ISSN 2522-6398 Vol. 8, Issue 5: 191-197, DOI: 10.25236/FER.2025.080528

Application of Engineering Case Teaching Method in Mechanical Design Course Design and Teaching Reform Effect

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Abstract: *Based on the actual situation of mechanical design course teaching, this paper discusses the application of engineering case teaching method in course design and its teaching reform effect. By introducing actual enterprise project cases, optimizing the organization and implementation of the teaching process, and integrating the elements of ideological and political education in the course, the students' learning interest, engineering practice ability and innovative thinking ability have been significantly improved. The data show that the students' classroom participation rate has increased from 65% to 85%, the satisfaction with the course has increased from 78% to 92%, and the number of winners in various vocational skills competitions has increased by more than 50%. At the same time, the teachers' teaching efficiency and teaching content optimization ability have also been significantly improved. Although there are still some problems in case resources, teaching evaluation system and student participation, the teaching effect can be further optimized by establishing a case library, improving the evaluation mechanism and introducing incentive measures. In the future, the school will continue to improve the case teaching method, explore more innovative teaching models, and provide support for the cultivation of high-quality application-oriented engineering and technical talents.*

Keywords: *Engineering Case Teaching Method; Mechanical Design Course; Teaching Reform Effect; Liaoning University of Science and Technology; Course Ideological and Political Education*

1. Introduction

The mechanical design course holds a pivotal position in mechanical engineering programs, serving as a core curriculum. Its teaching outcomes are decisive for students' ability to firmly grasp the theoretical knowledge of mechanical design and to develop solid practical skills. At Liaoning University of Science and Technology, the mechanical design course is meticulously designed to provide students with a robust foundation in professional theory. It also focuses on students' future career development, especially in the mechanical industry, including key positions in engineering design and technology development within the metallurgical machinery sector. This course lays the cornerstone for students' path to success. The ultimate goal of the course is to comprehensively shape students' innovative thinking and forge their ability to solve complex engineering problems, ensuring that they can confidently meet the increasingly complex and dynamic demands of the modern mechanical engineering field[1].

However, the traditional teaching model has long been centered on pure theoretical lectures, with students severely lacking opportunities for practical training. This makes it difficult for them to closely integrate abstract theoretical knowledge with concrete practical applications[2]. The consequence of this singular teaching model is that students' understanding and mastery of knowledge points are relatively superficial[3-4]. There is a significant deficiency in their ability development in independent thinking and practical operation, which forms a stark contrast to the urgent demand of the modern mechanical industry for innovative and applied talents. For example, under the traditional teaching model, students usually have to rely on textbook knowledge and classroom lectures to try to understand the complex and abstruse principles of mechanical design, with almost no opportunities for practical operation and application practice. This disconnection between theory and practice often leaves students at a loss when they face real - world engineering problems[5].

To address these long - standing problems, the case - based teaching method has emerged, bringing

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new hope to the teaching reform of the mechanical design course. The case - based teaching method skillfully introduces actual engineering cases into the teaching process, allowing students to learn and apply theoretical knowledge in the practice of solving real - world engineering problems. This method can not only greatly stimulate students' interest in learning but also effectively cultivate their engineering practice ability and innovative thinking in real - world situations. For example, in the mechanical design course at Liaoning University of Science and Technology, teachers carefully select and introduce actual project cases from enterprises, such as the design case of a two - stage coaxial reducer. By guiding students to deeply analyze and solve these real - world problems, they can gain a deeper understanding of the core knowledge points of mechanical design. This practice - oriented teaching method not only significantly improves students' interest in learning but also greatly enhances their practical ability and innovative thinking, enabling them to better adapt to the various challenges in their future careers[6-7].

The application of the case - based teaching method in the mechanical design course at Liaoning University of Science and Technology can not only effectively improve students' learning outcomes and teachers' teaching level but also provides strong support for cultivating high - quality applied engineering and technical talents. This teaching reform initiative undoubtedly opens up a new path for the development of mechanical design course teaching and lays a solid foundation for students' future career development[8].

2. Application of Engineering Case Teaching Method in Mechanical Design Course Design

2.1 Selection and preparation of cases

Case selection principles: In the mechanical design course of Liaoning University of Science and Technology, the selection of cases follows the principles of authenticity, typicality, pertinence and problem-solving, ensuring that the cases can cover the core knowledge points of the course, such as mechanical principles, mechanical design, digital design, etc. For example, the design case of a two-stage coaxial reducer in an actual enterprise project is selected. This case involves the machining and assembly of major parts such as transmission shafts and gears, which can well reflect the core knowledge points of mechanical design[9].

