

# Study on Curriculum Reform of Fluid Mechanics based on OBE Concept in Civil Engineering Undergraduate Program

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**Abstract:** With the advancement of global engineering education standardization, the teaching quality and talent cultivation model for applied undergraduate civil engineering programs urgently require optimization. As a core course in civil engineering, fluid mechanics has long suffered from issues such as the disconnect between theory and practice, monotonous teaching methods, and an imperfect assessment system, making it difficult to effectively cultivate students' engineering practice capabilities and innovative thinking. Based on the OBE (Outcome-Based Education) philosophy, this paper proposes a series of curriculum reform strategies for fluid mechanics courses, including clarifying learning outcomes, optimizing syllabi, adopting seminar-style teaching models, improving assessment systems, and strengthening faculty development. The reform practices demonstrate that this approach significantly enhances students' self-directed learning abilities, practical operational skills, and innovative thinking capabilities. It provides robust support for cultivating engineering application-oriented talents while offering valuable references for curriculum reforms in other engineering disciplines.

**Keywords:** OBE Philosophy; Fluid Mechanics; Curriculum Reform; Engineering Education; Practical Skills.

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## 1. Introduction

With the rapid development of global engineering education, particularly the promotion of international standards like the Washington Accord, China's engineering education is progressively advancing towards internationalization and standardization. As a crucial base for cultivating applied engineering talents, the teaching quality and effectiveness of applied undergraduate civil engineering programs directly impact technological progress and innovation capabilities in China's construction industry [1]. Fluid mechanics, as a core course in civil engineering, is not only highly theoretical but also widely applicable, playing a vital role in developing students' engineering literacy and comprehensive capabilities. For instance, in industrial and civil buildings, groundwater and wind loads significantly influence structural stability. Knowledge of fluid mechanics guides proper design and construction practices, preventing issues like foundation pit collapse and ground seepage. In road and bridge transportation, fluid mechanics helps address water's impact on subgrade stability and continuous damage to piers caused by water flow in bridge designs. Additionally, fluid mechanics plays a key role in high-rise building design and construction. By applying fluid mechanics principles appropriately, complex challenges such as wind load analysis can be scientifically resolved [2]. However, traditional fluid mechanics education tends to emphasize theoretical knowledge transmission while neglecting the cultivation of students' practical skills and innovative capabilities, resulting in students' lack of problem-solving competence when facing real-world engineering challenges [3]. Therefore, curriculum reform for fluid mechanics based on OBE (Outcome-Based Education) principles has become particularly crucial.

This study explores the implementation of OBE-based curriculum reforms in fluid mechanics courses for applied undergraduate civil engineering students. Through optimizing

course structures, innovating teaching methodologies, and refining evaluation systems, the initiative aims to enhance students' self-directed learning capabilities, practical skills, and innovative thinking, thereby addressing the construction industry's urgent demand for high-caliber engineering professionals. Additionally, this research provides actionable insights for curriculum reform in similar disciplines.

## 2. Introduction to OBE

The OBE (Outcome-Based Education) philosophy is an educational approach that prioritizes learning outcomes, emphasizing the reverse design of teaching processes [4]. It requires educators to first clearly define the academic achievements students should attain upon completing their studies, then design curricula, teaching methods, and assessment systems backward from these goals. This ensures instructional activities directly target and achieve predetermined learning objectives. The core of OBE lies in "student-centeredness" – all teaching practices, curriculum content, and evaluation methods should focus on student development rather than merely focusing on how teachers deliver knowledge [5].

Under the OBE framework, educators must first define the competencies, knowledge, and qualities students should acquire upon completing their courses or degrees. These outcomes must demonstrate clarity, measurability, and attainability. Subsequently, they need to design a series of instructional activities, curriculum content, and assessment methods to help students achieve these goals. These activities, content, and implementation approaches should closely align with students' practical needs, aiming to stimulate learning interest while fostering self-directed learning and innovative capabilities [6].

