Research on Teaching Mode Reform of Fluid Mechanics Under the Consideration of Engineering Education Certification

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Abstract. Student-centered, output-oriented and continuous improvement education is the fundamental idea of engineering professional certification. Those philosophy should be thoroughly applied throughout the whole training program, the establishment of training objectives, curriculum system, graduation requirements, teaching evaluation and quality assurance system all shall fit the demand of engineering professional certification. Under the consideration of combining the teaching mode reform with daily education activities and engineering professional certification, combining the teaching mode reform with the development of "new engineering", it is necessary to carry out in-depth reform of fluid mechanics course, to summarize all kinds of reform and to apply them in practice, for continuously improvement.

Keywords: Engineering education certification · Teaching mode reform · Fluid mechanics course · Talent development

1 Introduction

Engineering education professional certification is carried out in view of professional expertise evaluation for undergraduate engineering education. It is designed to improve the quality and adaptability of graduates, to make sure they could achieve industry recognition of the established quality standards, in order to achieve the international engineering education and international quality recognition. The core concept of engineering education certification standards include three fundamental philosophy: the student-centered education concept, output oriented education system [1] and the continuous improvement of quality. It is the current major challenge to develop composite talent with the engineering practice and innovative scientific research abilities. It is also the current major challenge in the higher engineering education to coordinate engineering education certification with traditional teaching process, to reform and innovate.

The certification of engineering education emphasizes the three core concepts of "output oriented", "student oriented", and "continuous improvement [2]". It is essential

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to build an "output oriented" talent training system. "Students can solve complex engineering and technical problems" is particularly emphasized in the graduation requirement. Therefore, with the help of the certification concepts and standards of engineering education, we can establish effective operating mechanisms for energy and power engineering, clarifying responsibilities from various management levels and jointly managing them effectively. It is essential to improve the level of professional construction gradually and lay a solid foundation for further first-class professional construction [2].

Fluid mechanics is one of the most important basic course in many engineering professions. It also plays significant important role in the training of professional talents of energy and power engineering. Professional knowledge and practical skills, important basis for related engineering discipline theory, are provided in Fluid mechanics, clearly with the combination characteristics [3] of theory with practice. However, with the industrial upgrading and techno-logical change in the recent years, the problems of Fluid mechanics course has exposed: latest actual projects are not involved, the education evaluation system is not perfect enough and the requirements of the engineering education accreditation cannot be satisfied. Therefore, combined with the talent training goals and graduation requirements of related majors in fluid mechanics courses, and focusing on the professional certification standards of engineering education, the teaching content, teaching methods and teaching evaluation systems of fluid mechanics courses [4] will be reformed, and the teaching and training mode shall be transformed from traditional knowledge transmission to the training of compound professionals with strong engineering practice ability and high comprehensive quality.

2 Fluid Mechanics Course

2.1 Objective and Characteristics

The discipline of fluid mechanics is not only a basic discipline, but also a widely used applied discipline, which is closely integrated with various engineering majors and has extensive cross-penetration with other disciplines. On the one hand, this course contents highly theoretical, conceptually abstract content, on the other hand, engineering and application are also important aspect in this course, focusing on the combination of theory and practice, principle and application. It is essential to cultivate students' professional basic theory and analysis methods, it is also closely related to engineering practice. Course tasks include: (1) learn how to use the basic theory of fluid mechanics and the method to analyze, research and solve practical problems, and create solid foundations for the future study of uprising science and technology; (2) develop the students' dialectical-materialist worldview, cultivate students' basic analytical and problem solving skills.

Through the course, students need to master the basic concepts, knowledge and laws of fluid mechanics. Physical properties of fluid, methods for studying fluid mechanics, hydrostatics, hydrodynamics, basic laws of ideal fluid three-dimensional flow field and actual fluid flow, isentropic process of one-dimensional flow of gas and application of fluid mechanics in engineering, etc. The ability that students need to master through course include: preliminarily learn to use the basic theories and methods of fluid mechanics to analyze, research and solve practical engineering problems, abstract simple

practical engineering problems into theoretical mechanics models, establish necessary foundation for future series of subsequent courses.

2.2 Courses Status

The total number of students who is participated in fluid mechanics course reaches more than 700 person-times per year. It is an important theory course for energy and power engineering, civil engineering, mechanical engineering, chemical engineering, automation engineering and electronic engineering, etc. The fluid mechanics course group has rich teaching experience. Several kinds of course teaching mode, such as, mixed, task-based, research-based, flip type, group type, etc., are applied, comprehensively. It need to be mentioned that four majors: vehicle engineering, building environment and energy application engineering, civil engineering, machinery manufacturing and automation engineering, among whose students are participated in this fluid mechanics course, have passed engineering education certification.

