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Exploration and Practice of Teaching Reform in the Blended Teaching Mode of the Course "Engineering Fluid Mechanics"

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ABSTRACT

This study focuses on the course of Engineering Fluid Mechanics, deeply analyzes the deficiencies of the traditional teaching mode, and systematically elaborates the construction and implementation of the online and offline blended teaching mode. The research involves the selection of teaching platforms, the construction of teaching resources, the elaborate design of the teaching process, the innovation of assessment methods, and the organic integration of curriculum ideology and politics. By comparing the effects before and after the teaching practice, this study reveals the significant advantages of the blended teaching mode in improving students' learning achievements, teaching quality, and the effect of curriculum ideology and politics. At the same time, the article also comprehensively analyzes the problems encountered in the reform process and proposes targeted solutions.

KEYWORDS

Engineering Fluid Mechanics; Blended Teaching; Teaching Reform; Curriculum Ideology and Politics; Teaching Quality Evaluation

1 Introduction

In the current era of rapid development of engineering technology, Engineering Fluid Mechanics, as a cornerstone course for engineering majors, plays a crucial role in cultivating students' engineering literacy and practical problem-solving abilities. The effective teaching of this course has a profound impact on students' future engineering practice and the development of their innovative capabilities. The traditional teacher-centered teaching mode is gradually showing limitations in stimulating students' active learning and innovative thinking, and it is difficult to meet the needs of innovative talents in the new era of engineering education. The rapid development of information technology has promoted changes in the field of education, and the online and offline blended teaching mode has emerged, bringing new opportunities for the teaching reform of the Engineering Fluid Mechanics course. It integrates high-quality online resources and offline interactive teaching, which can not only improve teaching effectiveness but also stimulate students' learning interests and strengthen their comprehensive abilities, so as to better meet the urgent needs of the engineering field for compound talents.

This study explores and practices the blended teaching reform of the Engineering Fluid Mechanics course, analyzes its potential in improving teaching quality, stimulating students' learning interests, and enhancing students' comprehensive abilities. Through this reform, we hope to provide new ideas for the teaching of Engineering Fluid Mechanics and contribute to the cultivation of high-quality engineering talents required in the new era.

2 Construction of the Teaching Mode

In the teaching reform of the Engineering Fluid Mechanics course, a teaching mode of "three goals guiding, two dimensions integrating, six links organically linking, and multiple dynamic process assessment" has been constructed. This mode focuses on the in-depth integration of theory and practice, ensuring seamless connection between teaching activities in theoretical learning and practical operations. The three teaching goals of knowledge, ability, and quality are established to guide students to understand the basic principles of fluid mechanics and apply them to solve practical engineering problems. Multiple teaching modes such as online learning, online and offline blending, offline reporting, and the BOPPPS teaching model are used to improve students' participation and practical abilities. According to the characteristics of the students' learning situation each year, a dynamic process learning achievement assessment system covering online learning participation, classroom interaction performance, homework and project completion status, and formative evaluation is designed to comprehensively evaluate and promote students' learning achievements. The teaching mode is shown in Figure 1.

