Research on the Project-based Teaching Mode of "3D Digital Innovative Design" Course

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Abstract. In order to improve students' interest in learning and strengthen practical teaching, this paper proposed to introduce project-based teaching methods into teaching, combining computer technology with engineering practice. At the same time, in the process of process, we used layered teaching according to the differences of students. In the allocation of projects, we tried our best to meet the learning needs of different students and to reflect individualized education. Practice has proved that this method is feasible and has achieved good teaching results.

Introduction

With the development of computer, digital information technology and graphic technology, CAD/CAM/CAE technology has been widely used, which greatly improves the design and production efficiency of the mechanical industry. Enterprises choose one or more software as design tools according to their own industry development and application needs. Therefore, mechanical professionals are required to master a three-dimensional software [1].

According to the needs of talent training, many colleges and universities have also offered three-dimensional software courses such as CAD, PEO/E, SOLDWORKS, but most of the teaching process is biased towards the learning of software operation methods. The teaching mode is relatively simple, the students' interest in learning is not high, and the teaching effect is not ideal. At the same time, because the current enterprise needs more than just a simple software operation drawing staff, but a mechanical designer who can combine computer technology and engineering practice. Based on the above considerations, this paper proposed the introduction of project-based teaching methods in teaching, using specific mechanical product projects throughout the teaching of three-dimensional software. In this way, the traditional teaching method is changed, and students are taken as the main body to cultivate students' self-learning ability and practical ability.

Introducing Project-based Teaching to Courses

Project-based teaching was originally proposed by American scholars and widely used by American universities. With the advancement of education modernization, the connotation of project teaching has been re-excavated and spread to the whole world [2-3].

Project-based teaching means that an independent project is handed over to the students themselves under the guidance of the teacher. Students understand and grasp the basic requirements of the entire process and each link, through the implementation of the project. Project-based teaching is a teaching method in which teachers and students work together to complete projects [4-6].

The "3D digital innovative design" course of our school is mainly about the study of 3d software. While learning 3d software, we pay attention to the combination of theory and practice and the innovative design of machinery. At present, in the whole teaching process, we adopted a teaching method of teacher teaching and students on the machine. Students learned each module one by one, and there was a lack of connection between modules in the teaching process. In this way, students mainly learned to create models, and students' innovative design capabilities had not improved. At
the same time, teaching adopted the mode of unified teaching, which couldn't reflect the individualization of students.

In order to solve this problem, we tried to introduce the project-based teaching method into teaching, and used a "project" to spread the whole teaching, combining theory with practice. At the same time, in the implementation process of the project, the idea of innovative design was introduced to solve practical problems. In addition, we assigned different projects according to the specific conditions of the students, and encouraged students to complete the project on their own, thus improving students' enthusiasm for learning.

The Design of Project-based Teaching

In the process of developing teaching contents, the selection and formulation of projects are of vital importance. Through the investigation of machinery related enterprises, the requirements of mechanical designers were fully listened to, and the teaching contents were re-formulated with the combination of students' early courses and enterprises' demands for talents [7].

"Three-dimensional digital innovation design" course used two weeks of concentrated teaching. In the first week, we chose a project to complete the basic teaching process so that students could master the application of 3D software. Fig.1 shows the single-stage cylindrical gear reducer. The reducer was a typical assembly of machinery. It is mentioned in the previous engineering drawings and subsequent mechanical design courses. So we chose this design as a teaching project to develop teaching content.

Single-stage cylindrical gear reducer is mainly composed of upper and lower casing, gear, shaft, bearing, bearing cover and enclosure accessories. The enclosed space formed by the upper and lower boxes is the working area of the gear. The gear and shaft are connected by the key, and the parts on the shaft include bearing cover and sleeve, etc. The bearing and the bearing cover are respectively installed in the bearing holes of the casing. The whole reducer contains the main parts of mechanical design, which is representative to a certain extent.

The 3D software consists of four main modules: sketches, modules, assemblies, and drawings. Through the implementation of the entire project, the learning of each module was integrated into a project. The specific implementation process of the reducer project is shown in Table 1.

