Advances in Social Science, Education and Humanities Research, volume 505
6th International Conference on Social Science and Higher Education (ICSSHE 2020)

Exploration of Course Teaching Reform Practice under the Background of New Engineering Course and Engineering Education Certification—Taking "Digital Fundamentals" as an Example

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ABSTRACT
Engineering education certification is proposed in the context of integrating new era engineering education with international standards to guide modern engineering education and cultivate international engineering talents with the concept of "student-centered, results-oriented, and continuous improvement." This paper focuses on problems faced by the current course teaching, use "Digital Foundamentals" as an example, the strategy of teaching reform and innovation for "Digital Foundamentals" is constructed from three aspects: the development of the syllabus of the contract system, application implementation, hybrid teaching model based on Rain classroom, and the formulation of the evaluating plan based on engineering education certification engineering. The practice has shown that after the teaching reform that students' learning initiative has been effectively improved, students' innovation ability and ability to solve intricate digital circuit engineering design and application problems have been enhanced, and the course teaching effect has been improved to meet the requirements of engineering education certification, which is a new exploration idea for education reform.
Keywords: *new engineering; engineering certification; OBE; course teaching*

1. INTRODUCTION

In June 2016, at the International Engineering Alliance Conference held in Kuala Lumpur, China became an official member of the "Washington Agreement". China's higher engineering education was included in the international engineering education certification system, and the quality evaluation standards for talent training were in line with international standards[1]. To this end, colleges and universities have rapidly accelerated the teaching reform in line with the international engineering education certification system [2], and further promoted the student-centered certification concept, output-based education design (OBE, Outcome-based Education), and continuous quality improvement, and the teaching reform of the new engineering concept with ability training as the mainline. Course teaching reform is the key to effectively improve the engineering practice ability of students, and it is worthy of continuous exploration and improvement.

With the continuous innovation and development of the digital world, and the application of new digital circuits has become more extensive, "Digital Foundamentals" has become a compulsory professional basic course for electronic information and computer majors. The course covers logical algebra, combinational circuits, sequential circuits, and digital systems, which are responsible for cultivating students to master the basic concepts, basic theories, and analytical design methods of digital electronic technology, and to solve more complex digital system-related engineering problems. Therefore, the introduction and integration of engineering certification and new engineering concepts, with the goal of cultivating international engineering and technical talents, is of great significance to the teaching reform and innovation of the Digital Circuit Fundamentals course.

This article combines the actual training of talents in our school, takes the "Digital Fundamentals" courses of Computer Science and Technology and Internet of Things Engineering as the experimental objects, and aims to improve students' course learning effects and engineering application innovation ability, focusing on affecting and restricting the quality of course teaching and the key issues and weaknesses, and orienting the teaching outcome emphasized by project certification philosophy, focusing on discussing the "student-centered" course teaching interactive classroom teaching and outlining the development and application mode, the project-based studying and thinking blending with practice teaching

mode, and emphasizing the reform and practice on learning process evaluation aspects including course evaluation and ways of incentive, which provides a new idea for the new engineering in the context for enhancing the quality of personnel training course reform.

2. THE SYLLABUS FOR CONTRACT MAKING DESIGNING AND PRACTICING BASED ON AI

The syllabus is the reference of the class content, the exact reflection and practice of the talent education goal, and the fundamental guarantee of high-quality education of school. Under the circumstance of large reducing in actual delivering time on "Digital Fundamentals", achieving the teaching goal is a challenge especially on how to arrange content delivering, organize each part correctly and effectively. Thus, designing an innovative, doable and scientific course planning is of vital importance.

2.1. Current State and Issue

The problem on the traditional syllabus is serious from two perspectives. Firstly, advancing technology is challenging to obtain and show in the syllabus when designing it. Because teachers are unable to gain the variety and need of industry on new knowledge and technology of "Digital Fundamentals". Resulting in difficulty in designing scientific planning. However, university not only refers to each other when designing syllabus and neglect the difference which leads to unclarity and pertinence, but they also overlook the unbalance development in different areas and production technology varies. Secondly, there is no quantified method in organizing the content and delivering time, instead teachers use their experience. It is obvious this method is outdated, lack support of data, lack evidence of analyzing in students studying situation, lack consideration of the outcome of online delivering. Thirdly, the designing of syllabus is not student and education result oriented. There is lack of consideration of student's involvement, the education administration department or school management department focuses the designing and operating solely on teachers. This teacher-centered type of teaching form hinders the initiative, activeness and innovativeness of students if this form is not able to transfer to student-centered.

