

## Original Paper

# Research on the Reform of the Course “Fundamental Principles of Engineering Structures” in the Context of School-Enterprise Cooperation and Integration of Production and Education

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### Abstract

*The course “Fundamental Principles of Engineering Structures” is one of the compulsory courses for undergraduate students majoring in civil engineering, structural engineering, and bridge engineering. It mainly introduces the basic concepts, principles, and design methods of engineering structures. The course’s emphasis lies in the integration of theory and practice, aiming to enable students to acquire fundamental theoretical knowledge of engineering structures in the classroom and to consolidate this knowledge through practical activities such as experiments and design, thereby enhancing their comprehensive abilities. Therefore, the teaching reform of the course on fundamental principles of engineering structures should start with improving students’ practical abilities and strive to achieve organic integration of theory and practice. This paper explores how the teaching reform of the course should be conducted against the backdrop of course ideological and political education, mainly focusing on the integration of school-enterprise cooperation and production-education integration. Firstly, the author analyzes the current issues and challenges from the perspectives of school-enterprise cooperation and production-education integration, and then proposes corresponding measures for the reform of course teaching, including establishing a curriculum system in line with modern engineering practices, fully leveraging the role of teaching design, and stimulating students’ interest in learning, among others. It is hoped that this research can provide some reference and inspiration for developing relevant teaching reforms in the course of fundamental principles of engineering structures.*

**Keywords**

*School-enterprise cooperation, Production-education integration, Fundamental principles of engineering structures, Teaching reform.*

**1. Introduction**

The course on Fundamental Principles of Engineering Structures is a foundational subject in engineering education and serves as a core compulsory course for students specializing in intelligent construction. It holds significant disciplinary importance. Based on an analysis of student learning situations and the current state of theoretical courses, the reform of teaching Fundamental Principles of Engineering Structures is a crucial task in engineering education today. This paper will discuss the course's teaching reform focusing on ideological and political education. This course primarily covers engineering structures' fundamental concepts, principles, and design methods. The emphasis lies in integrating theory with practice, allowing students to acquire fundamental theoretical knowledge of engineering structures in the classroom. It consolidates this knowledge through practical activities such as experiments and design, thereby enhancing their comprehensive abilities. Therefore, the reform of teaching the Fundamental Principles of Engineering Structures should prioritize enhancing students' practical abilities and strive to achieve an organic integration of theory and practice.

**2. Status of the Curriculum and Problems**

The course "Fundamental Principles of Engineering Structures" is primarily targeted at students specializing in intelligent construction. It is taught in the second semester of the sophomore year for undergraduate students and in the first semester of the junior year for students upgrading from junior college to university (the first semester upon entry into the program). Whether undergraduate or students upgrading from junior college to university, their grasp of foundational knowledge when studying this course is not yet solid. However, this course covers the design calculations of the three major basic structures: steel structures, concrete structures, and masonry structures. With its complex content, students have limited capacity to absorb information in the classroom. Through analysis of student learning situations and post-class communication, the following issues have been identified in the teaching of the Fundamental Principles of Engineering Structures course:

**2.1 Theoretical Learning Detached from Practice**

Traditional courses on the fundamental principles of engineering structures emphasize students' grasp of theoretical knowledge but overlook the importance of practical application. Many students may understand the theory in the classroom but struggle to apply it proficiently in practice. According to the training program, we aim to cultivate students as "engineers capable of design, management, and construction throughout the entire process." For students specializing in intelligent construction, their practical skills are particularly emphasized. However, in the classroom, students often only learn "how to solve" problems without mastering "how to do."

### *2.2 Limited Diversity in Practical Activities*

Traditional courses on the fundamental principles of engineering structures mainly rely on simulated experiments for practical activities, which often differ from real-world engineering situations. Additionally, due to limited teaching resources, students cannot conduct mechanical performance tests in laboratories. As a result, students lack targeted and feasible practical experiences, hindering the full development of their comprehensive abilities.

### *2.3 Inadequate Emphasis on Ideological and Political Education*

Traditional courses on the fundamental principles of engineering structures primarily focus on imparting engineering knowledge while neglecting the cultivation of ideological and moral character. University students should possess the ideological understanding of serving the people, along with key qualities such as professional ethics and a sense of responsibility as engineers. However, developing these qualities requires guidance and cultivation through ideological and political education.

## **3. Significance and Approaches of Industry-Education Integration**

Industry-education integration involves incorporating practical work into curriculum teaching, making classrooms more distinctive and ensuring that students learn more effectively, practically, and with greater interest. For the course on Fundamental Principles of Engineering Structures, ideological and political education can play a role in the following aspects:

### *3.1 Strengthening Engineers' Professional Ethics and Sense of Responsibility*

In the teaching of the Fundamental Principles of Engineering Structures course, introducing elements of ideological education helps students consciously establish beliefs and concepts of serving the people. This fosters the development of engineers' professional ethics and sense of responsibility, enabling students to possess critical thinking and moral judgment abilities, thereby avoiding shortsighted behaviors and blind pursuit of interests.

