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# Research on the Teaching Reform of "Engineering Mechanics" Course in Civil Engineering Majors

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**Abstract:** With the rapid development of the civil engineering industry, the "Engineering Mechanics" course in civil engineering majors, as a basic subject, faces the challenge of how to adapt to the modern engineering needs, and strengthening the teaching reform work is crucial for enhancing students' professional ability as well as promoting their future development. Traditional teaching content and methods have many deficiencies in cultivating students' comprehensive application ability, and teaching reform is urgently needed. This study discusses the teaching reform strategy of "Engineering Mechanics" from the aspects of updating course content, optimising teaching methods, training teachers and improving students' abilities. By analysing the necessity of teaching reform, the dilemmas faced and the possible solution paths, it aims to provide theoretical basis and practical reference for the improvement of the course in civil engineering majors.

**Keywords:** civil engineering majors; engineering mechanics; curriculum reform; strategy

## Introduction

The "Engineering Mechanics" course in civil engineering majors, as a fundamental and core discipline, is directly related to students' ability to solve engineering problems in their future careers. With the progress and increased complexity of civil engineering technology, engineers face more and more stringent technical requirements, and the traditional "Engineering Mechanics" course content and teaching methods appear to be insufficient in coping with these demands. At present, the "Engineering Mechanics" courses in many universities still remain in the mode of mainly theoretical lectures, ignoring the combination with the actual engineering needs, which makes it difficult for students to flexibly apply what they have learnt in practice. In addition, the teaching reform is also faced with many dilemmas such as insufficient teachers, limited teaching resources, and uneven learning ability of students. Therefore, exploring how to effectively carry out the curriculum teaching reform, improve the comprehensive quality of students and enhance their ability to cope with complex engineering problems has become an important topic in current civil engineering education.

## 1. The Necessity of Teaching Reform of the Course "Engineering Mechanics" for Civil Engineering Majors

### 1.1. Conducive to adapt to the modern engineering needs

With the rapid development of science and technology and the increasing complexity of the engineering field, the traditional teaching content and method of "Engineering Mechanics" course has been gradually difficult to meet the needs of modern engineering practice. "Engineering Mechanics" as a core foundation course of civil engineering, although the theoretical level laid the students' basic knowledge, but with the significant increase in the complexity of engineering projects in design, analysis and construction, the traditional teaching mode focuses on theoretical lectures, ignoring the drawbacks of practical application is increasingly apparent (Liang, 2024). Modern engineering projects not only require engineers to have solid theoretical knowledge of the fundamentals of mechanics, but also require them to be able to flexibly use this knowledge to solve practical problems, especially in the face of uncertainty, high complexity and diversified needs. Therefore, modern engineers are not only masters of mechanics theories, but also practitioners who apply these theories to innovative design and problem solving. This requires that the

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teaching content of the "Engineering Mechanics" course must keep up with the development of the times and introduce the latest research results, especially by combining the contents of emerging fields such as computer simulation technology, intelligent engineering materials and new construction technology, so as to help students better understand the practical application of mechanics in modern engineering. In addition, through the teaching reform, the course can incorporate actual engineering case studies so that students can better combine theoretical knowledge with real engineering problems, thus cultivating their innovative thinking and practical operation ability.

