obtained.

***Keywords*—** Circuit Design Course, Problem Based Learning, Active Learning, Learner Centered.

I. INTRODUCTION

IN contemporary engineering and technology education, significant changes are being experienced in the last ten years. Accordingly, in this study, a practical experience on Computer Aided Circuit Design Course Curriculum which has been redesigned is explained in detail. The course had been given with conventional lecture and laboratory methods in previous years. Unfortunately, for engineering and technology students, this approach was not satisfactory to gain insight of the technical information that continuously and rapidly evolving [1]. After the students graduate, they must be prepared for the real life work that is increasingly becoming competitive. For this reason, in addition to technical content, students must gain critical thinking, problem solving, team working, life-long learning, written and oral expression skills and attitudes during their education period [2-3].

II. NEW PARADIGMS OF EDUCATION

In the conventional educational approach, an uneducated student brain is considered as an empty page on which a teacher can write with a pen or as an empty cup in which a teacher can fill with information. Regrettably, this approach is practiced by many teachers without any alternative. Comparison of new paradigms and former paradigms of education are given in Table 1 in summary [4].

Table I. Comparison of the Paradigms

	Old paradigm	**New paradigm**
Knowledge	It is transferred from instructor to student.	The instructor and student are structured together.
Student	Passive cup to be filled with the knowledge of instructor	Effective, creative, discovering, convertible to knowledge
Learning Method	By remembering	By making connections
Purpose of teaching	To classify and ordering	To develop abilities of student
Purpose of student	To fulfill necessities and provide certification under discipline	To grow and focus on continuous learning within a broad system
Power	Instructor holds the power, applies it and provides authority and control	Student is strengthen and power is shared between students and instructor
Evaluation	Norms are taken as a source.	Criteria and typical performance are taken as a source and instructor makes permanent evaluations
Technology use	Supported with book, blackboard and chalk	Problem solving, communication, cooperation, accessible to knowledge and expressive

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Today, one of the desired habits of the students to have is lifelong learning. The only way for the electronic and communication technology students to keep up to date after they graduate is to continue their lifelong learning Besides, it is expected that students who will develop this attitude during college education would pass on to their own students when they become teachers themselves. To develop and strengthen students' lifelong learning attitudes is quite different compare to other attitudes and abilities desired to be given to the students. To develop lifelong learning mind-set contains development of some specific attitudes and desires related to learning in addition to acquire new abilities [5]. The other lifelong learning related subject is self learning. Students who learn themselves generally have specific attitudes and skills. Such attitudes require habits such as accepting personal responsibility, challenging to problems and learning desire. Lifelong learning includes being motivated, independent, self-confident and self-disciplined. Moreover, lifelong learning requires basic studying skills and time management [6].

The learning desire must be strongly felt. School must orient students growing of this desire. Students must understand that one of the aims of the department is to bring lifelong attitudes and skills to students and the diploma they will get when they graduate is only a starting point. It must be clearly stated that learning will last ceaselessly, and necessary attitudes and skills must be gained for this purpose. Furthermore, the students should be made sure that the institution expects this from students. On the other hand, bare explanations during lectures or seminaries alone would not be sufficient. Students must be given responsibility during their learning processes to bring lifelong learning attitude and develop it. If students are to continue to learn after they graduate, responsibility for learning and managing their own education must be given to students while they are students and they must be assisted to develop their learning manners.

Mini project homework's should be assigned off lecture hours to students ensuring taking responsibility, learning off class hour. Moreover, home works should be so designed that they should help students improve their team working skills, and their ability to apply engineering and technical problems to practical problems. Besides, home works should help students to build up their written and oral communication skills [7]. Facts and activities supporting lifelong learning are given in Fig. 1 [5].

Instructors and students must give up passive education approach and use effective education methods. They should introduce open-end activities, such as designing instead of close-end problems requiring integration of learned materials and exploration of information by means of experiment and research. This may assist development of lifelong skills and attitudes necessary for all-time learning.

III. Problem Based Learning

Problem Based Learning (PBL) is a student centered education method. More responsibility is given to PBL students during their education and their gradual independence from teacher is maintained. It is thought that, with PBL, students can continue to learn independently during their professional life after they graduate [8]. PBL takes into account the problems of real business life and so students who struggle with the problems of real world are stimulated for learning. Students integrate and arrange what they learn and they can remember and apply them when they face with similar problems in the future. Problems in PBL include practices that are designed to ensure effective problem solving and critical thinking skills for students. [9].