The OBE philosophy also emphasizes the importance of continuous improvement and feedback mechanisms. Educators need to regularly assess students' learning

outcomes and collect their feedback to adjust teaching strategies and curriculum content in a timely manner, ensuring that educational activities consistently promote students' development [7].

In general, the OBE concept provides educators with a new perspective and approach to focus more on students' learning outcomes, design more effective teaching activities, and develop students' self-learning and innovation abilities to adapt to the rapidly changing social and economic environment.

### 3. Problems Existing in Traditional Fluid Mechanics Teaching

(1) Disconnection between theory and practice: lack of application of knowledge

In traditional fluid mechanics education, theoretical instruction dominates while practical application remains marginalized. Although students systematically acquire fundamental principles, equation derivations, and theoretical models in classrooms, this knowledge often remains abstract and rarely integrates with real-world engineering challenges. This disconnect between theory and practice leaves students struggling to apply their learning to solve practical problems, ultimately limiting their problem-solving capabilities.

The disconnect between theory and practice manifests in three key aspects: First, students rarely get opportunities to convert theoretical knowledge into practical skills, making it difficult for them to fully grasp and effectively apply what they've learned. Second, lacking hands-on experience, they often feel overwhelmed when tackling complex engineering challenges involving interdisciplinary integration, system coupling, and multifaceted factors, resulting in both capability gaps and confidence issues. They may not have mastered critical skills like comprehensive analysis, simulation modeling, optimization design, and intelligent control – all essential for solving complex engineering problems. Finally, this disconnect can dampen students' motivation and interest in learning, as they perceive their studies as disconnected from real-world applications, leaving them uncertain about the practical value of their education.

(2) Single teaching method: lack of students' initiative

Traditional teaching methods predominantly rely on lecturing by teachers while students passively absorb knowledge, lacking opportunities for active exploration and practical application. This monotonous approach not only fails to spark students' interest in learning but also hinders the development of critical thinking and innovative capabilities. In fluid mechanics education, when instructors solely use lectures and blackboard notes to deliver content, students often find the instruction tedious and struggle to maintain focus.

This monotonous teaching approach may gradually erode students' ability to think independently and solve problems. As learners become accustomed to passive knowledge absorption, they often lack the initiative and capacity for self-directed exploration and practical application. This challenge is particularly pronounced in fluid mechanics—a discipline that combines strong theoretical foundations with broad real-world applications. To deepen their understanding and practical application of knowledge, students need more hands-on engagement through experiments, simulations, and case studies.

(3) Imperfect assessment and evaluation system: lack of

ability assessment

Traditional assessment methods predominantly rely on exams and assignments, often overlooking the evaluation of students' practical skills and innovative capabilities. This evaluation system tends to emphasize the memorization and reproduction of theoretical knowledge while failing to adequately address students' hands-on competencies and creative thinking. As a result, students become overly fixated on exam scores, thereby neglecting the cultivation of practical abilities and innovative thinking.

An imperfect assessment system can lead to several detrimental consequences. Firstly, it may cause students to focus excessively on exam scores while neglecting practical application and innovation in the learning process. Secondly, overly narrow evaluation criteria might fail to comprehensively reflect students' true capabilities and competencies. Lastly, such an assessment framework could dampen students' motivation and interest in learning, as they might perceive education merely as a test-preparation exercise lacking real-world value and significance.

In summary, the existing issues in traditional fluid mechanics education primarily include the disconnect between theory and practice, monotonous teaching methods, and an imperfect assessment system. These problems not only reduce students' learning outcomes and interest but also hinder their ability to solve practical problems and develop innovative capabilities. Therefore, it is particularly crucial to reform and innovate traditional fluid mechanics education.