### 1.2. Beneficial to the improvement of students' comprehensive quality

"Engineering Mechanics" is not only a basic theoretical course for civil engineering majors, but also relates to students' practical application ability and ability to solve complex engineering problems to a large extent. As a core course, it not only teaches the theory of mechanics, but also requires students to be able to transform the theory into an effective tool in engineering practice, such as conducting analysis, modelling and solving real-world problems (Tao et al., 2024). The traditional teaching mode focuses too much on theory transmission, and students' cultivation of practical ability and teamwork awareness is often insufficient. Through teaching reform, more flexible and diversified teaching methods can be introduced, such as project-based learning, case studies, simulation experiments and so on. These methods can help students apply mechanics knowledge in real or simulated engineering situations through hands-on practice and teamwork. Project-based learning allows students to personally participate in engineering projects, from the proposal of the problem, programme design, analysis to the final solution, the whole process of students' logical thinking and practical ability will be improved. Case studies allow students to better understand and master how to apply the theories learnt in real scenarios by introducing mechanical problems in real engineering projects. Simulation experiments, on the other hand, provide students with a low-cost but efficient experimental platform, enabling them to carry out dynamic observation and experimental analysis of mechanical phenomena, thus consolidating theoretical knowledge. These teaching methods not only enhance students' practical ability, but also effectively improve their sense of teamwork, as many projects require students to work in groups to complete tasks. Through co-operation, they can not only learn how to co-ordinate their work with others, but also develop communication skills, conflict resolution skills and collective decision-making abilities (Zhang et al., 2023).

### 1.3. Favourable to the promotion of interdisciplinary integration

With the rapid development of engineering technology, many complex problems in modern civil engineering often no longer rely solely on the knowledge of a single discipline, but require interdisciplinary thinking and skills to solve. Therefore, it is particularly important to promote interdisciplinary integration in the teaching reform of the "Engineering Mechanics" course. By combining "Engineering Mechanics" with other related disciplines, such as materials science, computer science, structural engineering, information technology, etc., students can not only learn the basic theories of multiple disciplines, but also master how to integrate and apply this knowledge in solving complex engineering problems in actual engineering. For example, materials science can help students understand the performance of different materials under mechanical stress, providing a theoretical basis for material selection and optimal design; computer science can help students carry out structural analysis, simulation experiments and engineering design more efficiently through the introduction of technologies such as engineering simulation, data analysis and machine learning. This interdisciplinary curriculum design can significantly enhance students' comprehensive application ability and equip them with the ability to think and solve problems from multiple perspectives in complex engineering situations (Yu & Guo, 2023). In addition, the interdisciplinary teaching mode not only improves the attractiveness and practicality of the course, but also stimulates students' innovative thinking. Through exposure to knowledge and technology from different fields, students can think outside the traditional thinking framework when solving engineering problems and find more creative and efficient solutions from new perspectives. Interdisciplinary integration also provides students with a broader space for career development, enabling them to stand out in diverse positions with their cross-disciplinary knowledge base and skills when facing various challenges in the future

workplace.

## 2. The Dilemma Facing the Teaching Reform of "Engineering Mechanics" Course for Civil Engineering Majors

### 2.1. Disconnect between course content and actual demand

In the current "Engineering Mechanics" course in many colleges and universities, the teaching content is still mainly focused on traditional theoretical explanations, often ignoring the close integration with modern engineering practice. With the rapid development of engineering technology, the complexity and accuracy of building structure design, civil engineering construction and other areas of increasingly high requirements, but the course content of the update speed is relatively lagging behind, unable to keep pace with the pace of technological progress. This lag leads to a lack of understanding of the actual needs of modern engineering in the learning process of students, and there is a certain disconnect between the knowledge imparted by the course and the application in real engineering. This not only affects students' interest in the course as they are unable to see the practical application of the theories learnt in reality, but also makes it a huge challenge for them to enter the job market after graduation. Many students find that the theories learnt cannot be directly applied to complex engineering environments when solving real engineering problems, leading to the dilemma of theory not matching practice. For example, modern civil engineering projects often involve the use of new materials, complex mechanical analysis tools, and interdisciplinary solutions, while the traditional "Engineering Mechanics" course may ignore these practical needs. The lack of modern engineering case studies, use of advanced computational tools, or participation in field engineering projects makes it difficult for students to gain the necessary practical application experience in the classroom. This disconnect not only limits students' professional competitiveness, but also is not conducive to the training of modern engineers with innovative abilities and practical skills.

