TEACHING REFORM PRACTICE FOR BASIC COURSES OF ELECTRICAL AND ELECTRONIC SPECIALTY —— A CASE OF DIGITAL ELECTRONIC TECHNOLOGY COURSE

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ABSTRACT

Basic specialty courses are the cornerstone of learning professional knowledge in institutions of higher learning. They determine the future height that students can reach. As one of the most important professional basic course, Digital Electronic Technology is always attracting close attention from related teaching organizations and faculties. The paper introduces the new ideas and methods of teaching reform for Digital Electronic Technology Course under the guidance of CDIO engineering education concept. It starts reforms in classroom teaching methodology to cultivate engineering talents, to broaden knowledge horizon, to generate passion and improve experimenting ability. The teaching reform is summarized as sandwich principle of “one point and two sides” and as the method of “three linked points”. It is designed as a student-centered, multi-channel approach to enhance both theory and practice by linking classroom teaching, extra-curricular activities and course design together.

KEYWORDS

Electrical and electronic major, basic specialty course, teaching reform, education concept

INTRODUCTION

Millions of Chinese people are once proud of the phrase of “Made in China”, now it bears us heavier burden. Nowadays, with the rapid development of science and technology, our nation is urgently expecting the change to “Designed in China”. Innovation begins in education, even the national hope lies in education. The innovation of engineering field starts as early as from the engineering education in student period.

Under the influence of CDIO idea, for cultivating excellent talents for the future engineering field, the China’s Ministry of Education launched the Excellent Engineers Plan in June 2010. The plan requires the university to change their educational concept, to reform the talents cultivation model to train outstanding engineering talents and to improve the international competitiveness of Chinese industries(Zhang et al., 2011). Excellent Engineers Plan is ambitious and exciting, but just like the skyscraper tower has to start from the lower foundation, future outstanding engineers must get nutrition from one course after another, and then gradually grows up.

As the cornerstone of learning professional knowledge in institutions of higher learning, basic specialty courses play very important roles. It is necessary for basic specialty courses to have reform in accordance with the concept of CDIO(Wang et al., 2009). It is necessary for

teachers to strengthen engineering knowledge and cultivate the students' practical consciousness and team spirit in the teaching.

This paper introduces the new ideas and methods of teaching reform for Digital Electronic Technology Course under the guidance of CDIO engineering education concept. The teaching reform which started in 2012 is summarized as sandwich principle of “one point and two sides” and as the method of “three linked points”. Brave attempt in the teaching content and teaching method has led to good teaching effect.

PRINCIPLE OF “ONE POINT AND TWO SIDES”

Nothing can be accomplished without norms and standards. Teaching reform should follow certain principles. The principle of “one point and two sides” is proposed here. One point refers to the students as the center, because any reform must conform to the actual conditions of the student's own abilities. Two sides refer to the theoretical knowledge in the textbook and engineering knowledge outside the textbook. In fact, the two kinds of knowledge are closely related to each other. On the one hand, theoretical knowledge is the foundation of engineering knowledge, on the other through the engineering practice can promote and deepen the understanding and grasp of theoretical knowledge. Total hours for this course are 60 hours. Among them, the theoretical knowledge of teaching hours accounts for 90%, while practical knowledge accounts for 10%.

