

Teaching Reform of Civil Engineering Materials Course Based on Project-Driven Pedagogy

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Abstract. In view of the scattered experimental projects in practical courses of civil engineering materials, the poor practical ability of students and the disconnection between practical teaching and theoretical teaching, this paper proposes a practical teaching procedure. Firstly, the single experiment should be offered which emphasizes on improving the students' basic experimental operating ability. Secondly, the compressive experiment is offered and the overall quality of students can be examined in the form of project team. In order to investigate the effect of teaching reform, the comparative analysis of the students of three grades (2014, 2015 and 2016) majored in civil engineering was conducted. The result shows that the students' ability of experimental operation is obviously improved by using the project driven method-based teaching reform. Besides, the students' ability to analyse and solve problems has also been improved.

1. Introduction

As the material basis of civil engineering, building materials is of vital importance in construction project. Currently, all colleges and universities have taken civil engineering materials course as a basic course and a compulsory course for civil engineering major. One of the main features of the course is the strong practice and the dispersion of the knowledge system^[1]. Civil engineering is a highly applied specialty. Therefore, the experimental teaching of building materials has become a very important and indispensable part of the teaching practice in civil engineering major^[2]. In order to realize the application-oriented and engineering-oriented education, how to carry out the teaching reform under the current social needs and undergraduate education plan has been a key issue for experimental instructor. Project-driven pedagogy is a teaching method based on constructivism teaching theory. The basic idea of this new teaching method is to combine the students' learning activities with the practical application of the engineering and give full play to the students' creativity and initiative. Teachers play an organizing and guiding role in the whole process of experiment. The overall quality of students has been tempered and improved in the process of conception, design, realization and operation of specific experiments. Project-driven pedagogy is currently recognized internationally as a scientific application-oriented undergraduate training method^[3]. In view of the fact that the training mode of project-driven pedagogy is highly consistent with the goal of civil engineering materials experiment, it is decided to carry out the project-driven teaching reform for some undergraduates majoring in civil engineering and compare it with those who did not carry out project-driven teaching.



2. Current status of the course

Civil engineering materials are currently the most widely used materials in the world, which covers many areas, including inorganic materials, organic materials, polymer materials and composites [4]. This makes building materials more intersecting with other disciplines, and students have some difficulties in understanding the production process, performance, and application of many materials. Owing to the limitation of time, budget and resources, the content of practice teaching is relatively simple, the number of experiments is few, and the analysis is not contrastive. Besides, there is no comparative analysis. The content of practical training is somewhat out of line with the content of theoretical courses, which makes the students more dependent on the experimental teachers and cannot stimulate students' interest in learning. In addition, since the experimental items are single and fixed, the students cannot play a dominant role in the learning process, even if they want to design some experiments to verify and solve the problems encountered in learning.

3. The content of the course reform

3.1 Reform of practice teaching methods

Before the course reform, the experimental teaching content is scattered, and the experimental projects are independent from each other. Combined with the training objectives of civil engineering professionals and the current engineering practice, the experiment course of civil engineering materials were set up based on the principles of simple and comprehensive, gradual and orderly progress. Some basic experiments of common used building materials, such as the basic properties testing of cement and aggregate, are set up. The main purpose of these experiments is to train students' basic experimental skills and to deepen their understanding of theoretical knowledge of civil engineering materials. A number of comprehensive pilot projects were subsequently set up to deepen students' understanding of the performance experiments of civil engineering materials. This kind of comprehensive experiment can be completed by a project group which is composed of around 6 students. Each group can be a voluntary combination or designated by the tutor. The team leader organizes group members to conduct regular experimental discussions and to find out relevant information on the unclear contents encountered in the experiments. The experiments can be designed by the teachers or by the project group according to the experimental instruments in our school, such as concrete mix design, concrete durability (anti-carbonation, resistance to chloride ion permeability, frost resistance and sulfate erosion) and the application of industrial waste in cement concrete. According to the proposed topic, the groups determine the preliminary experimental scheme. Based on the experimental plan, the instructors evaluated the feasibility of the experiment, and then the experiment was carried out by the project group. The instructor supervises the entire experimental process and gives guidance as appropriate in key areas. When the experiment is approximately completed, the instructor organizes all the students to discuss and review the main advantages and problems of each group in the process of the experiment. When the experiment is finished completely, the instructors will give the experimental result of the students according to the role and contribution of the group members in the whole process of experiment, combined with the writing of the experiment report and the result of the project experiment. Through this teaching method reform, students' enthusiasm for learning has been greatly mobilized. Because the experimental project is not fixed, and some experimental projects are proposed by the students themselves, the students are bound to think spontaneously and constantly in order to achieve a good experimental result. Through information review and group discussion, this course reform has cultivated students' scientific accomplishments in teamwork and laid the foundation for cultivating applied undergraduate talents.

