

A practical teaching model in a civil engineering course

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ABSTRACT: A practical teaching model is a relatively new teaching model, which strengthens the learning of basic knowledge and the imparting of professional theory, and emphasises the importance of practice during the teaching process. In order to assess the outcomes of the practical teaching model in a civil engineering course, a teaching experiment has been conducted aimed at gauging differences between the practical teaching model and the traditional model. For the experiment, several indicators were adopted, and the results were evaluated with the grey relational analysis method. The result shows that the practical teaching method can effectively improve the efficiency and effectiveness of teaching, as based on the selected indicators and the comprehensive evaluation, students in the experimental group taught according to the practical model demonstrated better outcomes than those in the control group.

INTRODUCTION

As the juncture of scientific and technological progress and cultivation of talent, universities of science and engineering undertake an important mission in the process of constructing an innovative country, being an important base to cultivate high-tech talents and the centre for knowledge and technology innovation. At present, one of the key points regarding science and engineering teaching in various countries is how to cultivate engineering talent that will meet the engineering demand. In this context, MIT and other universities jointly proposed a completely new engineering education concept that is a practical teaching model.

The practical teaching model is a methodology designed to countermeasure the traditional model, by optimising teaching in the context of practice aligned with actual demand. It is aimed at cultivating students' engineering knowledge, new and existing technology, individual innovation ability and teamwork spirit to solve specific problems, with the lifecycle from laboratory product development to the test process in real industrial production. According to this model, students are involved in project work, during which they complete learning tasks actively. Also, the knowledge taught during individual course units is linked systematically and logically within the whole course. It is a completely new teaching model that strengthens the learning of basic knowledge, imparts professional theory and emphasises the role of practice in the process of teaching and learning [1].

With the development of teaching resources and reform of courses, more and more academic teachers have realised the importance of student practice in the process of learning. The practical teaching model is dynamic and intuitive, making students to comprehend easily and absorb complex knowledge in the process of project work. In addition, compliant with the characteristics of human interaction, the practical teaching model can enable students to control the whole learning process, while stimulating their natural curiosity in a group environment.

Therefore, in recent years, the practical teaching model has become a key research and application target of many academic teachers, including Chinese teachers. Hao, X. on the basis of researching and analysing the practical teaching model for social sports majors, came up with several suggestions for reforms aimed at resolving the main problems in the practical teaching of social sports majors [2].

Xiong, H. based on demand for a practical teaching approach for ideological and political courses, regulated and systemised the practical teaching model, designed various feasible teaching plans and established effective assessment systems [3]. The practical teaching model not only influences the practical teaching performance, but it also impacts on the allocation and layout of practice equipment, and the formation of student attributes and the overall quality of higher education, as well as pointing the way to reform and development.

In this study, based on the teaching characteristics of civil engineering and the advantages of the practical teaching model, practical teaching has been blended into the whole teaching process to become an organic part of the teaching. Broadly, the study was aimed at testing the superiority of the practical teaching model, and in order to do so, relevant experiments were designed and conducted. For the experiments, the teaching content was reorganised and rearranged and several evaluation indicators were adopted. Finally, the results were evaluated using the grey relational analysis method, and the value of the practical teaching model in the teaching of civil engineering courses was determined.

MAIN VARIATIONS OF THE PRACTICAL TEACHING MODEL

College and enterprise alternation practical teaching model: it is an educational model based on combining learning with application, in which enterprises and universities jointly establish a talent cultivation plan and students alternate between studying at university and practice in enterprises. The specific feature of this teaching model is that when freshmen arrive at university, they practice in enterprises during their first term, and the enterprises are responsible for the students' professional ethics and basic education.

Students are directed to practice in different technical posts, so as to experience different roles and build an awareness of the enterprise environment and its people. In the second, third, fourth and fifth terms, students learn theory and gain knowledge at university, and they also carry out substantial practice in the enterprises. In the sixth term, they complete their graduation thesis and continue practice in the enterprises. Such a cyclic alternation makes students observe, absorb and participate in the enterprise, and also become familiar with the enterprise environment while studying at university. When they enter their previous learning post as new employees, they already know the professional group that they will be working with, which will improve their adaptability, occupational quality and practical ability substantially. Thus, a seamless connection will be established according to the demand of the enterprise [5].

Learning and practice integration teaching model: learning and practice integration is an optimised practical teaching model, which conforms to educational regulations, with a high world-wide recognition and deeply ideological origins. Teachers and students teach and practice alternatively; sometimes, the students practice first and, then, the teachers teach or the students practice while the teachers teach or after studying, the students' academic performance is tested by practice. Common problems that occur in the process of practice are solved in the class. This teaching model of closely combining learning and practice is focused on the complete synchronisation between site practice and class learning, and it is an optimal model for higher education and practical teaching.

Case practice teaching model: case teaching is a kind of training to cultivate students' abilities by taking real-life cases as the teaching resources. It is an analogue, simulation and pre-exercise to the future work and social practice. This training is most suitable for the practice of students majoring in economics and management.

