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Research and Application of "Task Driven" Non-Mechanical Engineering Drawing Curriculum Reform

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Abstract

In view of the challenges of class hour compression and content update in the course of "Fundamentals of Engineering Drawing" for non-mechanical majors, this paper puts forward a set of curriculum reform scheme based on "task driven". In view of the problems of the traditional teaching mode, such as the disconnection between teaching content and professional needs, the lack of computer graphics skills training and the limitations of teaching methods, the scheme strengthens the training of image thinking and spatial thinking, and integrates diversified teaching methods, such as courseware animation, solid model and three-dimensional software, so as to stimulate learning interest. Through the design of challenging tasks closely related to students' majors, we should guide students to deepen theoretical knowledge in computer modeling practice, and significantly improve learning interest, enthusiasm, practical ability and innovative thinking. The application effect of project-based instructional design is remarkable, and students' scores are significantly improved. In the future, the reform will deepen the innovation of teaching methods, the integration of educational technology, the construction of personalized learning path and the improvement of evaluation and feedback mechanism, aiming to cultivate high-quality and innovative engineering talents. This study provides an important reference and support for the teaching reform of related courses.

Keywords

Engineering Drawing, Task Driven, Thinking in Images

1. Introduction

As a compulsory course for freshmen of non-mechanical majors, the course of

"Fundamentals of Engineering Drawing" carries the important task of cultivating students' spatial imagination ability, graphic expression ability and image thinking ability. Engineering drawing is the basis of learning engineering equipment and factory design and other follow-up courses, and it is also the key link to cultivate students' sense of space. Through drawing and reading training, students can build a bridge between drawing knowledge and professional knowledge, and lay a foundation for future interdisciplinary cooperation and engineering problem solving.

With the deepening of education reform, non-mechanical majors often relax their study of the course, because they are not deeply involved in the mechanical field, resulting in the failure to fully achieve the training objectives of the course. In the context of a significant reduction in theoretical class hours, how to effectively consolidate students' mastery of the basic theoretical knowledge of cartography and stimulate their interest in learning has become a difficult problem in teaching reform.

In view of this situation, this paper summarizes the teaching of non-mechanical drawing course, and puts forward a "task driven" oriented curriculum reform scheme. The program aims to build a geometric scene under the guidance of image thinking, and cultivate students' ability to read drawings in the forward and reverse directions between two and three dimensions. At the same time, drawing on the successful experience of "Practical Exploration on the cultivation of spatial thinking ability of non-mechanical engineering drawing", this reform scheme will further strengthen the cultivation of spatial thinking ability, and adopt a variety of teaching methods, such as courseware animation, entity display, three-dimensional software, etc., so as to stimulate students to quickly grasp the essence of engineering graphics course within a limited class hour, and lay the foundation for relevant engineering design.

2. Current Situation of Non-Mechanical Engineering Drawing Teaching

2.1. Course Status

2.1.1. Course Content and Professional Requirements

At present, domestic colleges and universities have made innovative progress in the mechanical drawing course, but the reform of the drawing course for non-mechanical majors is still insufficient. According to the Journal of China higher education, about 70% of non-mechanical majors report that the relationship between the content of existing teaching materials and practical engineering applications is not close enough (Yan, 2021). The singleness of textbooks and exercises and the lack of integration of actual cases lead to difficulties for students in applying theoretical knowledge to solve engineering problems. A survey of 50 non-machine majors found that only 20% of the students thought they could effectively apply the knowledge learned in the course to professional practice (Ou, 2021). In addition, the organization of knowledge points is lack of logic and organization,

which affects the students' in-depth understanding of the course content and reduces the learning efficiency.

2.1.2. Current Situation of Computer Drawing Skills

Computer drawing skills have become a necessary skill in the field of engineering drawing. According to statistics, about 95% of modern engineering design projects use computer aided design (CAD) technology (Bao & Zheng, 2019). However, the survey and analysis of 50 non-mechanical professional drawing courses show that only 30% of the courses focus on computer drawing skills (Kuppuswamy & Mhakure, 2020). This situation is far from meeting the needs of students' future career development, which limits their ability to adapt to the digital working environment.