2.3 Key Issue to Be Addressed

Due to enthusiasm and maturity difference of students, their adaptability to the changes of teaching environment and methods in the micro-media era is also quite different, and therefore polarization phenomenon exists. It is relatively difficult to integrate the requirements of different students' abilities, in the preparation of teaching activities. For some difficult concepts, only face-to-face traditional teaching methods is used, network learning has not been effectively integrated yet. In the independent online learning stage, it is difficult for teachers to carry out real-time monitoring, thus the learning effect cannot be guaranteed.

Traditional teaching style of student cultivation is textbooks and teachers centered, students are normally lack of learning enthusiasm and initiative, which does not reflect the engineering education certification concept of "student-centered and result oriented", resulting in weak engineering practice and innovation abilities of students. In addition, the traditional assessment and evaluation methods for courses are relatively simple, lacking real-time tracking and evaluation of students' learning effects and practical operation abilities, neglecting the evaluation of students' ability to analyze and solve practical problems.

3 Teaching Mode Reform

3.1 Diversification of Course Objectives

The fluid mechanics course is highly theoretical and conceptually abstract, it is also a course that combine theoretic with engineering, principle and application. Optimization of course objectives is extremely important, guiding the reform activities of teaching mode, as shown in Fig. 1.

Several influential factors such as school positioning, professional resource conditions, social needs, and stakeholder expectations has been considered during this optimization of course objectives. Professional teachers and employers are fully mobilized

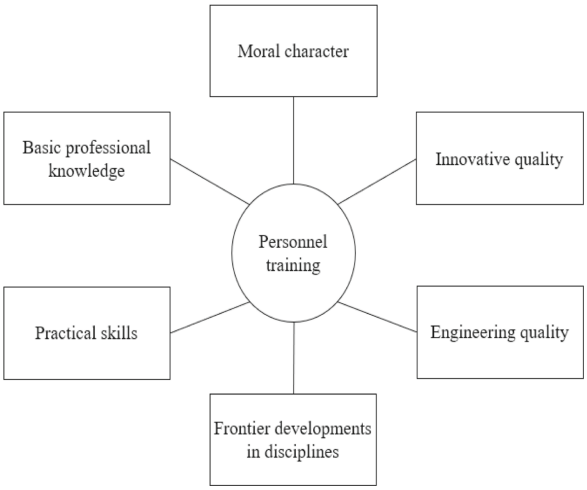

Fig. 1. Course objectives

to participate in the process of formulating course objectives. The professional course objectives is announced and well interpreted through clear public channels, so that the whole society could understand the meaning of the professional training objectives.

3.2 Case Studying

Measurable is the most important standard when it comes to students' graduation requirement, which means it no longer emphasizes whether students have achieved it, but rather tests whether they can perform. It is insufficient, unreasonable, and unscientific to rely on traditional course exams solely to evaluate students' learning outcomes. Not only does it require knowledge, but it also emphasizes the ability to apply knowledge, analyze and judge, communicate and express, and solve complex engineering problems. Introducing case based studying during the teaching process can effectively solve this problem.

Case based studying refers to the actual practice case related to the content of lesson raised before or after the teaching of the course content, through the solution of the actual practice case to deepen the understanding and application of the relevant principles or formulas. Students 'curiosity could be aroused by the proposed actual practice case before course, interest and thirst for knowledge will inspire students to think about solution of the problem, it is clearly to improve students' enthusiasm for learning, and teachers will be focused to teach targeted section when students try to solve the actual problem with certain principle or formula.

3.3 Exploratory Experiment Project

Traditional experimental course topics are mainly designed to meet the teaching requirements of the course content taught in the classroom, and are not designed to solve practical engineering problems. As long as students can apply certain parts of knowledge

Table 1. Lab course content sheet

Classification	Name	Class hour
Demonstration experiment	Hydrostatic pressure demonstration	2
Demonstration experiment	Demonstration of Bernoulli equation	2
Demonstration experiment	Demonstration of fluid flow state	2
Demonstration experiment	Flow visualization demonstration	2
Verification experiment	Momentum Theorem Experiment	1
Verification experiment	Flow rate and flow measurement experiment	1
Comprehensive experiment	Flow Resistance Measurement Experiment (in Pipe)	2

taught in the classroom, they could complete the experimental course directly without special consideration of whether there are any other problem-solving solutions available, and students are also unable to independently choose the best solution to solve the exercises. This definitely deviates from the current engineering education certification goals, which is also significantly contradicted from the teaching goals of engineering education certification in China. The content of traditional fluid mechanics experiment course is shown in Table 1.