2.2. Innovation

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations. Focusing on these problems and based on OBE concept, this course sets goals of "Digital Fundamentals" professionally and extracts technical key words from descriptive texts in each goal. Then, uses the data as reference extracted utilizing AI tools including web crawler, natural language comprehension and the data analysis to gain information and data from industry study, job website, tests, new knowledge. Meanwhile, organizing teaching time using AI, which analyzes students initial corresponding subject grades and student's data in platforms like rain classroom and Chaoxing.

Based on these data, using algorithm to confirm teaching time is doable. The teaching time can be divided into four parts: fundamental time(A), teaching aim weight time(B), students learning efficiency adjustment time(C), online study time(D). Fundamental time is set by experience including personal teaching experience and on studying or discussing general experience. Teaching aim weight time is from key word discovering including marketing need analysis and production technology improvement, etc. students learning efficiency adjustment time is decided by ai analysis. While online study time will be based on teaching contract plan management. The teaching time can be included by equation (1).

$$H = A + B + C + D \tag{1}$$

Using algorism to weight and average each key word extracted, lowering small weight goal time and increase larger teaching time of larger goal. This could be included by equation (2).

$$B = \text{all current teaching goal key word number} / \Sigma \text{all goals} * \text{corresponding teaching time} \tag{2}$$

2.3. Practice

The requirements of complicated problem-solving ability, innovative thinking mode, ability to utilize modern tool, communication and reports writing shown in Table 1:

This syllabus is handed to teachers and students to let both sides clear that what the students learn and what the teachers deliver. It clears the responsibility to students and teachers. The class will enhance the learning efficiency and link teaching with working in the future with the consensus and contract of two sides.

Table 1. Aims and requirements

Aims	Requirements
1	1.2 Solid engineering foundation knowledge of CS and technology 2.1 Ability to notice problem and clearly express problem using science basic knowledge
2	2.2 Ability to analyze problems using science basic knowledge and referring to extra essays 3.1 Ability to design system goal, software function and structure based on user and user experience
3	4.1 Ability to study complicated engineering problems using complex experiments and reflecting science principle
4	5.3 Ability to use modern tool to predict and evaluating problems and understand its limits 12.1 Self-learning

3. TEACHING DESIGNING BASED ON OBE MIXED WITH CERTIFICATION

Outcome orientated education certification starts from cultivating talents and student's lifelong development and ability improvement, and the actual need from society, created this standard and the planning derived from the standard. Based on all above, we integrated this map of content shown in Fig. 1. That content includes the requirements in professional ability, coordination in engineering and society, professional standard execution and communication in person and team[3].

According to this content and actual teaching environment, the teaching design is divided into two: foundation teaching in a large group and online offline mixed teaching with rain classroom; the PBL project teaching and practice teaching in small group that only have less than 30 students.

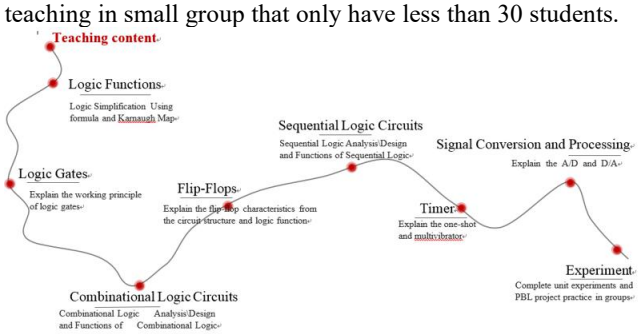

Figure 1. The teaching content of the syllabus for contract making

3.1. Online Offline Mixed Teaching with Rain Classroom

The average number of students in large grouping class of digital fundamental is 100 or larger. Students will be interviewed before and after each start of new term so that teachers could be aware of the attitude, interests, effect, pre-learning and preferred learning methods. Pushing mixing way teaching and break the space and time limit of traditional delivering mode by fully using flexible function like pre and post-class study, test, interaction, practice assignments and full data in Rain classroom with plug-ins in slides and WeChat linking[4-6].

After many experiments, the research group designed this mixture way teaching based on rain classroom, shown in Fig. 2.