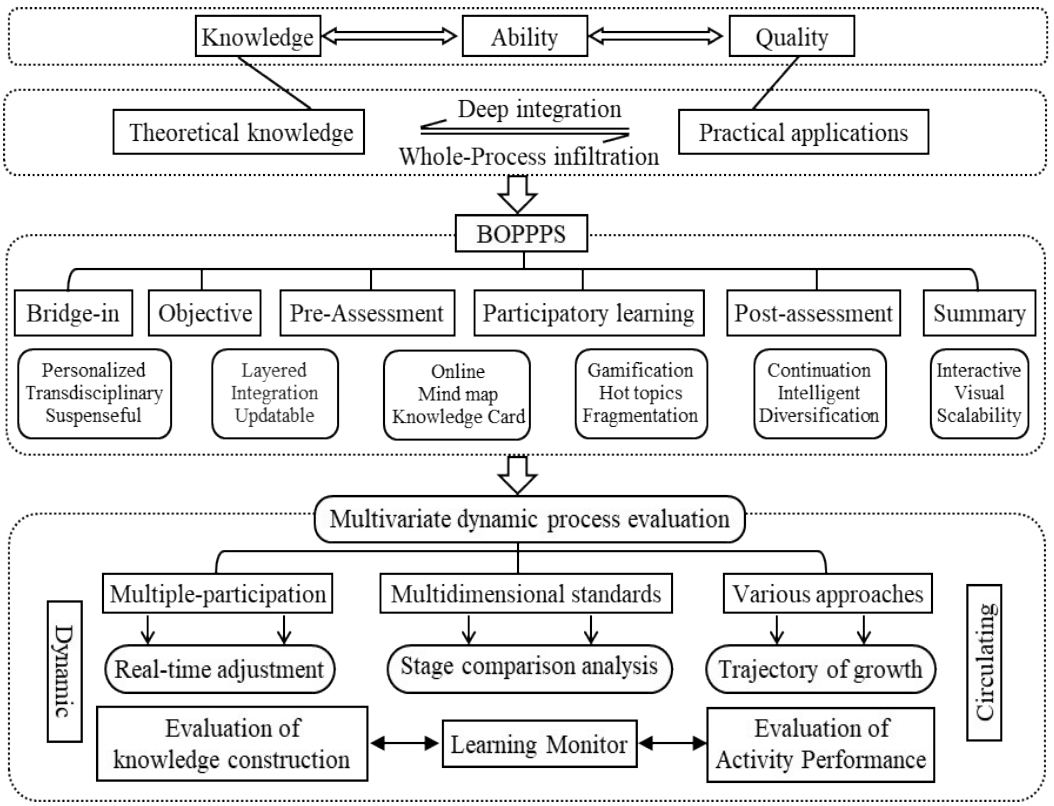

Figure 1 Integrated Teaching Mode of Engineering Fluid Mechanics

2.1 Three Goals Guiding

The teaching reform of the Engineering Fluid Mechanics course sets three goals of knowledge, ability, and quality to construct the teaching framework[1]. At the knowledge level, it helps students master basic concepts, principles, and formulas, understand the characteristics and pressure distribution of fluids, and derive dynamic equations, laying a solid theoretical foundation. In the ability dimension, through case analysis and experimental teaching, students' abilities to use

principles to solve engineering problems, innovative thinking, independent experimental design, engineering thinking, teamwork, and communication are enhanced to meet engineering challenges and enhance comprehensive qualities. Guided by the three goals, it paves a solid path for students' continuous learning, all-round development, and future careers.

2.2 Two Dimensions Integrating

The teaching implementation of the Engineering Fluid Mechanics course adopts a two-dimension integration strategy, integrating theoretical knowledge and practical applications. For example, basic theories such as the principle of buoyancy are integrated with engineering cases such as ship design to promote knowledge transfer. Project-based teaching is adopted, and a project such as the design of the fluid conveying system in a sewage treatment plant is used to improve students' practical abilities. Experimental teaching is synchronized with theoretical learning.

For example, when conducting the Reynolds experiment, in-depth explanations of relevant theories are combined to strengthen the teaching effect of the combination of theory and practice, ensuring that students can effectively transform theoretical knowledge into the ability to solve practical engineering problems[2].

2.3 Six Links Organically Linking

The BOPPPS teaching model is adopted to improve the learning experience and effectiveness, and it is implemented through six organically connected links: introducing relevant engineering problems or life phenomenon videos to stimulate interest; setting clear, specific, and measurable goals; pre-testing to evaluate the degree of prior knowledge mastery and adjusting teaching strategies; conducting participatory learning through group discussions, case analyses, experimental operations, etc., and interacting on the online platform; post-testing to evaluate the results and provide feedback; summarizing and reviewing key contents, cases, and training achievements, and assigning homework and preview tasks to ensure that students actively participate and achieve the goals.

2.4 Multiple Dynamic Process Assessment

In the construction of the assessment system for the Engineering Fluid Mechanics course, a diversified and dynamic assessment model is carefully designed to comprehensively capture and reflect students' learning achievements.

This model covers two dimensions of learning behavior (such as online participation, classroom interaction, homework projects, and formative evaluation) and ability expansion (interdisciplinary, innovative thinking, self-evaluation and peer evaluation), integrates curriculum ideology and politics, and examines students' knowledge application and professional qualities through engineering practice and ethical responsibility cases. The dynamic nature is prominent, and the assessment weights and contents are adjusted according to the learning process.

