Enlightenment of Engineering Teaching in Canada on Design Experiment Courses in Local Colleges and Universities

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ABSTRACT: Combined with the demand of training electronic professionals in China and the current status of design experiment course teaching in our school, through the semi-annual research of higher education teaching method of engineering in University of Ottawa, Canada, with the classroom teaching reform in our school as an opportunity, reform and practice have been carried out for the project-based topics, teaching methods and assessment methods of the design experiment course. Project-based topics combine with the classical electronic system design topics and innovative topics to meet the needs of students for multi-level and personalized practice and innovation training; increase a link of collaborative training for quickly screening effective information; its content is theoretical knowledge points concerned by large enterprises; its discussion mode includes think-pair-share, fishbowl and world cafe method; the refined procedural assessment method is used, so that the evaluation runs through the entire course; work exhibition of classroom teaching reform is held to motivate the improvement of project achievement quality. Practice proves that the reform has achieved a certain effect, but there are also some shortcomings, and suggestions for improvement are put forward.

Keywords: design experiment course; classroom teaching reform; engineering teaching in Canada

China Engineering Education Quality Report (2013) stated that, engineering education is an important part of China’s higher education. In the higher education system, “one-third in the world”, in the process of national industrialization, it plays an irreplaceable role in the formation and development of an extensive, independent and complete industrial system. Electronic specialty is one of the most important parts of engineering, aiming at training applied talents with multidimensional ability, oriented by social needs. At the present stage, the electronic experiment teaching in our school is a main way to train students’ abilities, such as practice innovation and team cooperation, which mainly include three links: verification experiment course, design experiment course and graduation design. The design experiment course is a supplement to the pre-order theoretical course, which trains students’ practical ability and innovation ability through the design and production of circuits and systems, thus laying a foundation for the improvement of students’ comprehensive ability, completion of graduation design and future employment.

University of Ottawa, Canada is one of the top universities in Canada and ranks the seventh among research-based institutions in Canada, in which the School of Engineering has its strengths and its educational quality and scientific research level enjoy a good reputation in the academic circles and industrial circles in Canada. In August 2016, it participated in the six-month research project for the engineering higher education teaching method sponsored by the China Scholarship Fund Management Committee, observed and participated in the course of Engineering Design set up by the Department of Electrical Engineering of the University of Ottawa for the teaching method of electronic design experiment course. Compared with the current status of design experiment course teaching in our school, a lot of enlightenment has been obtained. With the classroom teaching reform currently vigorously carried out in our school as an opportunity, reform and practice have been carried out for the project-based topics, teaching methods and assessment methods of the design experiment course, and the reform has achieved some results, but there are also some shortcomings, so the appropriate recommendations are put forward, which is also one of our follow-up work.

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1 CURRENT STATUS OF DESIGN EXPERIMENT COURSE

With the rapid development of information technology and Internet technology, the society has an increasing demand for the practice innovation ability and team cooperation spirit of the electronic professionals. Talent training must keep pace with the development of times and the demand of industry as soon as possible \[7\], in order not to be eliminated. Experiment and design experiment course are an important way to train the practice innovation ability and team cooperation ability of the local college students at the stage of undergraduate education. The electronic design experiment course in our school has always used the project-based teaching method since 2008, that is, PBL (Problem Based Learning) method. A group of three to six students completes a task in a task-driven way, and its operation process flow chart is shown in Figure 1.

![Project-based teaching process flow chart.](image)

The teaching mode is similar to the current mode of the course of *Engineering Design* in the University of Ottawa, but it still has the following problems.

1. The project-based topic is an electronic system with a controller. The topic is fixed and lack of innovation and new technologies, so that students are unable to have an access to professional cutting-edge technologies.

2. Due to the lack of teaching links monitored in the whole process, it is unable to accurately grasp the thinking process of students’ finding problems and solving problems in this process, and unable to guarantee the deep participation of members in the group.

2 REFORM MEASURES

The electronic design experiment course in our school is to train the electronic undergraduate students to master the design process and methods of an intelligent electronic system with CPU as the core, index testing of electronic systems and preparation of technical documents, and train students’ team spirit, which is a major practice link to make sufficient reserves of practical skills for the employment. Combined with the teaching requirements of the course and the demand of talent training, the classroom teaching reform mainly includes the following aspects:

1. To add innovative topics with professional cutting-edge technologies. Combined with the current status of the development of electronic technology and the national economic development strategy of “public entrepreneurship and mass innovation”, remote control and data transmission are no longer mysterious. Especially when China Mobile and other operators provided open-source cloud transmission platforms to the public in 2015, new technologies of the electronics refreshed again. Therefore, in the classroom teaching reform, the course topics are no longer confined to the design of classical electronic systems, such as frequency meter, phase difference meter, digital voltmeter and so on. Some students who have spare capacity are encouraged to work with teachers to have a brainstorming and select topics with an independent innovation, and try to use new professional cutting-edge technologies, so that they can apply for new professional technologies to achieve their design philosophy, and can also use their design achievement for various kinds of innovation and entrepreneurship competitions, such as “Internet +” college students innovation and entrepreneurship competition. In addition to training students’ conventional practical ability, such as hardware circuit design, welding, debugging and software programming, innovation topics also involve in technical training, such as the use of open-source cloud platforms, GSM data transmission, Internet of Things and Zigbee, so that the students can contact and apply for the cutting-edge professional knowledge and skills, and greatly broaden the horizons of students through various online and offline competitions and communication with students from various colleges and universities inside and outside the province, and the students’ innovation awareness and innovation ability can be effectively trained and cultivated.