The experimental projects need to be integrated or optimized, the confirmatory experimental projects are reduced, and the exploratory experimental projects, relying on the scientific research achievements of professional teachers, are set up under the guidance of the concept of science and education integration. Students can complete exploratory research reports based on experiments, together with literature summarization and in-group discussion. Students can effectively master the relevant knowledge of fluid mechanics during exploratory experimental report writing process. The purpose of exploratory experimental projects is to help students to construct experimental system from scratch according to their designed scheme, and to analyze, solve complex engineering problems in real application.

3.4 Combination of Subject Competition and Curriculum System

It has been become current university teaching focus in China to cultivate students' sense of social responsibility, innovative spirit, and practical ability, to strengthen the innovative awareness and ability among college students. How to apply new technologies and methods, integrate innovative awareness and ability education into daily teaching, improve teaching effectiveness, and stimulate students' learning interest are the essential goal and unremitting effort for every teacher. Subject competition is one of the methods to solve the problem of disconnection between classroom and practice. In recent years, the number of college student competition projects organized by the Ministry of Education and other organizations in China has significantly increased. And the fixed format competition guiding propositions has gradually changed. Solving practical application problems proposition is used in the National College Student Engineering Training Comprehensive Ability Competition; non guided proposition is applied in the "Challenge Cup" National College Students' Extracurricular Academic Science and Technology

Competition. Regardless of the method of proposition, the innovation application in competitions is emphasized, demanding new methods, ideas, or technologies adopted by college students in their works.

Subject competition is an extracurricular practical activity with high participation and practicability for undergraduate students, organizing students to participate in subject competition is the best test of students 'learning effect in school. It is not enough to meet the requirements of enterprises for talents only through curriculum assessment. Subject competition could be a helpful supplement. In order to encourage students to actively participate in extracurricular subject competition, various scholarship are set up, and professional teachers are assisted to guide students, to better tap students 'potential and cultivate students' innovative consciousness. Through the subject competition the initiative of students 'independent learning is fully mobilized, while enriching students' extracurricular activities.

3.5 Teaching Quality Monitoring

Teachers need to evaluate the achievement situation of course content, teaching methods, assessment content, assessment forms, and their corresponding relationship with course objectives, and analyze the learning effectiveness of students. If the course objectives have been achieved, teachers need to summarize the specific achievement situation, effective measures for future classroom teaching; and weak achieved course objectives must be analyzed to propose improvement measures. If the course objectives are not achieved, teacher will analyze the specific reasons and propose improvement suggestions, such as adjusting the course objectives, teaching content, teaching methods, assessment methods, accordingly, then implement them in the next teaching round. The monitoring of teaching quality is inseparable part of assessment mechanism. A reasonable and sound curriculum assessment and evaluation system plays a crucial role in the cultivation of students' abilities in schools. The overall implementation plan for teaching quality monitoring is shown in Fig. 2.

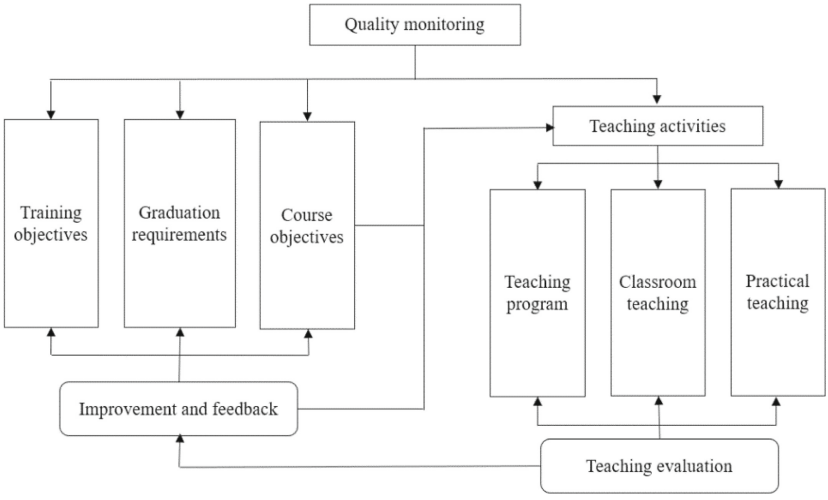

Fig. 2. Teaching quality monitoring

4 Conclusion

According to the engineering education certification standards and training requirements, and the current problems encountered during the fluid mechanics course teaching process, a series of in-depth exploration and reform have been carried out, optimizing the teaching methods and teaching content, strengthening case studying, strengthening students' participation, and optimizing the assessment and evaluation mechanism, to make this course more suitable for the needs of contemporary application-oriented talent training. The comprehensive teaching reform has significantly improved the teaching quality, teaching means, practical skills and professional level of teachers. Through this exploration of teaching mode reform, reference is provided for the certification of engineering education in relevant universities and the improvement of the training quality of engineering talents.

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