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Teaching Reform of Analog Electronic Technology Based on CDIO

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***Abstract*—This paper explores how to cultivate students with innovative consciousness in the course of Analog Electronic Technology under the environment of national innovation. On analysis of the drawbacks of the current curriculum, the teaching group integrated the curriculum resources. Using EDA (Electronic Design Automation) technology and based on the CDIO (Conceive, Design, Implement and Operate) philosophy, they developed a project oriented reform to guide students to complete from conception, design and implementation to the operation of the entire production process. The reform improves the teaching method from three aspects: teaching, experiment and course design. As a result it cultivated students' sense of innovation and practical ability, as well as their engineering consciousness, which is conducive to cultivating application-oriented senior engineering talents.**

Keywords—Innovation, CDIO; Analog Electronic Technology, Teaching reform

I. INTRODUCTION

With the rise of high-tech enterprises, the innovation ability of engineering talents is becoming more and more important. This puts forward higher requirements for universities aiming at cultivating application-oriented senior engineering talents. Analog Electronic Technology is a practical teaching course for electrical majors in colleges and universities. It mainly cultivates students' cognitive ability of basic electronic components and ability to use common electrical instruments and tools. This course is one of the few practical courses that can be carried out in the undergraduate colleges and universities that focus on theoretical teaching, so its teaching quality is crucial to the cultivation of students' innovative thinking engineering ability [1]. The traditional teaching method, with teachers as the main part of the course teaching and experimental links as verification experiments, fails to cultivate students' application ability because students are not clear about the teaching tasks and do not understand the circuit design process, which violates the original intention of teaching.

In most colleges and universities, the traditional course of Analog Electronic Technology includes three parts: teaching experimental course design. These three links are independent of each other. This teaching model can no longer meet the needs of the society for students' ability, and its disadvantages mainly include the following aspects [1-4]:

1) The teaching link is dominated by teachers, with short class hours and much content. Most teachers adopt the spoon-feeding teaching method.

2) The experimental teaching mode is simple and conservative. The teacher provides the experimental instruction, and the students control the circuit connection, among which the verification experiment takes up the majority, which is difficult to reflect the students' circuit design ability.

3) Obsolete curriculum design topic, the way a single focus for a week, the students first 1-2 days in under the guidance of the teacher about electronic components and electronic components of the test method of soldering skills and learning the basic methods of circuit assembly, and in accordance with the drawings on the ready-made circuit board welding assembly this slavish type teaching mode, can't inspire students' innovative thinking, also did not exercise the students' ability of design.

4) The modern electronic system disconnects with the new technology and the new era. EDA technology is widely used in the design and simulation of modern electronic systems. SMT surface mount reflow welding and other processing technologies are widely used in the production.

5) Lack of cooperation. Every student makes the same suite, there is no difference, there is no difference in the operation process of students, and there is no teamwork.

6) Teaching evaluation mode is single. Most of the theoretical examination is the examination of computational ability, most of the content involved is basic, comprehensive questions are very few, accounting for less than 10%.The practice link basically takes the student experiment report as the standard to measure the student achievement, cannot test the student's design ability, the innovation ability and the team cooperation ability.

In order to meet the needs of industrial production, according to the spirit of ministry of education and ministry of finance's opinions on implementing undergraduate teaching quality and teaching reform project of colleges and universities, the course group tries to introduce the CDIO teaching concept and reform the Analog Electronic Technology course with CDIO project teaching method.

II. METHODS

A. CDIO Education Concept and Project Teaching Method

Since 2000, after four years of exploration and research, MIT, royal Swedish institute of technology and other four universities have established the concept of CDIO engineering education, the latest achievement of education reform of international engineering and established the international cooperation organization named after CDIO.

CDIO represents Conceive, Design, Implement and Operate. These four parts contain the whole process of industrial products from Design and modeling to operation, and at the same time correspond to the ability of engineers and technicians [5, 6]. In the training program of CDIO, engineering graduates should have engineering basic knowledge, personal ability, interpersonal ability, team ability and engineering system ability. In order to achieve this training purpose, CDIO takes the life cycle from product r&d to product operation as the carrier. By implementing a complete engineering project, CDIO enables students to combine theory with practice in their study, which not only learns the basic knowledge and skills, but also cultivates the spirit of teamwork and innovation.