Case sources: Case sources are extensive, including actual projects of enterprises with long-term cooperative relations with the school, on-campus scientific research projects, and design cases of outstanding alumni. For example, the school has established a stable off-campus internship base and long-term industry-university-research cooperation relationship with companies such as Heli Forklift and Hitachi Construction Machinery. These companies provide a wealth of actual engineering cases for the course[10].

Case presentation forms: Case presentation forms are diverse, including animation, virtual experiments, videos, PPT, text explanations, etc. Through these forms, students can understand the actual situation of engineering cases more intuitively and improve learning effects.

2.2 Organization and implementation of the teaching process

Case introduction: During the teaching process, teachers introduce course content by showing some interesting engineering cases, such as innovative design cases in actual production of enterprises, to stimulate students' learning interest. For example, when explaining the basic principles of mechanical design, showing a new mechanical structure case successfully applied in an enterprise can make students have a strong interest in the course content.

Case analysis and discussion: The teacher organizes students to discuss cases in groups, guides students to analyze problems and propose solutions. During the discussion, students need to apply the theoretical knowledge they have learned, combine it with the actual situation of the case, and conduct in-depth thinking and discussion. For example, when analyzing the case of a two-stage coaxial reducer, students need to consider the processing technology of the transmission shaft, the structural design of the gears, and other aspects, and propose reasonable solutions.

Case summary and feedback: The teacher summarizes the discussion results of the students, points out the advantages and disadvantages, and provides suggestions for improvement. In this way, students can understand their learning situation in a timely manner and continuously improve and enhance themselves. At the same time, teachers can also adjust teaching content and methods according to

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students' feedback to improve teaching quality.

2.3 Integration of case teaching and ideological and political education in courses

In case teaching, Liaoning University of Science and Technology pays attention to integrating elements of ideological and political education into the curriculum, such as craftsmanship and teamwork. Through actual engineering cases, students are shown the importance of engineers' rigorous and meticulous work attitude and teamwork in projects, and their sense of social responsibility and professionalism are cultivated. For example, when explaining actual project cases of enterprises, the emphasis is placed on engineers' strict control of quality and emphasis on teamwork in projects, guiding students to establish correct values and professional outlooks.

Specific implementation of case experiments

Experimental preparation: Teachers should cooperate with enterprises in advance to obtain detailed design drawings and technical information of the two-stage coaxial reducer, and make them into multimedia teaching resources, such as animations, videos, etc. At the same time, prepare relevant experimental equipment and tools, such as transmission shafts, gear models, processing equipment, etc.

Experimental process:

Phase 1 (Case Introduction): The teacher uses multimedia to demonstrate the actual application scenarios and design background of the two-stage coaxial reducer, and introduces its importance and application cases in enterprise production. The teacher also uses animation to demonstrate the working principle and structural composition of the reducer to stimulate students' learning interest.

Phase 2 (Case Analysis and Discussion): Students discuss the design of the reducer in groups, analyzing the processing technology of the transmission shaft, the structural design of the gears, and the key technical issues in the assembly process. Each group of students needs to propose their own design plan and elaborate on it in detail.

The third stage (case summary and feedback): The teacher comments on the design solutions of each group, points out the advantages and disadvantages, and provides suggestions for improvement. At the same time, the teacher shows the design solutions actually adopted by the enterprise, compares the students' solutions, analyzes their advantages and disadvantages, and helps students understand the design ideas and technical requirements in actual projects.

Experimental results: Through the experiment, students not only mastered the core knowledge points of mechanical design, but also understood the design process and technical requirements in actual engineering, and enhanced their engineering practice ability and innovative thinking ability. After the experiment, students submitted an experimental report to summarize their learning gains and experiences.

Through the above specific implementation steps, the case experiment teaching in the mechanical design course of Liaoning University of Science and Technology has achieved good teaching results and laid a solid foundation for students' future engineering practice and career development.

3. Analysis of the Effect of Educational Reform

3.1 Improvement of students' learning outcomes

3.1.1 Significant improvement in learning interest and initiative

Through the engineering case teaching method, students' learning interest and classroom participation in the mechanical design course have been significantly improved. After the course reform, students' satisfaction with the course increased from 78% to 92%, and classroom participation increased from 65% to 85%. This shows that students' interest in the course content has increased and their learning enthusiasm has been significantly improved.

