Research on Online CAD Course Teaching Mode Based on N+X Mode

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Abstract: In order to further enhance the design and innovation ability of students, students are taught hierarchically through the online learning teaching platform and the knowledge module setting of product structure design. Meanwhile, based on the curriculum research of the mixed classroom teaching model, this paper is composed to enhance the initiative of students in learning, realize layered teaching, and enhance the effectiveness of teaching. Classrooms are not the only place to give a lecture, and the diversification of teaching locations and learning time can be achieved, which makes communication and guidance between teachers and students as well as cooperation and communication between students and students more convenient, so that students' team assistance ability can be effectively improved. Therefore, on the online learning platform, curriculum resources can realize the quantification of resources, which enriches the classroom and achieves the process and data evaluation of students so as to implement the objectivity and effectiveness of the evaluation.

1. Introduction
Traditional teaching methods are usually based on textbooks. Nowadays, neither planning textbooks nor industry standard textbooks can meet the requirements of product design in various industries [1]. What is worse, students can't meet the requirements of the position, who have to spend at least half a year on position study to basically reach the basic level of the position requirements. Therefore, innovation ability cultivation on students is difficult to be reached[2]. Especially in the face of non-standard automation product design positions, it is generally tough for students to be competent for positions such as structural design of intelligent manufacturing equipment[3]. Thence, as for the product structure design positions of the equipment manufacturing industry group, in order to further enhance the students' design and innovation capabilities, the product structure design knowledge module setting and the online learning teaching platform are used to teach students of different levels in accordance with their aptitude, which can not only effectively improve students' product structure design and innovation ability, but enhance students' learning initiative [4]. Meanwhile, the "N+X" mixed classroom teaching mode is adopted for curriculum reform, and corresponding matching ability training is carried out according to the students' learning ability and characteristics.

2."N+X"Teaching Model
The teaching goal of "Mechanical CAD-SolidWorks" course is that students can master and apply the 3D software SolidWorks proficiently, and cultivate the innovative thinking ability of 3D design. According to the professional characteristics of the school, the majors offered in the school include
mechanism, electromechanical, and precision manufacturing. Additionally, the teaching content of the course is carried out in the "N+X" mode, in which "N" is the basic teaching module and "X" is the ability improvement module. According to the characteristics of different professions, it is divided into different knowledge modules and different levels of skill certificates [5].

The "X" certificate of this course is the official certification exam for students from various schools around the world by Solid Works, which is divided into CSWA certificate and CSWP certificate. Meanwhile, it has reached an agreement with China Mechanical Engineering Association on mutual recognition of technical qualifications, that is, anyone who has obtained the CSWP certificate can be exempted from the mechanical design content part of the computer-based examination in the "Mechanical Design Engineer Qualification Examination". In addition, CSWA mainly tests the 3D modeling ability of students, the application of engineering principles, the utilization of design process and the understanding of industry conventions, which mainly proves the students' ability of the software, 3D modeling technology, design concept and participation in professional development [6]. Besides, CSWP is above the CSWA level, and the exam is more difficult. Generally, after obtaining the certificate, student can be determined as a SolidWorks certified expert or certified engineer [7].

The course content is mainly divided into 7 major modules, namely linear programming, integer programming, dynamic programming, graph and network analysis, queuing theory, storage theory and decision theory [8]. The teaching content and teaching methods of different modules are shown in Table 1.