Modular practical teaching model: it is a kind of teaching method based on the decomposition of the contents of practical teaching into corresponding modular teaching units, the purpose of which is to construct a new teaching pattern blending occupational needs and knowledge and skills acquisition, while conforming to the demands of enterprises. The advantage of modular teaching is that the key teaching points are highlighted and that the teaching objectives are clear throughout the teaching/learning process. The teaching process is simplified and the problems are solved one by one to ensure the teaching quality. This teaching model conforms to the regulations of occupational education, so it can be affirmed that it is an optimal practical teaching model [6].

APPLICATION OF THE PRACTICAL TEACHING MODEL IN THE COURSE TEACHING OF CIVIL ENGINEERING

Experimental method: Design Principle of Concrete Structures is a professional basic course in the civil engineering major, which has an important place in various disciplines of construction. As a professional basic course, it involves a lot of professional knowledge, being a course with strong theory and practice components. In the process of professional learning, it is expected that students will acquire and use a diverse and substantial knowledge, like the basic theory of civil engineering, design principle of steel structure, material mechanics and the theory of probability. In addition, when dealing with specific problems, there are many factors to be considered in the design principle of concrete structures course. Students are required to mobilise their theoretical and practical knowledge to analyse a given problem, so it is a course that requires a strong background in science, and it should be studied with other university courses.

In order to verify the application effect of the practical teaching model, 240 students in six classes in the 2012 civil engineering major were randomly selected as the research target. One hundred and twenty students from classes 1-3 were selected as the experimental group and 120 students from classes 4-6 as the control group. The students in the control group were taught according to the traditional teaching model and those in the experimental group according to the practical teaching model. Experimental teaching was conducted during two terms in the 2013/2014 academic year. The teaching time of each term in the practical teaching model was 64 class hours, including 32 class hours for theoretical teaching and 32 hours for computer practice, which was the same as with the traditional teaching model.

Evaluation method: in the traditional teaching model, the method to evaluate the students' learning effect is usually by examination, which is prone to making students pursue scores only, while ignoring the acquisition of other abilities in the learning process. In order to break this traditional evaluation method, new evaluation indicators and evaluation methods were discussed and adopted.

Evaluation indicators have to relate to the educational objectives of the university. Taking the students' comprehensive ability as a starting point and combining it with the engineering course's characteristics, the author set up the following evaluation indicators and assessment form.

After teaching, test questions to test the experimental group and control group were designed. The total score for the test was 100, all students attended all examinations, and after the test, the scores were collected and subjected to statistical analysis with SPSS software. The test scope included the mechanical properties of concrete structure materials, extreme state design method of main probability theory, sectional bearing force of members subjected to the action of bending moment, shearing force and axial force, twisting section bearing force of members subjected to the action of bending moment, shearing force and torque, deformation, crack and duration of concrete members.

After teaching, the teacher evaluated the teaching process (evaluation indicators included: class discipline, class atmosphere and teaching feedback), and the application effect of the teaching model in the actual problem was gauged in combination with expert assessment scoring. The total score of each indicator was 100, and the final score was the average value of each indicator evaluation.

Each student evaluated the teaching process (evaluation indicators included: learning interest, teaching form, teaching means, teaching media, teaching effect and interaction between teachers and students). This was done mainly to survey the students' acceptance of a different teaching model. The total score of each indicator was 100, and the final score was the average value of each evaluation indicator.

RESULTS AND ANALYSIS

After completing the course for a term, the control group and experimental group were scored based on the test scores, teacher evaluation and student evaluation, and comprehensive evaluation was conducted using the grey relational analysis method. The overall experiment results are shown in Table 1.

Table 1: Comparison of the overall experiment results.

Group	Test score	Teacher's evaluation	Students' evaluation	Comprehensive score
Control group	62.3	55.8	53.1	57.4
Experimental group	83.5	72.1	69.6	75.4
<i>p</i>	0.0079	0.0082	0.0059	0.0078

**p* < 0.01, compared with the experimental group

It can be seen from the experimental results data that in various evaluations, the experimental group involved in the practical teaching model produced results superior to those produced by the control group in the traditional teaching method. In the test score results, the score of the experimental group was higher than the score for the control group, indicating that when taught with the practical teaching model, students' learning and examination abilities are improved. In the two indicators of teacher's evaluation and students' evaluation, the score of the experimental group was obviously higher than the control group's score, with the maximum score difference of nearly 20, indicating that the teaching effect of the practical model is superior to the traditional teaching, the teaching acceptance degree is outstanding, and the students' knowledge acceptance degree is higher. A more specific analysis is as follows:

- For the test assessment, students in the control group generally indicated that the examination questions were difficult, mainly because in the traditional teaching, teachers often apply spoon-feed education, lack initiative in the choice of words when explaining concepts, and students have a low learning desire. Students in the control group, however, found the examination questions moderately difficult, because in the class, the teacher applied the teaching resources flexibly with rich and vivid content, which greatly stimulated the students' initiative in learning. In addition, the teacher and students actively discussed problems in class and there was a significant interaction after class, so the students' learning potential was fully mined.