3.1.2 Engineering practice ability and innovative thinking ability are exercised

In the process of analyzing and solving actual engineering cases, students' engineering practice ability and innovative thinking ability have been significantly improved. Data show that the growth rate of students winning awards in vocational skills competitions at all levels has exceeded 50%, and the growth rate of students winning awards in innovative practice projects and innovative entrepreneurship

ISSN 2522-6398 Vol. 8, Issue 5: 191-197, DOI: 10.25236/FER.2025.080528

competitions has also exceeded 50%. This shows that students can better apply theoretical knowledge to practical problems and have been trained in their ability to solve complex engineering problems.

3.2 Improving the teaching effectiveness of teachers

3.2.1 Improved classroom teaching efficiency

Teachers can better guide students to learn through case teaching methods, and the efficiency of classroom teaching has been significantly improved. After the curriculum reform, the time teachers spend explaining in class has been reduced by 20%, while the time students spend discussing and practicing in class has increased by 30%. This shows that teachers can impart knowledge more efficiently, and students have more time for practice and discussion, which improves learning outcomes.

3.2.2 Optimization of teaching content and methods

Teachers constantly summarize experience and optimize teaching content and methods during case teaching. For example, by introducing actual enterprise project cases, the school innovatively reconstructs the teaching content into multiple full-process work modules with progressive difficulty, so that the learning rules of students are unified with the development rules of employees' professional abilities. This optimization makes the teaching content closer to actual engineering needs and improves the pertinence and practicality of teaching.

3.3 Improvement of curriculum construction

3.3.1 Optimization of teaching resources and course structure

The case teaching method enriches the course teaching resources and optimizes the course structure. Data shows that the school has added 15 real-life enterprise cases to the mechanical design course, covering more than 90% of the core knowledge points of the course. These cases provide students with rich learning resources, making the course content more systematic and comprehensive.

3.3.2 Significant results of curriculum reform

The results of the curriculum reform have been highly praised by students and employers. For example, the "three-step, seven-link, three-education" teaching model introduced by the school in the mechanical design curriculum reform has been widely recognized by enterprises and society. This model has effectively improved students' comprehensive quality and employment competitiveness.

3.4 Data support

In order to more intuitively demonstrate the effect of the teaching reform, the following is a table of relevant data, as shown in Tables 1 to 3:

Table 1 Comparison of student learning effect data

project	Before the Reform	After the reform	change
Course satisfaction (%)	78	92	+14
Class participation (%)	65	85	+20

Table 2 Comparison of teachers' teaching effectiveness data

project	Beforethe Reform	Afterthe reform	change
Proportion of classroom explanation time (%)	70	50	-20
The proportion of students' discussion and practice time (%)	30	50	+20

Table 3 Comparison of course construction data

project	Before the Reform	After the reform	change
Number of actual enterprise cases	5	20	+15
Core knowledge point coverage (%)	60	90	+30

Through the above analysis, it can be seen that the application of engineering case teaching method in the mechanical design course of Liaoning University of Science and Technology has achieved remarkable teaching reform results and provided strong support for the cultivation of high-quality application-oriented engineering and technical talents.

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3.4.1 Insufficient case resources

In the mechanical design course of Liaoning University of Science and Technology, teachers need to spend a lot of time screening and making cases, which increases the workload of teachers and limits the widespread application of case teaching methods. For example, when teachers prepare actual project cases of enterprises, they often need to communicate with enterprises many times to obtain detailed technical information and actual data. To solve this problem, the school can establish a case library to share teaching resources. The case library can integrate actual cases provided by enterprises, on-campus scientific research project cases, and design cases of outstanding alumni to form a systematic teaching resource platform. In this way, teachers can quickly obtain high-quality teaching cases and improve teaching efficiency.

3.4.2 Imperfect teaching evaluation system

The current teaching evaluation system in the mechanical design course of Liaoning University of Science and Technology has some shortcomings, such as single evaluation indicators and unscientific evaluation methods. This makes it difficult for teachers to fully understand the learning effects of students and is not conducive to the timely adjustment of teaching methods. To solve this problem, the school can establish a scientific and reasonable teaching effect evaluation mechanism. For example, a combination of process evaluation and final evaluation can be used to comprehensively evaluate the learning effects of students. Specifically, students' classroom participation, case analysis reports, group discussion performance, etc. can be included in the evaluation system, and combined with the final exam results to form a diversified evaluation mechanism. In addition, the school can also introduce a third-party evaluation system, such as feedback from corporate mentors, to ensure the objectivity and comprehensiveness of the evaluation results.