### 4. Teaching Reform Strategies of Fluid Mechanics based on OBE Concept

(1) Clarify learning outcomes: Construct an OBE framework for fluid mechanics courses

Guided by the OBE philosophy, the primary objective of curriculum design is to clarify students' learning outcomes, ensuring that teaching content, methods, and assessment approaches all focus on enhancing students' competencies and meeting graduation requirements. For fluid mechanics—a course with profound theoretical foundations and practical orientation—the definition of learning outcomes must be comprehensive and specific, aiming to cultivate students' integrated capabilities. Specifically, the learning outcomes of fluid mechanics courses should encompass the following core aspects:

Theoretical knowledge mastery: students should have a deep understanding of the basic principles, basic equations and derivation process of fluid mechanics, including but not limited to fluid statics, dynamics, flow resistance and energy loss, similarity principle and dimensional analysis of fluid, etc., so as to lay a solid theoretical foundation for subsequent professional study and work.

Practical operation ability: Through course experiments, computer simulation and engineering case analysis, students can skillfully use fluid mechanics experimental equipment, master the methods of fluid flow observation, data recording and analysis, as well as the ability to use professional software for fluid flow simulation, so as to deepen the understanding and application of theoretical knowledge in practice.

Ability to analyze and solve problems: cultivate students' ability to use the principles of fluid mechanics to analyze practical engineering problems, including problem identification, mathematical modeling, numerical simulation or experimental verification, and solution based on analysis

results.

**Innovation ability:** encourage students to explore new technologies and methods in the field of fluid mechanics, stimulate their innovative thinking, and cultivate their ability to seek innovative solutions to complex engineering problems, so as to lay a foundation for future scientific research and engineering practice.

The clarification of these learning outcomes not only provides a clear goal orientation for curriculum design, but also provides a solid foundation for the optimization of teaching content, the selection of teaching methods and the construction of evaluation system.

(2)Optimizing syllabus and teaching content: deep integration of theory and practice

Based on the above learning outcomes, the syllabus and teaching content of fluid mechanics course need to be systematically optimized to ensure the deep integration of theoretical knowledge and practical operation. Specifically, the optimization strategies include:

**Theoretical and Practical Integration:** The curriculum design balances theoretical knowledge with practical application, ensuring students gain both academic mastery and hands-on experience. For example, fluid statics instruction incorporates pressure measurement experiments to demonstrate pressure distribution patterns, while fluid dynamics classes utilize pipe flow simulations to analyze velocity patterns, flow rates, and pressure loss relationships.

**Case analysis is introduced:** select practical engineering cases, such as bridge wind tunnel test, hydropower station turbine efficiency analysis, etc., and integrate them into theoretical teaching, so that students can understand the application background of theory in engineering, and enhance the practicality and pertinence of learning.

**Enhancing Experimental and Project-Based Learning:** By introducing hands-on courses and project-based learning modules—including fluid flow simulation software operations and fluid machinery performance testing experiments—students can effectively develop practical skills through hands-on practice. This approach not only sharpens their technical abilities but also significantly boosts their problem-solving capabilities. Furthermore, encouraging students to participate in research projects or innovation competitions allows them to apply theoretical knowledge to real-world challenges, further cultivating innovative thinking and practical problem-solving competencies.

Through these optimization measures, the aim is to build a fluid mechanics curriculum system that pays attention to both theoretical depth and practical application, so as to provide a strong support for cultivating civil engineering professionals with solid theoretical foundation, skilled practical skills and good innovation ability.

(3)The seminar teaching model: stimulate thinking and promote cooperative learning

As an advanced teaching methodology, the seminar-style instructional model focuses on skillfully designing thought-provoking questions to stimulate in-depth discussions. This approach not only activates students' cognitive abilities but also fosters teamwork and collaborative learning. In fluid mechanics courses, this pedagogical approach proves particularly vital—it effectively enhances students' academic engagement while cultivating critical thinking and articulate communication skills.

In fluid mechanics classes, educators can spark students' curiosity and drive through carefully designed curriculum-

aligned questions like "How does Bernoulli's equation explain aircraft lift?" or "What factors influence fluid resistance in pipeline flows?" These prompts are followed by group discussions where students brainstorm ideas, debate perspectives, and collaborate to find solutions. This teaching approach not only reinforces theoretical understanding but also cultivates teamwork skills and problem-solving abilities.