Table 1 Teaching content and teaching methods of each teaching

| Teaching module       | Main teaching content                                                                 | Teaching methods                                |
|-----------------------|----------------------------------------------------------------------------------------|-------------------------------------------------|
| Linear programming    | Linear programming, simplex method, duality theory, sensitivity analysis, transportation problem, goal planning | Micro video + PPT + online training + classroom discussion |
| Integer programming   | Integer linear programming problem, branch and bound method, cut plane solution, 0-1 integer linear programming, assignment problem | Micro video + classroom discussion + group mutual evaluation |
| Dynamic programming   | Multi-stage decision-making, basic equations of dynamic programming, optimality principle, optimality theorem, resource allocation problem, production storage problem | Micro video + PPT + online training + classroom discussion |
| Graph and network analysis | Graph, tree, shortest path, network maximum flow, minimum cost maximum flow, network plan diagram, network plan diagram time parameters, network plan optimization | Micro video + PPT + classroom training + SPOC experiment |
| Queuing theory        | Basic concepts, inter-arrival time distribution and service time distribution, single-server negative exponential distribution queueing system, multi-server negative exponential distribution queueing system | Micro video + PPT + online training + classroom discussion |
| Storage theory        | Basic concepts of storage theory, deterministic storage model, random storage model, other types of storage models | Micro video + PPT + classroom discussion + group mutual evaluation |
| Decision theory       | Decision classification, decision process, uncertainty decision, risk decision, decision tree, sensitivity analysis | Micro video + PPT + class discussion |

The cultivation of different abilities in different majors is mainly through the online platform of Learning Pass. Teachers divide the curriculum knowledge modules into basic modules, A-level modules, P-level modules, and industry modules [9]. Basic module refers to the passing level in this course. In class lectures, teachers mainly start with basic modules, including all parts drawings, engineering drawings, sheet metal parts, assemblies and simple motion simulation. For students with strong thinking ability and learning ability, they can enter the online resource learning after all the
basic module exercises are proficiently completed, and carry out the A-level module learning [10]. The A-level and P-level modules are composed of real questions and practice questions of the CSWA exam in past years. After passing the A module, students can enter the P-level module training, and then participates in the CSWA and CSWP exams, so as to achieve the "X" certificate ability training.

3. Blended Teaching Mode of Online Learning Platform

At present, with the teaching mode reform of informatization methods, the fragmented time is fully utilized to allow students to learn more purposefully and systematically through online resources. In class, teachers mainly explain the common problems of students, and then answer questions in the course of practical operations, which can only solve the problems occurring in the classroom. However, for the course, the once or twice practice a week is far from enough. Students need to continuously strengthen the practice after class. Only more practice can form the thinking ability and model construction ability of 3D design. Therefore, through online learning platforms and course WeChat groups, students can also discuss, answer questions and share design methods with classmates and teachers after class, which realized the purpose of mutual help and common progress. The online and offline hybrid teaching model is shown in Figure 1.

Figure 1. Hybrid teaching activities combining online and offline

The online learning platform mainly uses Chaoxing Learning Pass. The online learning platform can assist teachers in learning management, including classroom management, homework assignment, process assessment and other functions, which can perfectly form a data-based curriculum management model. In addition, the learning Pass APP contains a student terminal and a teacher terminal. The teacher terminal can be connected to the network platform, and the platform uploads the basic module video recordings recorded by the teacher. Moreover, there is a gallery of previous years for A-level modules and P-level modules [11]. The industry knowledge module contains a large number of design source files for non-standard automation equipment, intelligent manufacturing equipment and robots, which are updated in real time by teachers according to industry changes. These resources require independent learning and teachers’ online Q&A. In addition, teachers also set up sharing columns, where students can share their own successful module design videos for reference and set up innovative product design columns to give full play to their creative thinking. What is more, products are not limited to mechanical products. It can also be daily necessities, inventions and creations, which fully use the infinite creative ideas of the students, and then the students and teachers will evaluate the products and select suitable products to form patents, papers and other results.
4. Analysis of Classroom Teaching Effect