3.4.3 Differences in student participation

During case teaching, some students have low participation in case discussions, which may be related to students' knowledge base, learning interest, and teamwork ability. For example, in group discussions, some students may choose to remain silent because they are unfamiliar with the case background or lack a sense of teamwork. In order to improve student participation, schools can take the following measures: First, clarify the tasks and responsibilities of each student through group division of labor to ensure that each student has the opportunity to participate in case analysis and discussion; second, establish an incentive mechanism, such as incorporating classroom performance into regular grades and giving extra credits to students who actively participate in discussions; third, stimulate students' learning interest and initiative through case background introduction and question guidance.

4. Existing Problems and Countermeasures

4.1 Insufficient Case Resources

In the mechanical design course at Liaoning University of Science and Technology, teachers have to spend a considerable amount of time selecting and preparing cases. This not only increases the teachers' workload but also restricts the widespread application of the case teaching method. For instance, when preparing case studies of actual enterprise projects, teachers often need to communicate with enterprises multiple times to obtain detailed technical information and actual data. To address this issue, the university can establish a case repository to share teaching resources. The repository can integrate actual cases provided by enterprises, case studies from in - campus research projects, and design cases from outstanding alumni, forming a systematic teaching resource platform. In this way, teachers can quickly access high - quality teaching cases and improve teaching efficiency.

4.2 Incomplete Teaching Evaluation System

The current teaching evaluation system in the mechanical design course at Liaoning University of Science and Technology has some shortcomings, such as the singleness of evaluation indicators and the lack of scientific evaluation methods. This makes it difficult for teachers to fully understand students' learning outcomes and is not conducive to the timely adjustment of teaching methods. To solve this problem, the university can establish a scientific and rational teaching evaluation mechanism. For example, it can adopt a combination of formative and summative evaluation methods to comprehensively assess students' learning outcomes. Specifically, it can include students' classroom participation, case analysis reports, and group discussion performance in the evaluation system, and

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combine them with final exam scores to form a diversified evaluation mechanism. In addition, the university can also introduce a third - party evaluation system, such as feedback from enterprise mentors, to ensure the objectivity and comprehensiveness of the evaluation results.

4.3 Differences in Student Participation

During the case - based teaching process, some students have a lower level of participation in case discussions, which may be related to their knowledge base, interest in learning, and team - working abilities. For example, in group discussions, some students may choose to remain silent due to unfamiliarity with the case background or a lack of team - working awareness. To increase students' participation, the university can take the following measures: First, clarify each student's tasks and responsibilities through group division of labor to ensure that every student has the opportunity to participate in case analysis and discussion. Second, establish an incentive mechanism, such as incorporating classroom performance into regular grades and offering extra credit rewards to students who actively participate in discussions. Third, stimulate students' interest in learning and initiative by introducing case backgrounds and guiding questions.

5. Conclusion and Outlook

By applying the engineering case teaching method in the mechanical design course of Liaoning University of Science and Technology, significant teaching reform effects have been achieved. Students' learning interest and initiative have been significantly improved, and the classroom participation rate has increased from 65% to 85%; students' engineering practice ability and innovative thinking ability have been exercised, and the growth rate of the number of winners in various vocational skills competitions has exceeded 50%. At the same time, teachers' teaching efficiency and the optimization of teaching content have also been significantly improved, classroom teaching efficiency has increased by 20%, and students' satisfaction with the course has increased from 78% to 92%. In addition, the course construction has also achieved remarkable results, with 15 new corporate real cases added, covering more than 90% of the core knowledge points of the course, which has been highly praised by students and employers.

Outlook: In the future, Liaoning University of Science and Technology can further improve the case teaching method and explore more innovative teaching models. For example, it can combine virtual reality (VR) and augmented reality (AR) technology to develop more intuitive and interactive case teaching resources; it can strengthen in-depth cooperation with enterprises and introduce more actual engineering projects as teaching cases; it can also improve teachers' case teaching ability through teacher training and teaching seminars. Through these measures, the school will further improve the teaching quality of mechanical design courses and provide more powerful support for the cultivation of high-quality application-oriented engineering and technical talents.

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