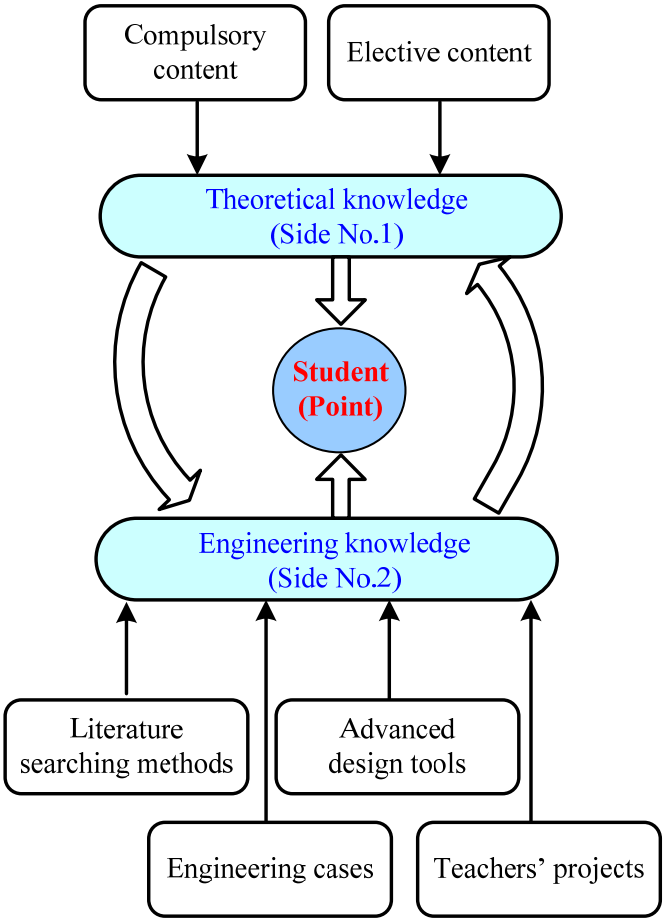

Figure.1 Diagram of reform principle named one point and two side

This kind of principle is named as sandwich mode because it looks like a sandwich, whose components are described in Figure 1. The theoretical knowledge has two aspects of compulsory content and elective content. The former should be presented detailedly in class, but the later just need to be simply introduced. The engineering knowledge mainly contains four aspects: searching methods of engineering literature, engineering cases, advanced design tools and teachers' projects.

Two sides not only serve one point, but their areas should be set in accordance with the size of the point. Areas mean the breadth and depth of knowledge, size refers to students' own conditions, such as foundation, comprehension etc. It's going against natural laws if arbitrary increasing the breadth and depth of knowledge.

METHOD OF "THREE LINKED POINTS"

The teaching reform includes three linked points: teaching in class, training outside class and course design. As the foundation, the first point has the function of knowledge accumulation. The second point refers to primary training for practical ability. The last point is a stage of overall training for theory and practice knowledge obtained from the first two stages. The relationship among them is shown in Figure 2. From inside to outside, it is an emanative process. The inner knowledge is the foundation of the outer knowledge. Since innovation and application are the ultimate goals of learning theory and practice knowledge, the inner knowledge must send out layer by layer to yield its effect after a period of accumulation.

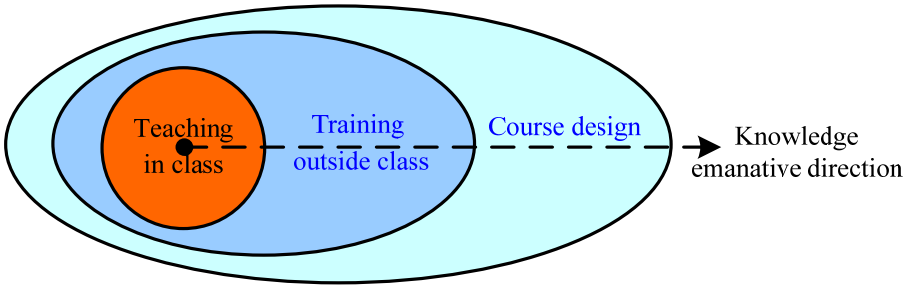

Figure.2 Diagram of relationship among the three linked points in teaching reform

Teaching In Class: Combination Of Extensive Content And Diversified Methods

As the first link of teaching reform, teaching in class involves rich content and long time lecturing, so it is the most important link. Extensive content refers to broaden the two aspects of theory knowledge and engineering practice knowledge. In this situation, single and traditional teaching methods are not proper. Instead, teaching diversification is introduced into class. Diversified methods, such as active learning, experimental exploration, static and rigid methods to more effective methods. All of these are for achieving the three goals: broadening knowledge horizon, motivating learning enthusiasm and establishing practice foundation.

Expanding Teaching Content

To broaden the theoretical knowledge, some of the elective content is introduced in class. The selected content should consider engineering conditions likely to be encountered by the students in the future. For example, in the chapter of “Gate Circuit”, the interface between CMOS and TTL circuits is introduced since the mix circuits consisting of the two kinds of circuit usually appear in actual digital circuit design. Another example, the “Competition and Risk” phenomenon is often confronted in engineer design, it is also necessary to show it to student.

Ways to broaden knowledge of engineering practice mainly has four categories, which are already indicated in Figure 1. The concrete knowledge is derived from the engineering experience accumulated by the teacher for many years. The difficulty and depth should be controlled properly, because the student's comprehension ability for engineering is still in the bud.