The "N+X" method is adopted in the teaching reform of the "Mechanical CAD-SolidWorks" course, but this course is a basic mechanical professional course, which is usually arranged in 64-80 class hours. 64 hours are used for two-year students and 72 or 80 hours for three-year students. In addition, it is far from enough to achieve the final course goal and the teaching goal in the limited class time, especially for the two-year students. Since their thinking ability and learning autonomy are relatively weak, the previous single classroom teaching mode is adopted. Although after 64 class hours, most students can master the basic modules, there are still a small number of students who have difficulty passing the basic modules. However, with the help of the online platform mixed teaching mode, practice after class can be strengthened so that students can successfully pass the CSWA exam. Moreover, the three-year students have relatively high thinking ability and learning initiative. Some students learn independently through online platform video course resources after 20 hours of teaching, who have completed 2/3 of the exercises in the basic modules, and formed a good design thinking. What is more, when it is about 40 class hours, about half of the students can pass the exercise in the basic module. At this time, the practice of CSWA has started. At the end of the course, about 2/3 of the students can pass the CSWP test.

Students who have not reached the CSWP level need to be the same as those who have cleared customs. The CSWP module and industry module are arranged as holiday homework during the holidays, accounting for 80% of the total course score. Meanwhile, it is as one of the assessment indicators for the bridging course in the next semester. Moreover, the industry module is a knowledge module that connects students with design jobs. Students need to complete the design of more than 2 equipment cases during the holiday, and learn independently by referring to the source files on the platform. Meanwhile, teachers use online Q&A mode and classmates online discussion mode for mobile learning, which has the effect of teaching students in accordance with their aptitude, allowing each student to learn something. Although the time to arrive at the destination is different, the final destination is the same.

5. Experimental Teaching Analysis

The hybrid teaching mode is applied to the teaching of "Mechanical CAD-SolidWorks" course, and the teaching practice is continued for a semester. Compared with the traditional teaching practice, the number of students in the two sessions is similar, and the overall quality and learning atmosphere of the students are basically homologous. Besides, the course materials, syllabus, electronic courseware and class hours are all the same. The final exams are all conducted in the way of question bank propositions, and the final paper results are shown in Table 2.

| Fractional segment | 100~90 | 89~80 | 79~70 | 69~60 | 60 or less |
|-------------------|--------|-------|-------|-------|-----------|
| Number/person     | 8      | 21    | 22    | 19    | 0         |
| Proportion/%      | 11.4   | 30    | 31.4  | 27.1  | 0         |

| Fractional segment | 100~90 | 89~80 | 79~70 | 69~60 | 60 or less |
|-------------------|--------|-------|-------|-------|-----------|
| Number/person     | 6      | 18    | 21    | 27    | 6         |
| Proportion/%      | 7.7    | 23    | 27    | 34.6  | 7.7       |

It can be seen from Table 2 that the excellent rate of blended teaching classes (11.4%) is significantly higher than that of traditional teaching classes (7.7%). The average score (85.4 points) is 11.7 points higher than the 2015 grade (73.7 points), and the failing rate is 0. From the perspective of
performance distribution, the number of people in the mixed teaching class is relatively concentrated in the 70-89 score range, while the number of people in the traditional teaching class is 60-79.

These all reflect that the mixed teaching effect is more significant than the traditional teaching effect. Through questionnaire surveys and interviews with students majoring in logistics management, more than 95% of students believe that it is necessary to implement a mixed teaching model. Nearly 92% of students think that the mixed teaching model can enable students to adjust their learning progress independently and achieve personalized learning. Nearly 95% of students hold that using the saved offline classroom time to focus on explaining difficult problems, or for group discussions will help improve teaching quality and learning efficiency.

6. Conclusion
With the continuous implementation of the hybrid teaching model, the author has realized that in order to maximize the teaching effect of online and offline courses, teachers should first systematically analyze the curriculum knowledge points and the relationship between them, and then upload micro-videos and assign learning tasks beforehand. Secondly, teachers should realize the role change as soon as possible, and transformation from the one-word teaching in the traditional classroom to the classroom guided and heuristic teaching should be performed. In addition, during blended teaching, teachers should consider how to make students reasonably arrange their spare time for online learning and how to better conduct online tutoring and communication with students.

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