### *3.2 Enhancing Practical Components*

The cooperation between educational institutions and industry enables students to actively engage in practical engineering projects, thereby enhancing their operational and application skills. This collaboration also facilitates the expansion of students' practical experience in engineering, deepens their understanding and mastery of structural principles, encourages the application of theoretical knowledge into practice, fosters concrete problem analysis, and enriches the practical components within academic courses.

### *3.3 Highlighting Innovation Education*

In the teaching process, significant emphasis is placed on nurturing students' innovation capabilities. Through knowledge guidance and practical guidance, students' innovative thinking is stimulated, allowing them to independently think and solve problems. This broadens their perspectives and abilities, cultivating engineering professionals with independent thinking and innovation awareness.

#### **4. Constructing a Framework for Industry-Education Integrated Curriculum Teaching**

##### *4.1 Designing Rational Course Content*

To fully leverage the role of ideological and political education in the teaching of the Fundamental Principles of Engineering Structures course, enhance students' thought of combining theory with practice, it is necessary to design rational course content. The content should fully integrate elements of ideological and political education while also ensuring the accuracy and practicality of the main teaching content. This ensures that students grasp the fundamental principles of engineering structures and possess sufficient foundational skills to engage in practical engineering projects.

##### *4.2 Designing Rational Practical Components*

To fully harness the role of practical education, rational practical components should be designed. Practical content should move beyond mere simulated experiments and emphasize the integration of simulation with reality. Guiding students to set objectives, clarify methods, strengthen operational capabilities, and enhance their ability to solve practical problems and gain practical experience.

##### *4.3 Strengthening Cooperation with External Companies*

In addition to teaching, it's crucial to enhance cooperation with external companies and encourage students to actively participate in practical activities. Encourage students to step out of the classroom and experience different company cultures, gaining a deeper understanding of various stages of construction projects. This comprehensive learning approach helps students understand how to become "whole-process engineers." In addition, we invite civil engineering industry elites to campus to give speeches, share current research hotspots and industry development direction with students, show students the charm of civil engineering in more dimensions, and better let students understand civil engineering, explore employment direction as much as possible, and find their own fun.

##### *4.4 Diversifying Teaching Methods*

To increase students' interest in the course, it's essential to diversify teaching methods in the classroom. For example, employing the method of "analogical reasoning to guide learning" can help students learn relevant knowledge through real-life experiences. Providing students with more learning avenues is crucial, especially considering the development of online teaching methods. By releasing short online classroom videos after class, students can engage in self-directed learning, reinforcing their knowledge and cultivating their ability to learn independently. In class, explaining real-time hot events, allowing students to analyze real-time hot topics by themselves with the knowledge they have learned, and sharing their views on the platform through flipped classroom can not only improve students' interest in the course, but also cultivate students' ability of expression. Make the classroom not just a classroom, but a stage for everyone to show themselves.

#### **5. The "Recite, Appreciate, Play, Create" Four-Word Teaching Model**

"School-enterprise cooperation and integration of production and education" is a new round of deep research and practice in teaching reform under the new era. It emphasizes that the conception and

design of courses, implementation processes, the role of teachers, and the psychology and values of students should all be guided and controlled by ideology. The course on Fundamental Principles of Engineering Structures is a foundational course, with its core being the teaching of basic principles and systematic content. Integrating theory with practice is also a focus of industry-education integration. Therefore, in engineering structure courses, there should be clear educational objectives and value orientations: not only mastering the basic principles of engineering structures but also cultivating engineers' professional ethics, moral integrity, and social responsibility awareness. Only under the guidance of such educational objectives and value orientations can the course on Fundamental Principles of Engineering Structures better fulfill its social functions.

This course unfolds around the "Recite, Appreciate, Play, Create" teaching model. "Recite" involves understanding principles and cultivating students' ability to solve practical problems using mechanical knowledge. It's about seeing through phenomena to essence, akin to the party's guidelines, reminding us to "never forget our original aspirations and keep our mission firmly in mind." "Appreciate" aims to help students grasp the spirit. In teaching the course, teachers should not only teach textbook content but also analyze practical situations deeply. By combining national policies and actively responding to national calls, teachers can share current political events related to structural engineering in class, expanding students' knowledge and fostering their ability to integrate theory with practice. Through gamified teaching methods and competition modes, students learn while playing. Based on the theoretical knowledge learned in this course, combined with software learning after class, leveraging the "industry-academia research and education research office" school-enterprise cooperation platform of the college, students participate in practical projects. This ensures that students not only learn knowledge at school but also truly integrate and apply their knowledge. Invite the top people in the industry to give lectures, share the current hot projects with students, exchange innovation, and improve students' understanding and interest in the profession. "Create" simply means innovation. Innovating teaching models and approaches allows the primary productivity to shine in teaching.

## 6. Conclusion

Through teaching reforms based on school-enterprise cooperation, integration of production and education, and the distinctive teaching features of "Recite, Appreciate, Play, Create," we can better address existing teaching problems, enhance students' comprehensive and innovative abilities, and promote the improvement of higher education quality. Relying on the teaching and research department of the college, we will strengthen the exchanges between schools and enterprises, so that students can more deeply realize the practical nature of knowledge. In practice, we need to continuously experiment and explore, constantly improve teaching content and methods, to better adapt to the needs of teaching reforms, and achieve high-quality course teaching.

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