In the future, when students are engaged in engineering work, the first thing is information searching. Therefore, the searching methods are added into the first link of broaden knowledge. Information searching involves a lot of content, such as paper searching, patent searching and IC searching etc. The teacher chooses IC “Datasheet” searching, because the student will use various models of IC in digital circuit design. All the characters, such as logic function, pin functions, etc, are included in datasheet. Compared with paper searching and patent searching, the datasheet searching appears more urgent.

Students in class often ask “what good is the knowledge?”. The second aspect of broadening knowledge of engineering design cases is introduced to answer this question. The selected cases should be familiar to students in their daily life. For example, to explain the usage of the “encoder”, “decoder” and “nixie tube”, the case of “call system in hospital wards” is displayed. In this system, the call signal emitted by the patient is firstly encoded into BCD code by the Encoder, and then transmitted to the display decoder through the signal wires, after decoding the call number displays on the nixie tubes. Students are not strange to such ward call problem, but they do not know how it is constructed. Through this example, they deeply understand the function of relevant digital circuits. Another example, to explain the usage of “monostable trigger”, the touch delay switch is showed. This kind of switch usually used to control the corridor lighting can be achieved by the monostable trigger.

As outstanding electronic engineers in the future, it is necessary to timely track the technology development in their work field. Therefore, the third aspect of broaden knowledge introduces the latest design means for digital circuits, i.e. the Electronic Design Automation (EDA) technology. The concrete content involves hardware knowledge of CPLD and FPGA, the software tools as Max+plus and Quartus. All of these introductions lay solid foundation for the following course design for the digital circuit.

The fourth aspect of broadening knowledge is the projects the teacher ever did. Striping out the digital circuit part from the project and explaining its details help students to understand how the circuit operates in the system. Students show great interest in this content. For example, in one project “diameter measurement system for plastic optical fiber”, the digital circuits involve A/D converter, CPLD, nixie tube and its driver, D/A converter and so on. Through this example, students can truly feel the powerful function of digital circuit.

A Variety Of Teaching Methods

The teaching effect is closely related to the teaching method. The methods used at present class are mainly divided into three categories: interactive teaching(Zhou, 2012), active learning and exploratory experimental teaching(Zhang et al., 2010).

In the interactive teaching, grouping is the common way(Li et al., 2014). Since there are about 90~120 students in one classroom, in order to increase the interest of the interaction, some reforms are performed. By way of free grouping, five students in each group, and each group must have at least one girl. Besides, the groups are named with the scenic spots of the city of Qinhuangdao. Students show great interests in this kind of grouping mode, and eventually submitted the group names covering all famous spots in Qinhuangdao. In the aspect of seating arrangement, students in one group can sit freely in the classroom, but it is better to sit together. In case of group competition activities, each group members must sit together, it will enhance team interaction.

In active learning style, teacher and student exchange their roles. The student, not teacher, explains the knowledge in class. In addition to exercise self-learning ability, active learning can train language organization and expression ability. These two points are very important for students in their future job. Active learning is divided into semi active learning and full active learning. For semi active learning, the learning content is arranged by teacher, while for full active one the content is determined by students themselves, the teacher only defines the scope.

For an example of semi active leaning, proving “XOR and NXOR are reverse operation”, after a few minutes’ thinking, the teacher chooses a student to come to the blackboard to list its proved procedure and explanation, the teacher then makes comments. About full active learning, one example is to ask students to collect extracurricular knowledge for digital electronic technology, and then use the PPT to present. The PPT presentation is a good way for students to exercise and show themselves(Huang et al., 2011).

For a long time, students are accustomed to receiving all the theory knowledge from textbook, though some content is slightly different with the actual situation. The exploratory experimental teaching encourages students to demonstrate the disputed content in textbook by the way of experiment. The experiment topic should have practical meaning with lower complexity and be easily operated. For example, aiming at “load characteristic of TTL circuit”, the students found the actual situation is not consistent with the textbook’s conclusion during the experiment. After analysis, they found that the device model given in the textbook is different with the actual device in experiment. As shown in Figure 3, the experimental devices include multimeter, DC power, IC, some resistances and wires, all are easy to carry to the classroom (Li et al., 2014).