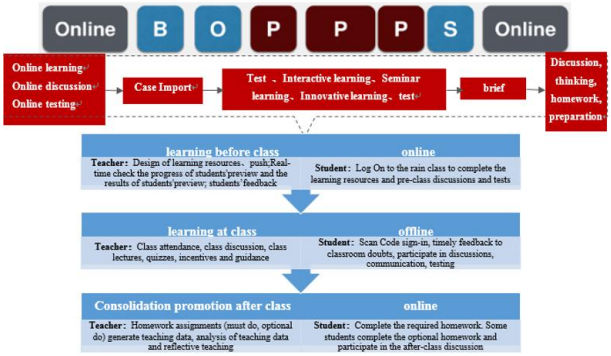

Figure 2. Online and offline mixed teaching based on Rain Classroom

Before class, according to the content of the knowledge points in the classroom and the actual situation of the students, teachers design appropriate pre-class learning resources including some relatively simple and conceptual related knowledge, documents and videos of expanded materials, and release them to students on Rain Class, and design related discussions and pre-class tests for students to study independently. Students can discuss and communicate with teachers and classmates on the doubts and difficulties encountered in the discussion area; at the same time, complete the pre-class test and check the preview effectiveness.

The learning in the class is carried out according to the BOPPPS course instructional design model, which includes import (B, Bridge-in), target (O, Objective), pre-assessment (P, Pre-assessment), and participatory learning (P, Participatory learning), Post-assessment (P, Post-assessment), summary (S, Summary) and other six organically linked parts [7]. Participatory learning is the focus and core of BOPPPS course design. This course adopts the in-class test, random roll call, bullet screen, and contribution and other function to develop a class which is student-centered. In the process of explaining, you can also use the "bullet screen" and "don't understand" functions of the Rain Classroom to understand the student's learning status in real time, adjust the teaching content in time, and

achieve precise teaching, and you can also send reward red envelopes students who perform well in class to stimulate students' interest and motivation in learning, and enable students to actively participate in the learning process of acquiring and forming knowledge, abilities, skills, attitudes, and emotions.

In the post-class phase, the corresponding phased homework will be further arranged according to the key and difficult points of this chapter. The homework is divided into two parts, mandatory and optional questions, for outstanding students to further boost themselves. The homework can be in the form of after-school exercises or small projects given to students. The homework after class will be completed independently by the students within the specified time according to the requirements. After submission, the students can know their mastery of the knowledge taught in the chapter and clearly understand their level in the class, so as to motivate them not to be left behind to study hard. For small projects, students are required to complete the work in a team. Groups of four are required to assemble freely. Each group selects a leader who is responsible for the division of labor and the overall control of the project. If you encounter problems that cannot be solved, you can go online to check the information and exchange and discuss with teachers, and peer students. The completed results will be sent to the platform discussion area and by student evaluation and teacher evaluation, excellent cases will be found and will be demonstrated in the class. Such exchanges and sharing not only enable students to learn the knowledge points of the chapters, broaden the content of classroom teaching, and improve student participation, but also cultivate students' teamwork ability and the ability to explore problems more.

3.2. Project-Based Group Teaching Based on Problem-Orientated

The practical teaching is divided into two parts, one is the unit project teaching part, which mainly aims at a certain knowledge point to design some projects to solve a relatively single problem. The example-style teaching method shown in Fig. 3 is used in the unit project teaching: Emphasize the teacher's exemplary role, the imitational study from students, the adjustment under teachers advice, and comparing with thinking and concluding.

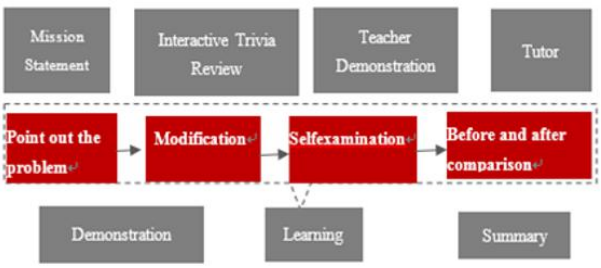

Figure 3. Teaching Method of Unit Project

The other is the teaching part of the integrated project (PBL project). The scaffolding teaching method shown in Fig. 4 is used in PBL project teaching. Teachers ask questions and throw out similar concepts to guide students to independently think and explore solutions, simulate and judge the rationality of the plan, check and modify the perfect plan, show the report plan, and then classmates and the teacher comment, students self-fix and think about more innovative solutions, and cultivate the initial ability to be creative in analysis and solving engineering problems.