Furthermore, through case studies and hands-on experiments, the seminar-style teaching model significantly enhances students' practical skills and innovative thinking. For instance, instructors can select representative fluid mechanics engineering cases for group analysis and discussion, exploring the underlying scientific principles and real-world applications. Simultaneously, experimental sessions allow students to validate theoretical knowledge through practice, cultivating both technical proficiency and laboratory design capabilities.

(4)Improve the assessment and evaluation system: diversified evaluation to comprehensively reflect learning outcomes

In order to comprehensively evaluate students' learning outcomes, it is crucial to establish a diversified assessment and evaluation system. In the fluid mechanics course, in addition to traditional examinations and assignments, there should also be experimental operation assessment, project practice assessment and innovation ability assessment.

The experimental operation assessment evaluates students' hands-on skills and experimental design capabilities, ensuring they can translate theoretical knowledge into practical applications. The project-based practical assessment requires students to apply their acquired knowledge to solve real-world problems, cultivating both engineering practice skills and teamwork spirit. The innovation assessment encourages students to propose novel perspectives and solutions, fostering innovative thinking and critical reasoning abilities.

Through the diversified assessment and evaluation system, it can not only comprehensively reflect students' learning outcomes, but also stimulate their learning motivation and creativity, laying a solid foundation for future study and work [8].

(5)Strengthen the construction of teachers: improve professional quality and promote teaching reform

Teachers are the implementers of curriculum reform, and their quality and ability directly affect the effect of curriculum reform. Therefore, strengthening the construction of teachers is the key to promote the teaching reform under the concept of OBE.

First, educators should be encouraged to participate in various training programs and academic exchanges to continuously enhance their professional expertise and teaching capabilities. Second, establishing an incentive mechanism for teachers will motivate them to actively engage in educational reforms and research activities, thereby boosting their teaching enthusiasm and innovative capacity. Finally, strengthening collaboration and communication among faculty members is crucial to jointly explore teaching methodologies and approaches that align with the Open and Blended Education (OBE) philosophy, driving the continuous reform and development of fluid mechanics courses [9].

## 5. Analysis of the Effect of Reform Implementation

Through implementing OBE-based reforms in the fluid

mechanics curriculum for applied undergraduate civil engineering programs, we have observed a series of positive changes. Students' learning enthusiasm and classroom participation have significantly increased, evolving from passive knowledge recipients to active explorers and problem solvers. In practical and innovative capabilities, students demonstrate enhanced performance by flexibly applying acquired knowledge to solve real-world problems and propose creative solutions. Moreover, teachers have greatly benefited from this reform, with their teaching proficiency markedly improved and educational quality enhanced to better meet the new demands of modern higher education. These remarkable outcomes unequivocally prove the practical effectiveness and high feasibility of OBE principles in fluid mechanics curriculum reform.

The trend of mass data in power system provides a basis for load characteristic analysis and prediction model establishment, but the classical load forecasting method can not afford such a huge time and computing resource consumption. The problem of over fitting in large sample set will affect the prediction accuracy. In this paper, a power load forecasting model is built by using the BP neural network model, making full use of the powerful data processing function of Clementine and preventing the over fitting function. The experimental results show that the BP neural network model has good predictability and robustness, and has a certain practical application value.

## 6. Conclusion

The curriculum reform in fluid mechanics based on the Open and Blended Learning (OBE) philosophy plays a vital role in enhancing the comprehensive competencies of applied undergraduate students majoring in civil engineering. By clarifying learning outcomes, optimizing syllabi and content, adopting discussion-based teaching methods, refining assessment systems, and strengthening faculty development, this initiative significantly improves students' learning effectiveness and practical skills, ultimately cultivating more outstanding engineering professionals for the civil construction industry.

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