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The Teaching Reform and Practice of Professional Courses for Engineering Students

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Abstract: Higher education is at the top of the educational hierarchy. With the booming development of the economy and society in China, its scale is also expanding greatly. Professional course teaching is a key component of higher education, and it plays a vital role in cultivating professionalism and even the overall level of students. According to several problems existing in the current teaching practice of professional courses at our universities, in order to improve the teaching quality to meet the requirements in the emerging engineering era, related strategies and approaches for teaching reform are proposed as follows. Firstly, we advance the traditional classroom teaching into the modern one with equal double-subjects of teachers and students to cultivate the active and comprehensive learning ability of students. Secondly, the scientific research practice-oriented teaching method is introduced, and it contributes to connecting theory with engineering practice for students. Thirdly, the diversified course assessment system is explored, and a closed-loop quality control strategy is discussed on the basis of a questionnaire survey and face-to-face interview. By questionnaires and final assessments, it is clear that teaching qualities of related professional courses are satisfactory in recent years, and the methods and strategies can be widely applied to the teaching practice of other courses.

Keywords: Teaching reform; Professional courses; Engineering; Teaching mode; Higher education

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1. Introduction

Currently, with the national economic prosperity and social progress, high-caliber talents in our country are in urgent demand, promoting the development of higher education. As universities bear the key responsibilities for shaping skilled professionals, it is now been an urgent task for them to cultivate large groups of innovative as well as entrepreneurial talents to adapt to today's rapid social development [1,2].

Since undergraduate enrollments began expanding thirty years ago, there has also been a substantial growth in graduate education lately. China has no doubt grown into the largest scale of university students around the globe. However, the contradiction between cultivating quality and cultivating quantity is also increasingly prominent [3]. At present, along with the rapid development of modern science and technology, higher and more comprehensive

requirements for the quality of higher education have been put forward compared to previous standards [4]. Professional course teaching is the cornerstone of the entire cultivating systems at universities [5,6]. Therefore, it is of great significance to explore the proper teaching mode and methods, which are suitable for the real national and school conditions, as well as help to guarantee and improve the teaching quality of professional courses. Related strategies and approaches can also be applied to the teaching process of other corresponding courses.

2. Current issues in professional course teaching

Based on our practice, the following typical issues can be summarized during the teaching process of engineering professional courses.

2.1. How to ensure teaching quality in the face of reduced teaching hours

For many engineering majors, with the rapid development of new disciplines such as Big Data and Artificial Intelligence, courses combined with new technologies and methods are emerging rapidly in major cultivation programs. It results in the trends of professional courses along the direction of more diversification and fewer teaching hours. However, the general requirements for students in the syllabi have not decreased, and even increased with the development of new technologies, which also means that the learning difficulty of related courses for students has increased. Therefore, there is a contradiction between the reduction of teaching hours and the guarantee of teaching quality.

2.2. How to handle the relationship between teachers and students in classroom teaching properly

Based on the abundant and convenient learning resources on the Internet, many students are not ignorant of the course contents. However, there still largely exist traditional cramming teaching methods at our universities at present. This is extremely detrimental to the cultivation of innovative and creative thinking, independent learning, and practical ability of college students. Therefore, it is necessary to dilute the dominance of teachers and promote the status of students in classroom teaching, so that it will gradually evolve into a mutually beneficial relationship between these two subjects in classrooms. In other words, it is essential to really invite students into classrooms and improve their enthusiasm and initiative in learning.

2.3. How to combine classroom teaching with scientific research practice

For many engineering courses, curriculum theories and engineering practice are inseparable. However, in the current teaching practice, there is a general phenomenon of separation between these two aspects. Instructors tend to emphasize theories over practice in classroom teaching. The so-called “linking theory with practice” is mostly just adding a few verification experiments. This kind of teaching is not convenient for students to understand and master the theoretical knowledge of the courses in a comprehensive and systematic way, and it is also unhelpful to cultivate their ability in innovative scientific research and practice. Therefore, how to combine theoretical knowledge of the courses with scientific research practice is one of the key issues related to cultivating compound talents with strong innovation and practical abilities.