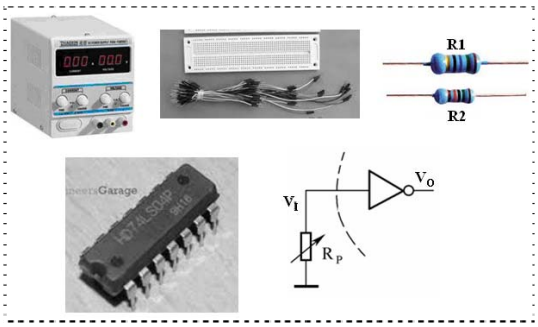

Figure 3. Devices and test circuit used in load characteristic experiment

Training Outside Class: Pay Attention To Self-Study Ability And Team Spirit

Considering engineering design work in the future, self-study ability and team spirit are very important. It is just the purpose of extracurricular training. Given by the teacher, the training topic should help the students get self-study and team work opportunities. Such as the design of “ward call system”, to complete it the students need to study independently a part of textbook knowledge about displaying decoder. In addition, the design consists of several modules, so that every student in a team could be responsible for a module. A clear division of labor is needed to carry out their duties. Mutual cooperation is necessary, because each module is closely linked with the other modules. Thus, students not only train their independence ability, but also exercise the cooperation ability.

After several steps of information searching, plan drafting, discussing steps of improvement, each group will eventually submit their plan. During this period, teacher can offer consultation. The train difficulty level should not be high and the 1~2 training times is appropriate. Students only need to provide the design scheme, rather than specific implementation. The specific implementation can be carried out in the next stage of course design. The final schematic solution is introduced by the way of PPT show, accompanied by the teacher's comments. In fact, the advantages and disadvantages of each scheme are not important; while the important thing is that the abilities of self-study, thinking and team cooperation have been improved in this process.

Course Design: Pay Attention To Comprehensive Ability

The EDA course of digital circuit design has been set up for many years; it has been proved to be an effective way to cultivate students' comprehensive ability.

The design topics of the course are closer to reality, such as traffic light controller, ward calling system, taximeter etc. The design requires students to use computer to complete the circuit design, and then realize the design on the hardware (CPLD or FPGA). Time frame is two weeks. Each round has 60 students to participate in course design and four teachers involve in guiding. Each group will be check before acceptance with the mode of reply.

Encouraging Guidance And Exploratory Design

During the course design, encouraging guidance and exploratory design can stimulate the students' enthusiasm, as well as help students master much more of the knowledge. For example, once a student asked “how to adjust the module port’s sequence”, actually this is also a new question for the teacher. Hence, the teacher encouraged the student by saying: “hope you explore and try by yourself, if you get the answer, don’t forget to tell me”. Later, the student found the adjustment method; I saw excitement on his face and felt his sense of achievement. We always believe that encouragement instead of criticism is more effective for students’ growth.

Pay Attention To “Fishing”

As an old Chinese saying goes, "it is better to teach one how to fish than simply give him a fish. In the EDA guide process, teachers pay more attention to “fishing” teaching. Students will encounter more software and hardware problems in the design. If the teacher simply tells

the answers to the students, it is easy and quick, but it does not do well to the students in the long run. The proper approach is that the teacher only tells students the method, and then asks the students do it by themselves. For a difficult problem, the teacher may help students to solve, but then must explain the principle why resolving that way. The fundamental objective is to have students to know not only the what, but also the why.

Encourage Discussion And Support Innovation

Innovative design, even fancy idea are warmly welcomed in the course design. Each design topic has a conventional way to design, but there is always students having strong interest to take the unusual way. They should be encouraged and reassured. For example, the topic "ALU arithmetic logic unit" only requires displaying the calculation results by LED. However, one student uses nixie tube to display results, which is more creative. Another example, the topic "automatic music player" requires to play a simple notation, but a student utilizes the principle to achieve a complex song named "Chrysanthemums Terrace". Besides this, in order to obtain perfect playing effect, he buys a better quality buzzer to play. This is indeed a masterpiece of innovation. Innovation is the soul of engineering design; a teacher should encourage and support innovation with kind heart of tolerance.

CONCLUSION

Guided under the principle of "one point and two sides" with three linked points of teaching in classroom, training outside classroom and the course design, the teaching reform on Digital Electronic Technology Course can adapt to the requirements of CDIO. More important is that students benefit a lot from the reform.

Course teaching reform is still a long way to go. We will focus our future work on two aspects. Teachers need to have further study to improve their capabilities through attending seminars and exchanging experience among them, etc. Simultaneously, new teaching concept and methods should be introduced, such as making a simple experiment board to demonstrate important content in class.

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