In the early stage, emphasis is placed on the foundation and attitude, and in the later stage, emphasis is placed on comprehensive application and overall quality. The evaluation method combines traditional written tests with modern electronic platforms, and uses digital technology to collect learning habits and styles to customize evaluation plans and feedback for students, creating a comprehensive, flexible, and supportive evaluation environment, which effectively promotes students' in-depth learning and all-round development and ensures the achievement of teaching goals and engineering education accreditation standards.

3 Teaching Implementation Effect and Existing Problems

Since the implementation of the blended teaching mode in the course, two teaching cycles have been experienced. By comparing and analyzing the 2020-level students before the implementation of the blended teaching mode with the 2021-level and 2022-level students after the implementation of the blended teaching mode, a comprehensive assessment and in-depth reflection are carried out around the students' learning achievements and the teaching process, in order to accurately understand the actual impact and potential improvement space brought about by the change of the teaching mode, and provide a strong basis and clear direction for the subsequent teaching optimization[4].

3.1 Teaching Implementation Effect

The 2021-level and 2022-level students used the same SPOC platform. On the basis of the 2021-level teaching, more cultivation paths for quality and ability were added. Different weights were set for each assessment item in the three teaching cycles, as shown in Table 1.

Figure 2 shows the achievement degrees of each assessment item and the comprehensive score, and Figure 3 shows the average achievement degrees of the course goals and the graduation requirements.

Table 1 Weight of process assessment items in each teaching cycle

Grade	Process Assessment Items							
	Online Learning	Assignments	Attendance	Discussion	Classroom interaction	Unit test	Experiment	Project
2020		0.05	0.025		0.025		0.1	
2021	0.1	0.1	0.025		0.025	0.15	0.1	
2022	0.05	0.1	0.025	0.05	0.025	0.1	0.1	0.05

Table 2 Weight of outcome assessment items for each teaching cycle

Grade	Result Assessment Items				
	Fill in the blanks	Multiple-choice question	True or False	Short answers	Calculations
2020	0.1	0.1	0.1	0.15	0.35
2021	0.05	0.05	0.05	0.1	0.25
2022	0.05	0.05	0.05	0.1	0.25

It can be clearly observed from the figure that since the implementation of the blended teaching mode, the implementation effects in multiple dimensions of the teaching process have shown a good upward trend.

Through the effective implementation of the blended teaching mode, students' learning enthusiasm has been significantly enhanced. As for the decrease in the achievement degrees of the unit test, choice, and judgment parts in the assessment items, the main reason is that the assessment content is deeply integrated with specific cases and social hotspots. On the basis of testing theoretical knowledge, the difficulty and depth of the assessment have been increased.

The fluctuation in the achievement degree of the comprehensive score is also attributed to the comprehensive implementation of the multiple evaluation system.

Through the organic combination of rich online resources and offline teaching activities, higher requirements are put forward for students' ability to apply knowledge and solve practical problems. Although the relevant data shows certain fluctuations, from the perspective of long-term talent cultivation, the cultivation quality of students has actually been significantly improved and leaped, laying a more solid foundation for their future development.

Figure 2 Average Achievement Degrees of Assessment Items in Each Cycle

Grade	Process Assessment Items								Result Assessment Items					Comprehensive score
	①%	②%	③%	④%	⑤%	⑥%	⑦%	⑧%	①%	②%	③%	④%	⑤%	
2020		96	98		90		90		68	80	94	92	79	87%
2021	98	90	100		95	82	95		85	82	88	94	80	90%
2022	96	94	98	85	98	79	95	80	90	78	85	90	82	88%

(Note: The items represented by the numbers in the figure correspond to the contents in Table 1)

Figure 3 Average Achievement Degrees of Course Goals and Graduation Requirements

Grade	Course objectives			Graduation requirements								
	Knowledge	Ability	Quality	①%	②%	④%	⑥%	⑦%	⑧%	⑨%	⑩%	⑫%
2020	85%	74%		85	78							96
2021	80%	84%	100%	82	84	90			100		95	98
2022	82%	86%	97%	84	86	92	83	84	96	87	96	100

(Note: The numbers in the graduation requirements represent: ①Engineering②Problem analysis④Research⑥engineering and society⑦sustainable development⑧Professional norms⑨Individual and team⑩communication ⑫Lifelong learning)

3.2 Existing Problems

(1) Uneven online participation: Although online learning provides flexibility, the online participation of some students is insufficient, which affects the learning effect. This may be due to the differences in students' autonomous learning abilities or the imperfection of the online learning environment.