In view of this, the teaching reform should focus on updating the course content to ensure that it matches the actual needs of non-machine majors. Strengthen the practicability and pertinence of the course by introducing projects in cooperation with the industry. At the same time, strengthen the teaching of computer drawing skills, such as incorporating SolidWorks, AutoCAD and other three-dimensional modeling software into the curriculum syllabus, so as to improve students' practical ability. Innovative teaching methods, such as case teaching and project driven interactive learning methods, have been proved to significantly improve students' participation and learning interest (Ishiguro & Miyake, 2020). A study on project-based teaching method found that the performance of students using this method in innovative thinking and problem-solving ability was about 40% higher than that of students using traditional teaching methods (Raffaeli, Cicconi, & Mandorli, 2019).

2.2. Current Situation of Course Content Teaching

At present, in the teaching of engineering drawing course, the multimedia teaching mode of PPT demonstration and blackboard writing is widely used. This teaching method has indeed improved the efficiency of information transmission, and its integrated stereo projection and animation effects have also added vividness to the teaching in terms of visual presentation, which can attract students' attention to a certain extent (Sprouse III et al., 2021). However, for non-machine major students, because the class hours of this course are usually tight and the knowledge required is relatively complex, this traditional teaching mode is often difficult to achieve the expected teaching effect (Wende, Giese, & Bulut, 2020). The core problem is that the core of engineering drawing, the three projection plane system, is essentially a three-dimensional expression, which puts forward higher requirements for students' spatial imagination. Although PPT presentation is more modern in form than blackboard writing, it is still limited to displaying static two-dimensional images, which cannot fully show the continuity and dynamic changes of three-dimensional space, limiting students' in-depth understanding of three-dimensional graphics. Students are often in a state of passive acceptance of knowledge, lack of sufficient participation and practice opportunities, and it is difficult to

effectively stimulate their enthusiasm and creativity in learning. The conclusion drawn in the article is based on research on students and interviews with experienced teachers, combined with literature and other aspects.

2.3. Reform Methods

In view of the limitations of the current teaching mode (Sinaga, Tanti, & Susiala, 2020), future teaching reform should focus on the improvement and innovation of teaching methods. On the one hand, more advanced teaching technologies, such as augmented reality (AR) and virtual reality (VR), can be introduced to provide students with an immersive three-dimensional learning experience and enhance their spatial perception. On the other hand, the teaching process should pay more attention to the subjectivity of students, and encourage students to actively explore and solve problems through practical operation, group discussion and project practice. When explaining the complex three-dimensional configuration, students can use computer-aided design (CAD) software to build the model in person, so as to deepen the understanding and application of theoretical knowledge in practice (Bzymek & Brown, 2019). At the same time, the role of teachers should change from the traditional knowledge imparter to the guide and promoter of learning. By designing challenging tasks and problems, teachers can stimulate students' interest in inquiry and innovative thinking, help them break through the shackles of traditional teaching mode, and realize the active construction of knowledge and the overall improvement of ability.

3. "Task Driven" Teaching Method

"Task driven" teaching method is a kind of inquiry teaching mode. Its core is to transform the learning process into a series of specific tasks, which are designed to stimulate students' subjectivity and creativity. This method emphasizes that under the guidance of teachers, students can gradually build a clear knowledge system through the process of discovering, analyzing and solving problems independently, and cultivate the ability of independent exploration and innovation in this process. Compared with the traditional teacher centered teaching mode, the "task driven" teaching method pays more attention to the cultivation of students' ability and the improvement of their comprehensive quality, so as to better meet the requirements of modern educational philosophy.

The implementation of "task driven" teaching method in non-mechanical drawing courses (Ardian, Munadi, & Jarwopuspito, 2020) requires teachers to carefully design challenging and practical tasks, which should be closely related to students' professional background and future career needs. For example, advance the learning content of computer three-dimensional modeling software to theoretical learning, so that students can more deeply participate in the "task driven" learning process after mastering the necessary computer modeling skills. When teaching abstract concepts such as intersecting line, students can not only observe the shape and formation process of intersecting line intuitively through computer modeling software, but also deepen the understanding of these concepts through practical

operation, so as to cultivate the ability of spatial thinking and innovative design in practice.

Practice has proved that the application of "task driven" teaching method in non-mechanical drawing course can significantly improve students' learning interest, enthusiasm, practical ability and innovative thinking. Through task driven, students can more actively participate in learning, constantly challenge themselves, and realize the organic combination of knowledge and ability. The role of teachers has also changed from the traditional knowledge imparter to the organizer, guide and promoter of the learning process.