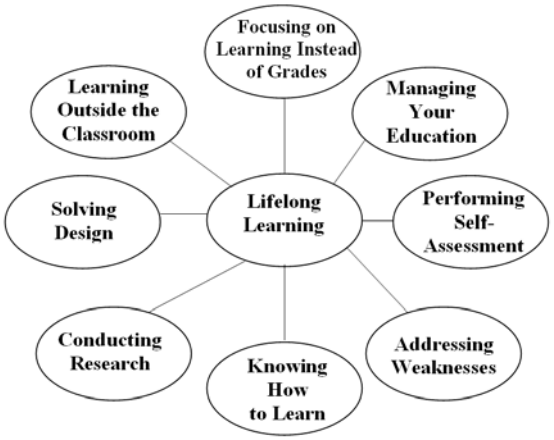

Fig. 1 Life Long Learning

During their learning process with PBL, students weigh the information they have before solving the current problem and identify what and how much they know. In this way, they can determine what they require to better understand to solve the problem. After students determine what information they need, they gain knowledge by researching it from various sources. With this process, students realize a self-management learning process. In this way, learning is individualized depending on requirements and learning styles of a person. Then, students attempt to solve the problem by using what they learn. When students solve the problem, they evaluate their and other's findings. Self-evaluation is an important process for an effective and independent learning. When the PBL practices are realized as a group work, group members work in cooperation and they gain effective work-in-team skills [10]. Working in harmony within team is a valuable skill required by employers for their work power because of multi-disciplined structure to today's work life [11].

In PBL practices, students learn in harmony and struggle with problems they may face in the real business world. By recognizing that what they learn at present will be valuable for their work life in the future motivates the students are highly.

In student centered arrangements, the role of instructors is to prepare education materials and provide guiding to activate learning process. In this development, the power does not lie on a single person. It is shared between students and instructors.

IV. Course Practice

Computer Aided Circuit Design Course is developed by considering the problem based learning and learning centered education approaches. This course is given in the 7th semester as two hours theoretical lecture and two hours laboratory class. Students must have completed most of the electronic and communication courses before they take this course. In the previous years, the course was presented with conventional lecture methods in class and with analysis and simulations works on circuits in the computer laboratory. However, insufficient outcomes necessitated redesigning of the course. Considering the fact that problem-based learning is a convenient method for this course and is beneficial to students, the course was developed and new paradigms of education were applied. The practicing flow of the course is given in Fig. 2.

Circuit design principles and computer software they would use are introduced to students in the first few weeks. Model circuits consisting of basic electronic, logic and communication circuit structures are analyzed in a computer laboratory through simulations. In this fashion experience is gained on simulation software. With the start of the course, design problems are given to students so that they work on them throughout the semester. Students are given priority to determine their own circuits. They select the problem they will work on from a previously prepared list. If a student has difficulty on what to select, he/she can get help from the course instructor. The common feature of all the problem works is circuit design.

A work can be assigned to 2-3 students depending on size and complexity of circuits. In this way, group work is ensured. However, each student is individually responsible for the design and application of some part of the circuit.

As it is shown in the flow diagram in Figure 2, firstly the problem is defined and then design purposes and criteria are determined. Students are asked to do research on the type of the circuits they will design. Then, students make design calculations of the circuit in conformity to the given criteria. After the design calculations, students realize the simulation of circuits. After the simulation, if the circuit meets previously determined purposes and criteria, the next phase, which is designing of printed circuit, is realized. If the simulation results indicate that the circuit does not conform to determined criteria, it is returned to the designing process and design is reviewed. This cycle continues until the simulation results indicate that the designed circuit conforms to determined criteria. Each phase is discussed with the guidance of the instructor and it is collectively decided whether to go through to the next phase. In circuit simulations, student version of PSpice 9.1 is used. With production and installation of the printed circuit, laboratory work begins. Students design the printed circuit in a computer medium. For the printed circuit design, educational version of the Eagle software belonging to Cadsoft Company is used. This version is only limited to a smaller size of printed circuit compared to the professional version.

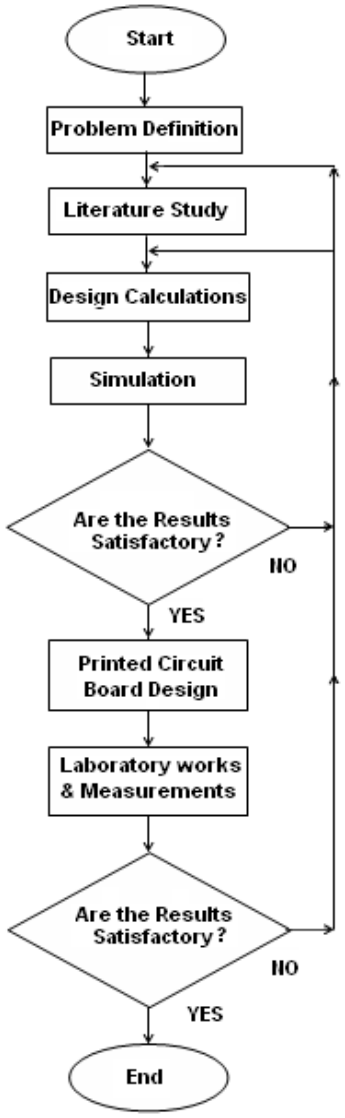

Fig. 2 Flowchart of the Student Activities

Students are allowed to choose the method to produce their printed circuit boards. An example to students' printed circuit board work is shown in Fig. 3.