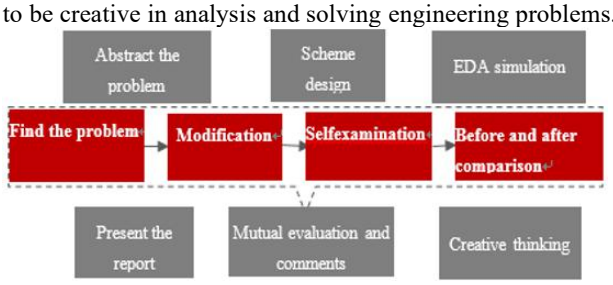

Figure 4. Teaching Method of PBL Project

4. EVALUATING METHOD BUILT ON PRINCIPLE OF ENGINEERING CERTIFICATION

This course adopts the concept of engineering certification to build a multi-dimensional evaluation system including students' comprehensive ability, independent learning, unity and cooperation, and learning in class, so as to realize the objective evaluation of teaching and learning effects and feedback teaching. The evaluation method of course scores is no longer the final "one test for life", but focus on process learning, establishing "online (video + discussion) + classroom (test + interaction) + homework (mid-term test + summary of each chapter) + A comprehensive performance evaluation system of "practice + final exam", as shown as Fig. 5, objectively evaluates students' learning effects and learning abilities from multiple dimensions.

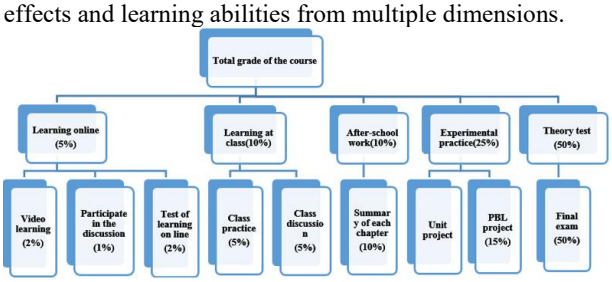

Figure 5. Course Evaluation System

According to the concept of engineering certification, to evaluate the achievement of each cultivating standard, we further decompose the support of the training standard by the multiple dimensions' evaluation method of the course. Through the statistics, sorting and analysis of the achievement of "learning results", feedback to the formulation and adjustment of assessment methods, a closed loop is formed, making the assessment methods

more scientific and reasonable. This method is helpful to adjust the teaching methods of different stages and different contents, and to find suitable and optimized teaching methods. In addition, according to the degree of achievement of learning achievements, adjust the difficulty, focus and class time of the teaching content.

5. CONCLUSION

By comparing the final exam scores of the 2016 level of Computer Science and Technology (completely not taught according to this teaching strategy) and 2017 (based on this teaching strategy), shown as Fig. 6, the average score has increased by 7 points; Judging from the participation in the electronic competition, the 2016 students have won 3 awards, and the 2017 students have won 7 awards; from the participation in teacher research projects, teachers generally report that the 2017 students are obviously better than the 2016 students. After a questionnaire survey of students in class, it is found that such teaching strategies have stimulated students' enthusiasm for learning, improved their circuit analysis and design capabilities, and received better results. It can be seen that the teaching strategy based on the concept of engineering certification has boosted students' sense of innovation and achieved problem-oriented learning for students. Students' independent learning ability, ability to solve complex engineering problems, teamwork and communication skills have been well trained. This effective strategy provides new ideas and directions for education and teaching reform.

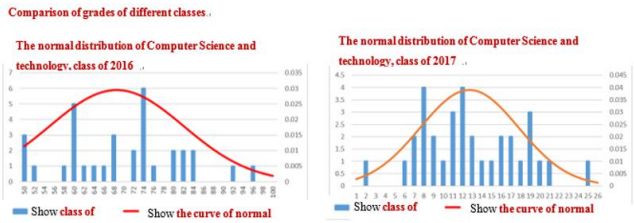

Figure 6. The result analysis of teaching reform practice

ACKNOWLEDGMENT

This study was supported by Sichuan Teaching Reform Project: OBE-oriented syllabus design and use based on contract mechanism; Number: JG2018-777. School-enterprise collaborative education project of the Ministry of Education: Teaching of "Digital Foundamentals" based on the concept of EDAI+PBL; Number: 201801174016. Key Research Base of Humanities and Social Sciences in Colleges and Universities in Sichuan Province Sichuan Education Information Application and Development Research Center: Research on Online Teaching Classroom Quality Evaluation Based on Micro-Expression Recognition No. JYXX20-030.

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