<table>
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<tr>
<th>Teaching module</th>
<th>Classroom teaching project</th>
<th>Task goal</th>
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<tr>
<td>Sketch module</td>
<td>Shaft, bearing cover</td>
<td>Master sketching skills</td>
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<tr>
<td>Parts module</td>
<td>Key, gasket, shaft, bearing cap, oil plug</td>
<td>Master the use of stretching and rotating features</td>
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<td>Screw, nut</td>
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<td>Gear, gear shaft</td>
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<td>enclosure</td>
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Figure 1. Structure of single-stage cylindrical gear reducer.
Assembly module | Gear assembly | Master assembly design ideas and implementation methods
---|---|---
Engineering drawing module | Drawing of gear shaft parts | Master the drawing method of part engineering drawing
| Draw the assembly drawing of the reducer | Master the drawing method of assembly engineering drawing
Innovative design | Interference analysis and further design modification of the whole model | Master the method of improving existing designs with 3D software

**Implementation of Project Teaching**

The whole teaching process was divided into four stages: teaching stage, independent exploration stage, project expansion stage and project evaluation.

**Teaching Stage**

The single-stage cylindrical reducer was selected as the implementation project of the teaching stage, and it was divided into four modules, which were explained separately for each module in the teaching. The sketching module mainly exercised the drawing of 2D sketches. In the part module, it mainly completed the creation of each part model of the project. In the assembly module, the assembled 3D components were assembled. And in the drawing module, the obtained part models and assemblies were converted into 2D drawings. We had a complete project throughout the learning process of the 3D software. The specific implementation process is shown in Table 1.

**Independent Exploration Stage**

Students have mastered the basic operation of the software through the project implementation of single-stage cylindrical reducer. Then the teacher arranged an actual project for the students to explore independently and learn independently.

In the specific implementation process, due to individual differences in student interests and abilities, we used “stratified teaching” [8]. Through the tiered teaching model, teachers assigned students different projects to help students build motivation, improve their interest in learning, and embody personalized education [9-10]. Students were grouped according to students' reading ability, mechanical principle and other theoretical knowledge mastery, and software proficiency. They were divided into three groups: A, B, and C [11-12]. The students in Group A were proficient in software operation, had strong ability to view pictures, and had a certain mechanical design basis; the students in Group B were more skilled in software operation, but the ability to view pictures was general; and the ability of students in Group C to operate and view pictures was poor. In the process of implementation, it could be adjusted according to the specific development of students.

In this stage, Students mainly practiced 3D software, which is to draw 3D models from 2D drawings. We assigned different items depending on the student's situation. Group A students chose the ball valve assembly in Fig.2, which is the most difficult. The whole model contains 13 parts, in which the valve body is the support of the whole ball valve. The modeling is more complicated and requires students to have certain ability to view pictures. Students in Group B chose the jack in Fig.3, which is difficult. The model consists of seven parts, in which the auger and screw sleeve modeling is more complicated. And students in Group C chose the linking device model of Fig.4 to practice, with minimal difficulty. The model has 11 parts, and the modeling of each part is relatively simple. It mainly exercises students' mastery of basic software commands. At this stage, the teacher mainly played the role of counseling, encouraging students to analyze the project and solve specific problems. At the same time, the teacher coordinated the process of project implementation and appropriately inspired and guided students.
Project Expansion Stage

At this stage, for students in Groups A and B, we encouraged students to design a part based on the assembly relationship. At the same time, students found problems through interference checks and could carry out structural improvements on their own to cultivate students' mechanical innovation ability. For the students in Group C, because the mechanical knowledge is relatively weak, the choice of the project was mainly based on software learning.

Learning Evaluation

After the completion of the project, the teacher would timely check and summarize, and feedback and evaluation of the project completion process and results. At the same time, the teacher evaluated the student's academic performance according to the actual situation.

Conclusion

In the 3D digital innovation design course, the project-based teaching method was introduced. Some typical projects in the mechanical design were selected as the carrier in the course, so that students could master a software and cultivated students' innovative design ability. Practice has proved that it is feasible to implement project-based teaching in this course, which greatly improved students' interest in learning and achieved better teaching results.

References