Project-based teaching method changes the traditional teaching mode from teacher-centered teaching materials to student-centered project practical experience [5]. Lets the student in school can experience to work after graduation may encounter all kinds of work situation given the CDIO innovative and efficient, many colleges and universities will be its ability to outline and 12 standard as the reform of education mode guidance document in June 2010, the ministry of education starting excellence engineers plan will also CDIO education mode as an important reference.

B. Teaching Reform

Since 2000, after four years of exploration and research, MIT, royal Swedish institute of technology and other four universities have established the concept of CDIO engineering education, the latest achievement of education reform of international engineering and established the international cooperation organization named after CDIO.

For example, when explaining the voltage comparator [7], first use the fire hazard example, lead out the necessity of smoke alarm design and then guide students to think about the working principle of smoke alarm and ask questions, how to design the circuit to achieve? Thus will stimulate students' interest in learning, and help them taking the initiative to complete the conception and design of the circuit. Teachers should properly prompt the working principle of voltage comparator and help students to realize the whole circuit function. Instead of focusing on teachers' teaching, teachers should guide students to explore the unknown and think about solving practical problems during the whole teaching process.

C. Experimental Teaching Reform

Delete the confirmatory experiment, combine it with classroom teaching, provide the experimental site for different topic content, encourage students to design and solve practical problems by themselves, and exercise students' practical ability and innovative consciousness.

Open the laboratory, organize electronic product production competition [8], and mobilize students' enthusiasm.

Curriculum Design and Teaching Reform. First change the curriculum, the opening in the fourth semester of analog electronic technology and the fifth semester digital electronic technology integration parallel to the fourth semester, the combined two curriculum design, improve the design of a comprehensive, at the same time to extend the design cycle for four weeks, students complete an electronic project around this time to make the whole process of design simulation.

Secondly, the teaching method is changed. Before the design, the teacher arranges some design projects with strong comprehensiveness [9, 10]. The topic selection is shown in TABLE I. During the course design, attention should be paid to the cultivation of various abilities required by CDIO, namely, basic engineering knowledge, personal ability, interpersonal team ability and engineering system ability.

TABLE I. TOPIC SELECTION TABLE OF COURSE DESIGN

Course design and topic selection	Numbers of people
Design of harmful gas detection alarm	3
Design of automatic scoring system for table tennis competition	2
Oscillator Design	2
Design of wireless transmitting and receiving system	3
Automatic thermostat design	3
Design of automatic flower sprayer	3

III. RESULTS

A. Strengthen Students' Basic Engineering Knowledge

Students in the design process of electronic components selection, parameter selection, quality of electronic components detection, commissioning of the whole machine and other steps, need a lot of circuit analog digital high frequency signal and system knowledge. These processes need to be completed by students themselves, and teachers only play an auxiliary role, so as to urge students to consult a large number of materials and review the courses they have learned. After four weeks of design, students' basic engineering knowledge will become very solid.

B. Improved Personal Ability

In the specific design of the circuit, software simulation design is generally adopted, which requires students to learn how to design the circuit with Multisim simulation software and how to detect the key parameters and waveforms of the circuit with virtual instruments. In the design of PCB board, students should learn to use Protel software and understand the production process of PCB board. Due to the limitation of teaching equipment, video and other network resources can be used to let students understand the SMT surface mount technology and other modern welding processes, and the actual operation of brazing. Due to the limitation of teaching equipment, video and other network resources can be used to let students understand the SMT surface mount technology and other modern welding processes, and the actual operation of brazing. In this way, after the course design, students not only mastered the use of mainstream design simulation software, but also learned manual welding technology, which improved their personal ability.