2.4. How to assess grades and construct teaching quality control systems scientifically

At present, there are many subjective and arbitrary elements in the assessment of professional course grades. Most of the final grades come from final exams or papers, and the usual performance grades are only evaluated

by course assignments or even class attendance. Scientific, objective, and comprehensive grade assessments can effectively stimulate the learning enthusiasm and initiative of students. In addition, the construction of closed-loop control systems for teaching quality control has received wide attention in educational circles nowadays [7,8]. However, how to construct the key feedback mechanisms in the above systems and make them operable is a question worth exploring in detail.

3. Methods and realization of teaching reform in professional courses

In contrast to traditional teaching techniques, the reformed approaches could make a good combination between in-class education and off-class self-study, as well as theoretical studies and scientific research practice. After classroom discussion among students, students and teachers analyze and explore the ways to solve various problems to help students acquire knowledge, obtain experience, and master the basic principles of professional courses more deeply. The specific contents of our reform approaches and practice can be elaborated as follows.

3.1. Transformation from traditional classroom teaching to double-subject teaching mode

In view of the fact that most of professional courses are offered to senior college students, who have already mastered the basis of professional theoretical knowledge of their own majors, and most engineering professional courses are oriented to the practical engineering applications, it is particularly well-suited for students to engage in presentation as well as discussion, and therefore master the course through self-study, group study, and discussion with teachers. Only by this means could the class be transferred from the traditional one-way teaching into a double-subject mode, which benefits the cultivation of students' comprehensive learning capabilities.

During each chapter's classroom instruction, teachers would first give the introduction, basic knowledge, and methodologies, then give the engineering applications as well as case studies, allowing students to choose according to their knowledge interest. Students could group themselves as they pleased. Through self-learning, group learning, and online and face-to-face meetings with teachers, they could dig into textbooks, search for scholarly works, or carry out research outside of class. Students are also required to give presentations in class with PowerPoint to declare general concepts, implement approaches, and provide solutions. After the presentation, there would be several minutes for the students to discuss and for the teachers to direct generally and answer the questions. Lastly, there would be peer reviews for students to evaluate the presenting groups or students.

When a course ends, several paper topics about the course are listed for students to pick. Those papers would require literature reviewing, material searching, data gathering, as well as question analyzing skills. Papers would be turned in at the end of a course, fully leveraging the edges of the dual-subject teaching mode, turning the students into the leading role in the procedure, as demonstrated in Figure 1.

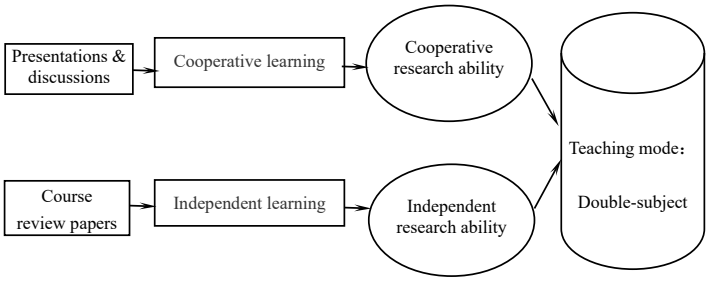

Figure 1. Diagram of dual-subject teaching mode

3.2. Scientific research practice-oriented teaching method

Most of professional course teachers have been engaged in research on course-related fields for decades. By combining students' research interests with various kinds of research projects undertaken by teachers, self-learning, research-oriented, and practical research-discussion based teaching could be conducted. Meanwhile, school-distinctive curriculum knowledge in the application of sea porting and shipping could be enhanced to improve students' interests and engagements, promoting their comprehensive understanding in the theoretical frameworks and engineering practices.

Specifically, combined with teachers' scientific research projects and engineering practice, as well as the characteristics of our universities, a special designing case base on engineering applications is designed for professional courses, which includes many practical design problems related to the courses. In the late stage of course teaching, students have almost mastered the fundamentals of the curriculum theory and methodology. Then, let them choose their own practical problems from above case base based on their interests, conduct literature retrieval, establish mathematical models according to engineering data provided by the case base, solve these models by methods learned in course teaching, as well as analyze and sort out the obtained results. Finally, complete curriculum design reports are requested to be written, which can be recorded as part of the course final assessments. At the same time, students are encouraged to enrich and improve the relevant research in the design reports for publishing papers or applying for patents.