(2) Limitations of experimental resources: In the practical and experimental teaching links, due to the limitations of experimental equipment and venues, some students have fewer opportunities for experimental operations, which limits the cultivation of their practical skills.

(3) Refinement of the evaluation system: Although a diversified evaluation system has been established, it is found in the implementation process that the assessment of abilities such as innovative thinking and teamwork still needs to be further refined and standardized to ensure the fairness and effectiveness of the evaluation.

(4) Transformation of the teacher's role: The teachers in charge lack effective ways to improve their teaching design ability and information technology application ability, and their understanding of the abilities required for the new role is not clear enough, which restricts the smooth transformation of the teacher's role.

4 Solutions

4.1 Improving Online Participation

To enhance the online participation of students in the Engineering Fluid Mechanics course, the following measures are recommended: First, interactive teaching activities such as online real-time Q&A, voting, and discussion boards will be integrated into the course to improve students' interactive experience and participation; second, customized learning resources and suggestions will be provided based on students' individual learning styles and progress to enhance the attractiveness and relevance of online learning materials; finally, the functionality and user interface of the online teaching platform will be optimized to improve its user-friendliness and stability, thereby optimizing the learning experience. The implementation of these strategies is expected to significantly improve students' participation and learning effectiveness in the online segment and ensure that they maintain a high degree of enthusiasm and interactivity in the virtual learning environment.

4.2 Optimizing Experimental Teaching Resources

To effectively alleviate the problem of experimental resource limitations faced by the Engineering Fluid Mechanics course, the following strategies are proposed after in-depth exploration and analysis: First, virtual experimental resources will be developed and integrated to provide a virtual environment for simulating experimental operations, thereby supplementing the shortage of physical experimental equipment and ensuring that each student has the opportunity to deepen their understanding of experimental concepts through simulated practice[5]. Second, interdisciplinary experimental projects will be designed and implemented. By encouraging students to participate in interdisciplinary teams, the integration and application of different disciplinary knowledge will be promoted, the utilization efficiency of experimental resources will be improved, students' innovative thinking and teamwork spirit will be stimulated, and their academic horizons will be broadened.

4.3 Adding Compensation Measures to the Evaluation System

To improve the fairness and incentive effect of the process assessment, a compensatory evaluation mechanism is constructed. For the submission of students' homework and online quizzes, a graded score compensation strategy is adopted. From the perspectives of balancing the 包容 of individual differences among students and maintaining academic norms, for students who fail to submit their homework in time, they are still provided with the opportunity to make up the work. However, to ensure the learning enthusiasm and motivation of students who submit their homework on time, it is recommended that a graded reduction in scores be implemented for the

make-up work. This not only reflects the fairness of education but also promotes the cultivation of students' academic integrity and sense of responsibility, ensuring the rationality and effectiveness of the evaluation system.

4.4 Improving Teachers' Professional Abilities

To ensure that teachers can effectively adapt and continuously improve their professional levels in the blended teaching environment, the following strategies are recommended in this article: Regularly hold professional development seminars and workshops to systematically improve teachers' teaching design and information technology application abilities; encourage teachers to participate in teaching research projects and improve teaching effectiveness through practice, feedback, and peer review; build an online teacher learning community to promote the exchange of teaching experiences and the collaborative development of resources[6]; at the same time, provide stable learning resources and technical support to help teachers continuously explore and innovate in teaching practice. The implementation of these strategies strives to create a supportive and incentive teacher professional development atmosphere to improve teaching quality and promote students' learning effectiveness.

5 Summary and Outlook

The blended teaching reform of the Engineering Fluid Mechanics course has successfully combined systematic curriculum design, diversified teaching methods, and a dynamic evaluation system, effectively improving students' learning achievements and teaching quality. Facing challenges such as uneven online participation, limitations of experimental resources, and refinement of the evaluation system, this study intends to continuously optimize teaching methods and evaluation systems by enhancing online interaction, introducing virtual experiments, establishing a compensatory evaluation mechanism, and strengthening teachers' professional development. Looking ahead, the teaching reform will continue to focus on improving students' learning achievements, optimizing teaching methods and evaluation systems, and deepening the integration of curriculum ideology and politics, aiming to cultivate new-era engineering talents with a strong sense of social responsibility and noble professional ethics, so as to achieve a comprehensive improvement of educational goals.

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