C. Developed the Ability of Teamwork

Three students compose a design team; with each student has the division of labor, but also to cooperate sincerely. It can be divided according to the hardware and software division, or be divided according to different parts of the system division. Each person in the consideration of their own part, but also to consider whether the other parts match. In the process of cooperation, communication is very important. The cooperators should be able to understand each other, figure out and make themselves clear [6]. What should be done in case of disagreement? These are the problems that students may encounter in their future work. Practice in advance can enable students to integrate into the design team more quickly and efficiently after work.

D. Improved Engineering literacy

Since it is their own design system, students will stand in the perspective of engineers to see problems, what is the purpose of the design? Whether the designed system is reasonable? Can it generate economic value? Which aspects of knowledge are applied in the design process? What shortcomings still are there? These problems are the reflection of the improvement of students' engineering system ability. They will think more comprehensively and carefully. At the end of the design, the acceptance assessment of the design results adopts the form of student works + defense, so that students can really understand their own works, and can describe the principle, function, advantages and disadvantages of the design works with concise and accurate language. The display of excellent works can not only encourage students to participate in the design, but also stimulate the interest of students.

During the course of implementing the teaching reform, the teachers of the research group conducted a survey, and the survey contents are shown in TABLE II.

A total of 120 tables were issued for the survey, and the statistical results are shown in Fig. 1. Nearly 60% of the students gave a score of 100 points, among which 76% thought the reformed teaching method had excellent results and 23% thought it had good results. From the perspective of students' suggestions, it is suggested to organize more in-class or after-class competition activities, and include the results in the course assessment

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TABLE II. TEACHING EFFECT SURVEY TABLE

Evaluation content	A(9-10)	B(8)	C(7)	D(1-6)
I am interested in the situation set by the teacher, I like the teacher's class.				
The teacher is vivid in class, students can actively think, answer, discuss and speak.				
Teachers encourage us to find and ask questions, to start with our problems, to carry out teaching.				
Teachers use familiar examples in our lives to guide us to learn to explore and understand.				
Teachers ask attractive questions, students around the problem to carry out discussion exchange cooperation learning.				
In class, teachers can take care of the learning and reflection of each student and treat them equally.				
The teacher's evaluation of us is based on affirmation, encouragement and praise, which makes us more confident in our study.				
The teacher has rich knowledge, accurate language, infectious teaching style and friendly attitude.				
Teachers attach importance to experimental teaching and can skillfully use modern education technology.				
The teacher's teaching makes us emotional harmony, learning enthusiasm high, fruitful.				
Add up the score.				
What do you want to say to the teacher?	Most appreciated aspect			
	I don't like			
	advise			

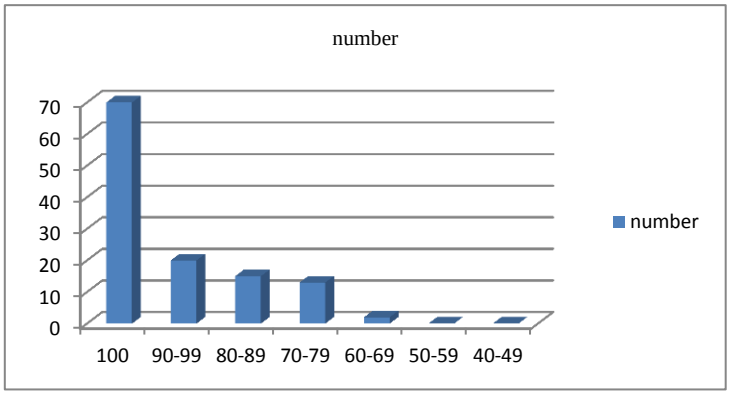

Fig. 1. Investigation and statistics results of teaching reform effect

IV. CONCLUSIONS

The Analog Electronic Technology course plays an important role in cultivating students' engineering practice ability and innovation ability, It will be constantly updated, according to the change of social needs, the course content setting, the innovation of teaching methods, the change of acceptance assessment methods and other aspects, which requires the full cooperation of education workers and employers. The application of project teaching based on CDIO in Analog Electronic Technology courses optimizes the teaching content, innovates the teaching methods, reforms the acceptance and assessment mechanism, cultivates students' innovative consciousness, teamwork spirit, and strengthens students' basic knowledge and personal ability.

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