All of these can not only help students to utilize the course theoretical knowledge in practice, but also further improve students' ability to make full use of their professional expertise to carry out project research and solve real engineering problems, as well as stimulate students' interests in autonomous learning and scientific research practice.

3.3. Diversified assessments and closed-loop teaching quality control system

Research-practice-oriented, teacher-student dual-subject teaching methods should be validated through an unbiased and objective course assessment system. Such a system could help students to consistently apply their effort throughout the semester instead of relying on the last minute before the final exams.

Thanks to the teaching reform, students' grade is now comprehensively assessed based on course reviewing paper that takes up for approximately 20% of total score; classroom PPT presentation and discussion that takes up for approximately 30%; course project design report that takes up for approximately 20%; and the final exam that takes up for about 30%. Such an evaluation system largely prevented rote study and encouraged free research.

More specifically, the quality of the reviewing papers and course project design reports would be evaluated from the dimensions of innovation, difficulties, and quality of the content, attitudes, and formatting. The PowerPoint would be estimated by the Delphi Method [9], incorporating assessments from three parts: teacher assessment accounting for 60%, self-assessment accounting for 20%, and peer assessment accounting for 20%. For the final examination, the score would be determined by the model answer.

Additionally, in terms of the presentation section, teachers would merely estimate from students' preparation, oral presentation, as well as the afterwards questioning and discussions. The designed grading chat would give self-estimation and peer estimation. The grading chat aims for four main sections: the questioning ability, the problem-solving ability, teamwork, and expression. Several secondary indicators are designed for the four sections above.

Therefore, the final grades of the students are fair, objective, and diverse. Scores from all sections that are mentioned above formed the final grade, which also provides teachers and educators with an objective final achievement of the course.

At the end of each curriculum, teachers would distribute questionnaires directly in class or online. They would also conduct interviews with student representatives. The results of those questionnaires and feedback from the interviews would be submitted to the teachers and the educating group together with the final score. Those in general would build a closed-loop educating quality control system and boost the continuous upgrade of the course, as shown in Figure 2.

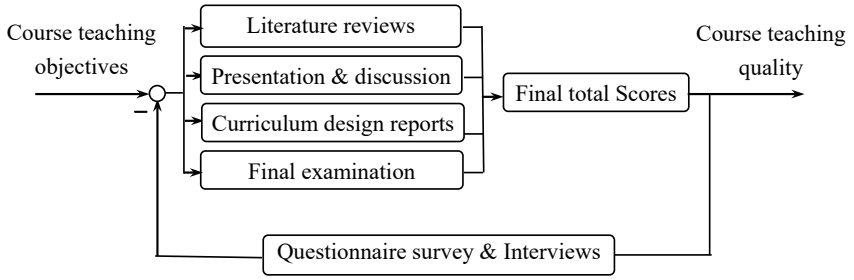

Figure 2. The closed-loop teaching quality control system with feedback from questionnaire surveys and interviews

4. Conclusion

With the rapid development of national economy and society, under the background of higher and more comprehensive requirements proposed for cultivating quality of all kinds of students at universities, based on our teaching practice, we put forward relevant teaching reform approaches and strategies in view of several problems existing in the teaching of professional courses for engineering students. The main contents include promoting the development of classroom teaching mode with equal double subjects of teachers and students, carrying out scientific research practice-oriented teaching method, as well as constructing diversified assessment mechanisms and a closed-loop teaching quality control system. In the past five years, i.e., from 2020 to 2024, the average scores of six professional courses taught by authors are all over 70 points. According to the past five years' questionnaires, the proportion of students who were "very satisfied" or "satisfied" with the courses was over 80%. The satisfaction ratios are stable and have increasing trends year by year. None of the students chose "dissatisfied", and the rest of them chose "basically satisfied." We have received three province-class and six school-class education reform projects, and two professional courses were awarded Provincial First-class courses.

From the above data and awards, it is clear that the teaching reform approaches and measures have made certain achievements in practice. They can effectively stimulate students to devote to creative learning and scientific research, as well as strengthen the combination of course theoretical knowledge and scientific research practice. All of these are more conducive to the cultivation of all-round qualified talents. The relevant measures and methods can be widely applied to other professional courses, which are also expected to provide inspiration and reference for the teaching reform of compulsory courses for engineering students.

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Disclosure statement

The authors declare no conflict of interest.

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