### 2.2. Insufficient teaching staff and teaching resources

The successful implementation of curriculum reform cannot be separated from the support of high-level faculty and sufficient teaching resources. However, many colleges and universities are facing the dilemma of insufficient faculty strength and teaching resources in the field of "Engineering Mechanics", which seriously restricts the advancement of teaching reform (Zhang, 2022). The teacher team of "Engineering Mechanics" in many colleges and universities has an insufficient number of professional teachers, especially teachers with rich practical experience are more scarce. Traditional theory-based teaching is easy for students to master the principles of mechanics, but if teachers lack experience in practical engineering projects, they are difficult to combine theory and practice in teaching, resulting in students' lack of ability to cope with complex real-world problems. Such a limitation makes the course content too theoretical and lacks the depth and breadth of practical application, which is not conducive to the cultivation of students' engineering practical ability and innovative thinking. At the same time, the lack of teaching resources further limits the diversified teaching methods and practical aspects of the "Engineering Mechanics" course. Many colleges and universities have not invested enough in experimental equipment, professional software tools and case banks, making it impossible for students to deepen their understanding of theoretical knowledge through experiments and simulation operations. For example, computer simulation tools and high-precision experimental equipment commonly used in modern "Engineering Mechanics" are not widely configured in many universities, and students lack the opportunity to operate, which makes the teaching often stays on paper, and it is difficult for students to get the experience of actual operation and verification.

### 2.3. Problems of students' learning ability and attitude

In the process of learning "Engineering Mechanics", students often face the plague of abstract theoretical knowledge that is difficult to understand and apply, resulting in unsatisfactory learning results. The theory of mechanics is relatively complex and involves a lot of basic knowledge of mathematics and physics, but many students have weaknesses in these basic disciplines and are unable to flexibly use mathematical models or physical principles to analyse mechanics problems. This lack of knowledge makes it difficult for them to understand the concepts of mechanics, and then they lose interest in the course and motivation to learn. Meanwhile, the application scenarios of mechanics are mostly practical engineering problems, which are

often highly complex and diverse, and for students without practical experience, the distance between theory and practice is too large, which can easily lead to frustration. Due to the lack of sufficient self-confidence, students are intimidated by mechanics in the learning process, which further reduces the learning effect. In addition, some students are used to passively accepting knowledge and lack the learning attitude of active exploration (Wen et al., 2022). This passive learning mode is not compatible with the teaching concept of active learning and independent practice advocated by the curriculum reform. Although the teaching reform has introduced practice-oriented teaching methods such as project-based learning, case studies and experimental sessions, the effect of the teaching reform will be greatly reduced if students lack the enthusiasm for active participation and hands-on practice.

## 3. The Civil Engineering Professional "Engineering Mechanics" Course Teaching Reform Strategy

### 3.1. Updating course content and teaching methods

In order to enhance the teaching effect of the "Engineering Mechanics" course, it is crucial to evaluate and update the course content on a regular basis in close conjunction with the actual engineering needs. With the continuous advancement of technology in civil engineering, architecture, bridges and other fields, the teaching content must be consistent with the latest trends in the development of the industry. Modern engineering cases and cutting-edge research results can be introduced into the design of the curriculum to ensure that what students learn is closely aligned with practical needs. For example, by adding specific application modules of "Engineering Mechanics" in the fields of construction, bridges and civil engineering, students can closely integrate theory with practice and understand the key role of mechanics theory in solving practical engineering problems. In this way, students can not only master the basic mechanics knowledge, but also appreciate the practical application value of this knowledge in complex engineering, further stimulating learning interest and professional identity. In terms of teaching methods, the curriculum reform should introduce diversified teaching methods to break the traditional single lecture mode. For example, through project-based learning, students can apply the theoretical knowledge they have learnt in practical projects to solve practical problems, thus improving their hands-on ability and practical ability. Flipped classroom is also an effective teaching method, in which students can learn the basic knowledge independently before class, and discuss and apply it with teachers and classmates in the classroom to promote their active learning (Zhang et al., 2022). At the same time, the use of online learning resources can enable students to get more learning support outside the classroom and expand the flexibility of learning. In addition, the introduction of tools such as simulation software and virtual laboratories provides students with near-real experimental and simulation environments to help them better understand complex mechanics phenomena and processes.