2. To increase training and teaching links through quick screening of effective information. As major electronic enterprises and institutions improve the
In addition, the project-based teaching method used for the design experiment course plays an important role in mobilizing the learning enthusiasm of each group of students. However, due to the lack of training and evaluation standards for group members' collaboration, some students may not or rarely participate in the design and production process, but hope that individual students in the group complete all design and production tasks, namely, a situation of "lift". Therefore, in the classroom teaching reform, the team collaboration training is increased. For the professional theoretical knowledge that is more concerned by major electronic enterprises and institutions in recent years, they are issued to each group in the form of interviews and answers in the classroom. Within the specified time, the group members adopt discussion modes of "think-pair-share" and world cafe, and use the Internet and other means for quick screening of effective information and resource integration, and organize language for statement, while teachers adopt "fishbowl" method to arbitrarily designate the group members to present discussion results, and make the individual's presentation effect as an evaluation result of the group in the link. For the training mode and judging mode, in order to bring prestige to the group or not hinder the group, each student must be deeply involved in thinking and discussion, so as to achieve mutual supervision of independent learning by group members, and force each student to participate in every link of the project design, and effectively reduce a phenomenon of "lift".

(3) To use a more detailed process evaluation method. Process evaluation focuses on the intelligent development of students in the teaching process, and timely makes a judgment of the students' learning quality level, affirms their achievements and finds out their problems, so as to promote further learning \[8\]. In the design course, the most suitable program is selected according to user needs (technical indicators specified by the topic) for physical welding debugging, and finally acceptance and defense are carried out. In the entire debugging process, it is the most complex and can train students' manipulative ability and ability of solving problems to a maximum extent. The students need to spend a lot of energy in class and after class, and the project progress will also be different due to various factors. There is a lack of teaching links monitored in the whole process between each periodic examination, and the periodical examination is also inclined to periodical design results, so as not to accurately grasp the thinking process of students' finding problems and solving problems in this process, and even unable to achieve the training effect of practice innovation under the background of honesty and trust.

Therefore, in the classroom teaching reform, the process evaluation is further refined, and the report of project progress is increased, so that the evaluation runs through the whole course. The calculation formula of students' total score is as follows:

\[ ONG = (0.10C + 0.10D) + (0.10T + 0.05G + 0.05V) \\
+ (0.10M + 0.10S + 0.30P + 0.10R) \]

\( ONG \) is a final score; \( C \) is class attendance; \( D \) is a training effect of quickly screening effective information; \( T \) is the effect of reporting group project progress; \( G \) is a brief introduction of the group project (including real pictures); \( V \) is demonstration video of the group project; \( M \) is discussion of project implementation program; \( S \) is project system design and simulation; \( P \) is project system debugging reply; \( R \) is project system design report. The first part is classroom assessment, the second part is learning assessment after class, the third part is practice assessment, and evaluation runs through the whole course.

(4) To hold a work exhibition of classroom teaching reform. Report of weekly project progress can guarantee the speed and efficiency of project implementation. The purpose of holding the work exhibition of classroom teaching reform is to improve the quality of project achievements. In the process of course implementation, students can not only promote the implementation progress of the project all night long, but also attach great importance to the reliability and effectiveness of the project operation. The internal demand of learning and practice prompts completion of work in advance, and the work exhibition of classroom teaching reform is successfully held. The work exhibition shows students' design philosophy and production level to more teachers and students, greatly enhancing students' self-confidence, improving their interest in technological innovation and production, and also playing a good guiding and demonstration role for lower-level students, so as to make clear of the professional learning objectives and learning content.

3 EXISTING PROBLEMS AND SUBSEQUENT IMPROVEMENT MEASURES

The classroom teaching reform uses the project-based teaching method to reform from four aspects, namely, selection of topics, team cooperation training, examination and evaluation, and work exhibition, and has achieved certain results. However, there are also some problems. For example, innovation topics are free of an individualized professional system; the training topics of quick screening of effective information are lack of updated professional theoretical knowledge.
concerned by employers; process evaluation has a large workload, project groups are numerous, and teachers are insufficient. For the problems occurred in the reform, the improvement will be made from the following aspects.

1. A multi-level and multi-directional project-based topic bank is established by relying on various kinds of innovative and creative entrepreneurship competitions, which covers the classical circuit and system design topics, and topics related to professional cutting-edge technologies, in order to meet the needs of individualized innovation training needs.

2. A training question bank for quick screening of effective information is established through communication with technical personnel of ZTE, Huawei Technologies, Shishuo Electronics and other cooperative enterprises, Intel, Ford Motor, Schneider Electric and FiberHome Group, combined with the announced written examination and interview questions in the recruitment of electronic enterprises and institutions.

3. Learning TA (teaching assistant) system of foreign countries, the assistant teaching by the senior students or graduate students is organized.

4 CONCLUSION

Combined with the semi-annual research results of higher education teaching method of engineering in University of Ottawa, Canada, with the classroom teaching reform in our school as an opportunity, reform and practice have been carried out for the project-based topics, teaching methods and assessment methods of the design experiment course in local colleges and universities, and have achieved a certain result, have obtained recognition and praise by undergraduate teaching review and assessment experts of the Ministry of Education and school leaders, and have obtained outstanding achievements in the acceptance of classroom teaching reform projects organized by the school. However, there are still some problems, and some corresponding improvement measures are put forward, and the application for school-level education reform projects has been approved. They will be the focus of our follow-up work.

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