4. "Task Driven" Teaching Design

Taking the intersection content as an example, this paper expounds the specific implementation process of "task driven". In the 48 class hour engineering drawing course, the class hour of the intersection content is 3 class hours. Engineering drawing course often gives the impression that it is abstract and boring. With the gradual advancement of the new course, the introduction of life situation into the new course is the preferred teaching method for teachers. Many knowledge points have created situations for the introduction of life, activities and problems, making the boring knowledge interesting and the classroom more attractive. When importing from real objects in life, the easiest thing for students to think of is pipe parts, such as tee joints. If conditions permit, real objects can be displayed instead of pictures. Everyone's ability to accept real objects is always higher than other methods. Physical models still have irreplaceable advantages over other teaching methods.

As shown in Figure 1, the transition from real objects in life to classroom content will guide students to analyze the known projection of the intersection line on two projection planes. The teacher will practice on the blackboard. The students will think and summarize the steps. The teacher will explain the examples, complete them by themselves, show them in the form of group competition, and the teacher will patrol to master the classroom learning effect.

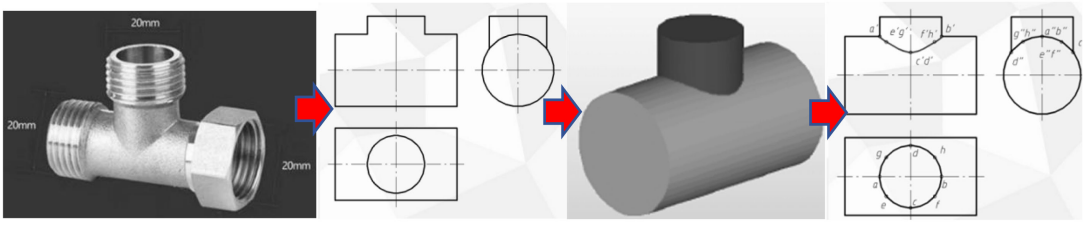

Figure 1. Example of "task driven" teaching method.

After students master the basic knowledge of intersection lines, they are given the tasks that students need to complete independently. Taking 20 students as an example, they can have a group discussion in groups of 3 - 4. The grouping situation should be reasonably matched according to students' learning ability, practical ability and personality characteristics. Students are encouraged to solve

problems after building a three-dimensional modeling software, as shown in Figure 2.

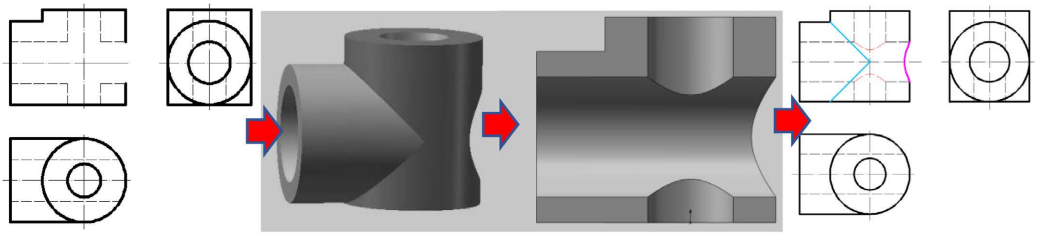

Figure 2. Example of autonomous task of "task driven" teaching method.

In the process of task completion, teachers should guide students' autonomous learning and encourage students to carry forward the spirit of teamwork. At the same time, when students encounter problems, teachers provide students with the necessary clues to solve the problem, and guide students to find, collect and use learning resources.

5. Results

In the teaching process of this course, it is crucial to ensure the teaching continuity. In order to effectively cultivate students' spatial thinking ability, this course adopts the teaching method of combining refined teaching with a large number of exercises to encourage students to actively participate in the learning process. In this way, students are guided to learn in practice, deepen their understanding in practice, and then imitate and learn the teacher's way of thinking, and apply the methods they master to the solution of practical problems.