### 3.2. Strengthening Teacher Training and Resource Inputs

In order to ensure the smooth implementation of the reform of the "Engineering Mechanics" programme, it is crucial to strengthen the construction of teachers and increase the input of teaching resources. First of all, enhancing teachers' teaching ability and practical experience is the basis for the improvement of teaching quality. Through on-campus training, external lectures and co-operation and exchanges with experts from other universities and industries, teachers can be helped to master the latest teaching methods and tools and continuously improve their teaching level. At the same time, encouraging teachers to participate in the practice of actual engineering projects can enrich their teaching content and cases, and ensure that the theoretical knowledge taught is closely integrated with the current engineering reality. Teachers can bring the latest technology, problem solutions and real cases in engineering practice into the classroom by participating in the projects, which can not only enhance the vividness and practicability of teaching, but also better guide students to apply theories in practice. At the same time, increasing the investment in teaching resources is also an important part of curriculum reform. Adequate equipments of laboratory equipment, software tools and case library can provide students with more practical and experimental opportunities to enhance their hands-on ability and engineering awareness. The introduction of resources such as simulation software, virtual laboratories and advanced mechanics experimental equipment will enable students to simulate and

analyse complex mechanics problems in the laboratory, consolidating theoretical learning while enhancing practical application capabilities (Wang et al., 2021a). In addition, schools can actively establish cooperative relationships with industrial enterprises, share resources through the school-enterprise cooperation platform, and provide students with opportunities to contact actual engineering projects. Such cooperation can not only enrich the content and form of the curriculum, but also allow students to exercise their problem-solving ability and accumulate practical experience in the process of participating in real projects. Engineers and experts from industrial enterprises can work together with teachers to supervise students' projects, helping students to understand and apply mechanics theories in real engineering environments, and to enhance their professionalism and expertise. By strengthening teacher training and resource input, the curriculum reform can be promoted more efficiently and high-quality talents adapted to modern engineering needs can be cultivated.

### 3.3. Cultivating students' active learning and practical awareness

In the reform of the "Engineering Mechanics" course, it is crucial to cultivate students' active learning and practical awareness, and students usually need to have a solid mathematical and physical foundation when they understand complex mechanical concepts. Therefore, more attention should be paid to the improvement of basic ability in the course, so that students can better grasp the principles of mechanics by strengthening the teaching of mathematical and physical knowledge. This cultivation of basic ability not only helps them understand complex theoretical problems, but also lays a solid theoretical foundation for future engineering practice. By setting up special tutorial sessions or providing revision materials on basic knowledge in teaching, students are helped to consolidate their mathematical and physical foundations to ensure that they have sufficient knowledge reserves and confidence when facing difficult problems. At the same time, stimulating students' interest in mechanics learning and their spirit of exploration is also an important means to enhance their sense of active learning. By organising diverse extracurricular activities such as academic lectures, technical competitions, field trips, etc., it can enable students to combine the theoretical knowledge in the classroom with real engineering problems and stimulate their curiosity and motivation for learning (Wang et al., 2021b). For example, inviting industry experts or alumni to give special lectures can enable students to understand the application of mechanics knowledge in real engineering and the latest technological development, and broaden their horizons. In addition, participation in mechanics competitions, academic research projects and field engineering visits can not only enhance students' practical hands-on ability, but also cultivate their sense of innovation and problem solving ability.

## Conclusion

To sum up, the necessity of teaching reform of "Engineering Mechanics", as a core basic course for civil engineering majors, cannot be ignored. By adapting to modern engineering needs, improving students‘ comprehensive quality and promoting interdisciplinary integration, the curriculum reform can lay a more solid foundation for students’ future career development. However, there are still many challenges in the process of education reform, which can be gradually overcome by optimising the course content, introducing diversified teaching methods, strengthening teacher training and enhancing students' practical ability. In the future, with the in-depth promotion of the education reform, the "Engineering Mechanics" course for civil engineering majors will play a more important role in enhancing students' practical ability and comprehensive quality, and provide more powerful support for cultivating engineering talents with innovative awareness and practical ability.

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## Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

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