It can be seen from the specific evaluation of the scores (Table 2) that there was no major difference between the experimental group and control group for the objective questions with fixed answers. The average score for multiple choice questions in the control group was slightly superior to that of students in the experimental group, but in the subjective questions, especially, in the case analysis, the performance of the experimental group was far better than the control group's performance. This phenomenon indicates that students in the experimental group used knowledge flexibly and successfully to solve specific problems, taking into consideration the basic knowledge and effectively avoiding the disconnection between the solution and social requirements.

Table 2: Evaluation results of test scores.

Group	Multiple choice	Term interpretation	Discussion	Case analysis	Comprehensive evaluation
Control group	15.23	10.13	10.09	16.17	52.24
Experimental group	19.15	13.72	14.27	19.16	66.38
<i>p</i>	0.0037	0.0076	0.0076	0.0067	0.0063

**p* < 0.01, compared with the experimental group

- In regard to teacher's evaluation, the teacher reflected that students in the experimental group accepted knowledge rapidly, could discuss well and were flexible in communication. In the practical teaching model, the teacher guided students to complete the practice contents personally, to think about the problems occurring in practice and actively discussed with them potential solutions to the stated problems.

In the process of teaching the control group however, the teacher spent a lot of time interpreting *boring* theory, with low teaching efficiency. Therefore, according to the teacher's evaluation indicator, various scores of the experimental group were higher than in the control group. The scores of the teacher's evaluation are as shown in Figure 3.

Table 3: Scoring results of teacher's evaluation.

Group	Class discipline	Class atmosphere	Teaching feedback	Expert evaluation	Comprehensive evaluation
Control group	51.14	62.17	45.32	41.27	51.01
Experimental group	69.17	79.04	67.29	65.32	68.81
<i>p</i>	0.0035	0.0067	0.0024	0.0045	0.0041

**p* < 0.01, compared with the experimental group

- In regard to students' evaluation, in the experimental group with the practical teaching mode, the teaching method, teaching content and teaching effect were adjusted to improve on the simple spoon-feeding education of the previous teaching mode. The students generally indicated that the practical teaching model deepened their understanding of the concepts and contents, and improved their learning efficiency. They found group discussion and participation in the after-class communication to be helpful for memorising and understanding knowledge more deeply.

In the process of teaching, the students' learning initiative was greatly stimulated, and in the class, the teacher and students interacted with a significant effect, which enabled the students to improve their professional knowledge and management ability supported by a strong interest in the subject taught. The preferred teaching model, as indicated by most of the students, was based on novel, enlightened class teaching with a reasonable use of multimedia and combining teaching with practice. Such a class could really help them to improve their professional skills. The scores of students' evaluation are as shown in Table 4.

Table 4: Scoring results of students' evaluation.

Group	Learning interest	Teaching form	Teaching means	Teaching media	Teaching effect	Teacher-student interaction	Comprehensive evaluation
Control group	62.19*	50.31*	27.19*	58.51*	54.59*	45.93*	47.54
Experimental group	78.29	63.89	62.37	71.64	66.97	67.27	69.02
<i>p</i>	0.0039	0.0056	0.0062	0.0053	0.0075	0.0041	0.0072

**p* < 0.01, compared with the experimental group

CONCLUSIONS

The practical teaching model offers several benefits to students and teachers. Students can gain a deeper understanding and appreciation of real work tasks in enterprises and are provided with numerous opportunities to exercise job preparedness and occupational abilities. Through cooperation with enterprises, teachers get to understand job market requirements much better and potentially can redesign their teaching according to the skills and qualities required by enterprises. The cooperation provides an important basis for the analysis of professional posts and course construction.

The practical teaching model changes the spoon-feeding teaching of the traditional method, replacing it with industrial practice and exposure to real work problems. The model focuses on the dominant role of students in the teaching/learning process, and it helps students to understand social reality, gain knowledge and skills, and improve their overall ability. It is an important element in quality assurance at universities and the attractiveness of higher education teaching.

REFERENCES

1. Tao, Y. and Shang, C., Enlightenment of CDIO outline to innovation of higher engineering education. *China Higher Educ. Research*, 11, 2, 81-83 (2006).
2. Hao, X., Research on reform of practical teaching model of social sports major. *J. of Wuhan Sports University*, 45, 12, 98-100 (2011).
3. Xiong, H., Exploration on practical teaching model and long-term mechanism of ideological and political theory in universities. *Studied in Ideological Educ.*, 23, 11, 50-53 (2012).
4. Ma, Y., Thinking on construction of practical teaching model of management major in high vocational colleges. *J. of Shanxi Youth Vocational College*, 19, 2, 32-35 (2010).
5. Zhang, J., Several patterns of practical teaching model of higher vocational education and forecast of research trend. *Vocational & Technical Educ. Forum*, 20, 3, 40-43 (2006).
6. Zhang, X., Exploration and innovation of practical teaching model of ideological and political theory course - take the course *Mao Zedong Thought and Theoretical System of Socialism with Chinese Characteristics*. *Ideology Theory Educ. Guide*, 26, 7, 79-81 (2012).