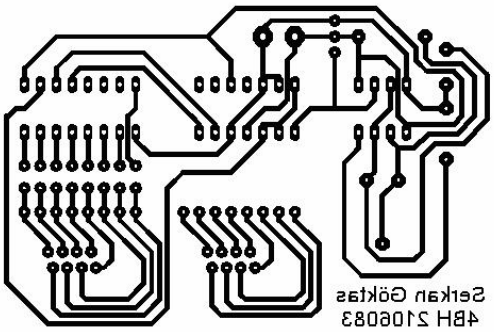

Fig. 3 Printed Circuit Board of a Design Work

Later, students set up their circuits on the printed circuit boards and carry out necessary laboratory practice to determine whether it conforms to previously determined criteria. If the circuit works in conformity to the criteria, students begin to write their reports with the approval of their instructor. Otherwise, students continue their studies until they obtain the desired result. Completed works are delivered in a report and orally presented to other students in class. Evaluation result of the work makes 40% of the overall grade and is counted as midterm exam. Students must attend 85% of the total class hours. Performances of students are evaluated as a result of face to face discussion with their instructor every week. Performance of a student is determined by considering how much he/she has progressed in a one-week period. Starting from the first week, students record in their notebooks the studies they realize with reference to the flow diagram in Figure 2. The instructor examines notebooks of students every week and makes an evaluation after discussing with students about their weekly work and progress separately. The instructor records the date, his/her one-week evaluation mark, and the following week assignment of the student on the notebook. Later, the instructor puts aside his/her teacher role for two-three weeks and guides students in realization of their works. In this way, circuit design, computer simulations and practice of the course can be realized with learning-centered method. Besides, students are directly responsible for learning process and can develop their learning skills, attitudes and habits by themselves. An example to completed design projects, which is RJ45 cable tester, is shown in Fig. 4.

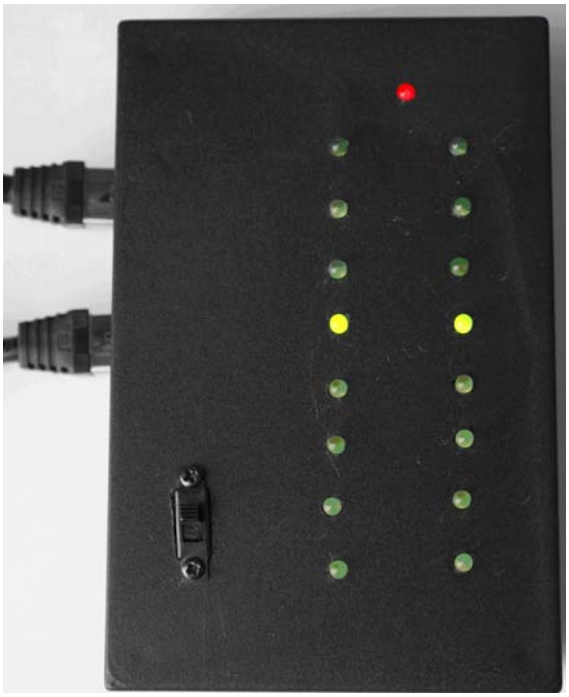

Fig. 4 Student's Finished Work

V. Findings

It is observed that students more eagerly attend class and their motivation increases in periods when the above stated strategies are applied in comparison to years when the course was given with conventional methods. Their skills in using computing and laboratory devices related to problem solving, critical thinking and circuit designing improve. During the CACD course, they use internet services, electronics and computer laboratories more frequently, thus, their self-learning skills and attitudes get better. During the workshop and laboratory studies, they work collectively, so their team working skills improve. Lastly, as students present their works in written and oral forms, their communication skills build up extensively.

VI. Result and Suggestions

In this paper, realization of the curriculum developed for the computer aided circuit design course is explained. The course practice carried out by student-centered methods and techniques contributed to students in their preparation for today's competitive business life conditions. By directing students to effectively work out off course hours, their problem solving, self-learning and lifelong learning skills and attitudes are developed. As knowledge continuously builds up and evolves nowadays, giving students the skills and lifelong learning attitudes after they graduate is as important as to educate them as well-prepared individuals in their fields.

The techniques explained with this article can be applied to other courses having similar content and design.

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