This course emphasizes the transformation of knowledge acceptance and understanding into knowledge digestion, memory and application, so as to realize the internalization of knowledge and the improvement of ability. By using the "task driven" teaching method, the correct rate of students' after-school exercises has been significantly improved, from the original 30% to 80%. At the same time, the failure rate also decreased significantly from 15.48% to 7.56%, and the average score increased from 70.38 to 80.21, as shown in Table 1. These data fully prove the effectiveness of "task driven" teaching method in improving students' learning effectiveness. Through carefully designed teaching methods and "task driven" teaching mode, this course not only improves students' mastery of knowledge, but also promotes the development of students' spatial thinking ability, and realizes the optimization of teaching objectives and learning effects.

Table 1. Comparison of data before and after the reform.

Indicators	Before the change of teaching method	After the change of teaching method	Variation
Operation accuracy	30%	80%	+50%
Failure rate	15.5%	7.6%	−7.9%
Average score	70.4	80.2	+9.8

In this study, we implemented the project-based teaching design of engineering drawing course, namely the "task driven" teaching method, and tracked and analyzed the academic performance of 70 students. By comparing the data before and after the change of teaching methods, we find that this method has a significant effect in improving students' learning effectiveness.

Project based instructional design is a student-centered teaching mode that emphasizes the promotion of knowledge internalization and ability improvement through practical activities. In this course, we have adopted the method of intensive teaching and more practice, and the combination of teaching and practice, so that students can apply the knowledge they have learned to solve practical problems through practical operation while imitating and learning the teacher's thinking method. This teaching design not only improves students' participation, but also promotes the cultivation of students' spatial thinking ability.

After the change of teaching method, the correct rate of students' after-school exercises in engineering drawing course has significantly increased from 30% to 80%, and this change has reached 50%. The significant improvement in the accuracy rate reflects a significant increase in students' understanding and mastery of the course content. In addition, the failure rate also decreased from 15.48% to 7.56%, a decrease of 7.92%, indicating that more students have met the basic requirements of the course, and the change of teaching methods has effectively improved the learning effectiveness of students.

In terms of average score, the average score of students before the change of teaching method was 70.38 points, but after the change, it increased to 80.21 points, an increase of 9.83 points. This improvement not only reflects the improvement of students' overall performance, but also reflects the enhancement of students' ability in applying knowledge and solving problems.

The improvement of student performance is closely related to the review before and after class, and the impact of this part of the teaching process was also measured in this study.

By combining abstract theoretical knowledge with specific practical tasks, project-based teaching design enables students to deepen their understanding of knowledge in practical operation, and apply the knowledge they have learned to practice by imitating and learning teachers' thinking methods. The implementation of this teaching method enables students to better digest, remember and apply knowledge in the process of accepting and understanding knowledge, and finally transform knowledge into practical ability.

To sum up, the application of project-based instructional design in engineering drawing course not only improves students' learning interest and enthusiasm, but also effectively improves students' knowledge mastery and problem-solving ability. Through the implementation of "task driven" teaching method, students' learning effect has been significantly improved. This teaching reform provides a useful reference for the teaching of engineering drawing course. The data and analysis results show that project-based instructional design has important application value in improving students' learning effectiveness. In the future, we will further

explore and improve the project-based teaching design, in order to promote its application in a wider range of courses and disciplines, and provide more effective teaching support for cultivating high-quality talents with innovative spirit and practical ability.

6. Conclusion

This paper discusses the teaching status and reform scheme of engineering drawing foundation course in non-mechanical majors. This paper puts forward a "task driven" oriented curriculum reform plan, which emphasizes the guidance of image thinking and the cultivation of spatial thinking ability. In the "task driven" teaching method, it carefully designs a series of challenging and practical tasks, which are closely related to students' professional background and future career needs. This teaching method not only improves students' participation, but also promotes the cultivation of students' spatial thinking ability.

By comparing the data before and after the change of teaching methods, the "task driven" teaching method has a significant effect in improving students' learning effectiveness. Students' correct rate and average score of exercises after class in engineering drawing course have significantly improved, and the failure rate has also decreased. These data and analysis results show that project-based instructional design has important application value in improving students' learning effectiveness.

In the future, we will create a more interactive and immersive learning environment for students by integrating multiple teaching modes such as flipped classroom and collaborative learning, and actively introducing cutting-edge technologies, such as AR, VR and AI. At the same time, through customized learning experience and continuous teaching evaluation, we will ensure that each student can obtain teaching support that meets personal needs, so as to maximize the teaching effect.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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