3.2 Reform of practice teaching

Before the course reform, most of the experimental curriculum of civil engineering materials testing belongs to confirmatory experiment [5], such as the basic properties testing for cement, concrete aggregate experiments, mortar, brick and some other decorative materials. Combining the current

engineering practice and the training goal of the civil engineering specialty of our university, the practical teaching content is optimized. The experiment course was divided into two parts: practical training of individual project and comprehensive training. For the practical training of individual project, the emphasis is to enhance students' understanding of concepts and mastery of experimental skills. Taking the experiment of cement setting time as an example, the initial setting time of cement is defined as 'from the time of adding water to cement until the test needle sink to 0.5-1.0mm on the bottom board', and the final setting time of cement is defined as 'from the time of adding water to cement until the test needle immersed in the paste does not exceed 1.0mm'. In this way, students can understand the concepts of "setting" and "hardening", "initial setting" and "final setting" of cement in theory teaching. While for comprehensive training, the real task was simulated. The instructors only provide raw materials and design requirements. Other work is done jointly by the project team. Taking the experiment of external wall concrete material layout for example, the students used the learned knowledge to test the performance parameters of the sand, gravel and other components. On this basis, the mix proportion was designed. Through such a training project, students can practice lots of civil engineering materials experimental skills. Besides, through the cooperation between students, the students' cooperation ability is improved, and a good foundation is laid for the future work.

3.3 Reform of examination evaluation

Before the course reform, owing to the fixation of experimental project, the evaluation of students' scores is mainly based on the students' experiment report. Due to the identical experimental projects, students' plagiarism is serious which leads to the similarities of the experimental reports. Besides, due to the limited number of teachers, teachers are unable to ask questions to all the students, which leads to a certain deviation in the students' performance. By adopting the new teaching method, the evaluation of students' performance consists of four parts: experimental operation skills, experimental report, literature review ability and experimental discussion performance. The experimental operation skills are mainly based on the performance of the basic physical properties of building materials to be assessed. The experimental report of basic skill requires all students to write in accordance with the procedures. While for the experimental report of comprehensive training, each project team writes different tasks. The literature review ability is aimed at comprehensive experiment, which requires a group of students to evaluate the entire project together based on the experimental tasks. As for the experimental discussion, each member of the project team is evaluated according to their cooperative ability, innovation ability and working attitude in the whole process of the experiment. In this way, although there is a similar part of the report among the project team members, the phenomenon of seriously students' plagiarism can be avoided. The evaluation system of students' experimental scores is also more specific, which reduces the proportion of teachers' subjective scores. Therefore, students are also easy to accept the assessment of grades. In order to obtain higher evaluation, the students will make greater efforts during the entire process of experimental course.

4. Results and Discussion

In order to evaluate the effect of teaching reform, a comparative study of students in 2014, 2015 and 2016 majored in civil engineering was conducted. The evaluation indexes are as follows: plagiarism rate of experimental report, students' basic skills operating ability, follow-up teacher evaluation, as is shown in Table 1.

Table 1 Comparison of experimental materials for building materials reform

Evaluation index		Student number		Evaluation results	
		Group undertaking course reform	Comparison group	Group undertaking course reform	Comparison group
2014	Experimental skills			Excellent	Average
	Plagiarism rate of experimental report	57	53	2 teams (12 students)	18 copies

	Follow-up teacher evaluation			Good	Average
	Student achievement is excellent number of people			10 students	3 students
	Experimental skills			Excellent	Good
	Plagiarism rate of experimental report			0	10 copies
2015	Follow-up teacher evaluation	52	55	Good	Average
	Student achievement is excellent number of people			11 students	5 students
	Experimental skills			Skilled 1team (6 students)	Know 13 copies
	Plagiarism rate of experimental report				
2016	Follow-up teacher evaluation	30	30	Excellent	Poor
	Student achievement is excellent number of people			7	3

As can be seen from Table 1, by adopting the teaching reform based on project-driven pedagogy, all the students in different grade have better understanding of experimental skills than those who didn't undertaking teaching reform. The plagiarism rate of experimental report is greatly reduced and the proportion of excellent students' experimental scores increased significantly. The results show that project-driven reform of experimental teaching methods can significantly improve teaching effect. It is worth continuing to promote in the future

5. Conclusion

In order to cultivate engineering and applied undergraduate students, the teaching contents and evaluation methods of the experimental course of civil engineering materials have been reformed and optimized. The comparison and analysis of students' experimental abilities before and after the reform shows that through the project-driven practice teaching reform, the enthusiasm of students is stimulated and the experimental skills and innovative abilities of students are improved.

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