Exploring the Teaching Reform of "Mechatronics System Design" Course Based on the Integration of Race and Education

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Abstract. With the continuous innovation of education mode and the rapid development of technology, the "competition and education integration" mode, as an emerging teaching reform method, has been gradually applied in various fields of higher education. As a comprehensive course in mechanical and electronic engineering, the "Mechatronics System Design" course is highly compatible with the requirements of the competition. The purpose of this paper is to explore the application of the "competition and education integration" model in the "Mechatronics System Design" course, analyze the problems and challenges facing the current course construction, put forward specific teaching reform ideas and implementation paths, and evaluate the reform effect. Through this reform, we aim to improve students' practical ability and innovative thinking, and promote the overall development of students' comprehensive quality.

Keywords: race-teaching integration; teaching reform; implementation path.

1 Introduction

Since the new engineering discipline was proposed in 2016, it has become a major strategic choice for the reform of engineering education in the context of the new scientific and technological revolution, the new industrial revolution, and the new economy, and it is a new thinking and new way for the development of engineering education in China in the future [1]. The construction of new engineering specialties requires that the teaching content focuses on improving students' learning interest, learning participation, learning effect and ability cultivation, and the reform of teaching content and education and teaching method is an important part of the talent cultivation mode of new engineering [2-5]. Discipline competition as a form of practical teaching is an important driving force and second classroom for colleges and universities to enhance students' innovative thinking, engineering ability and comprehensive quality, and it is an important way to cultivate composite and application-oriented talents [6]. Colleges and universities vigorously promote the discipline competition as an important initiative to cultivate innovative talents, based on the teaching concept of "race to promote teaching, race to promote learning, race to promote training", the "race and education fusion" training

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mode has been actively explored and practiced. For example, Wang Jian [7] explored the practice of race-teaching integration in the teaching of microcontroller courses, from the organization of competition activities, extracurricular practice, practice effects, etc. to discuss and promote the cultivation of students' innovative thinking and practical ability. Wang Tianlei [8] and others explored the intelligent production engineering professional course "industrial perception technology" of the "competition and education fusion" way to stimulate students' interest in learning, from the competition project to refine the innovation topic, improve students' practical ability. In this paper, we will start from the actual situation of the course "Mechatronics System Design", discuss its teaching reform ideas and implementation path, improve students' learning enthusiasm, and enhance the classroom teaching effect.

2 Course teaching reform conceptualization

2.1 The basic situation of the course

The current social demand for talents is a composite talent with cross-thinking and able to solve practical engineering problems [9]. Mechatronics system design" course is adapted to the current needs of personnel training. The theoretical system of the course is based on industrial technologies such as mechanical structure design, control technology, sensor technology, measurement circuits and information technology. The course is formed by the intersection and penetration of a variety of technical disciplines.

Course by a variety of technical disciplines intersection, penetration and the formation of a comprehensive course, the technology involved in a wide range of areas, to cultivate students electromechanical product design capabilities, innovation, hands-on ability and to solve practical engineering problems has an important role.

The target of this course is the senior students majoring in mechanical and electronic engineering, and the teaching hours are 48 hours. Based on the first three years of study, students have a deeper understanding of mechanical technology, computer-aided design technology, microcontroller system design technology, sensor technology, mechanical system design technology. At the same time, students have good independent learning ability.

2.2 Problems of course construction

The traditional teaching of this course is mainly based on classroom theory teaching, with few practical sessions. Due to the fact that this course involves many knowledge points, poor consistency of chapters, large jumps in knowledge, abstract content and difficult to understand, most of the students are not interested in this course, which leads to the teaching effect of this course is not ideal.

The course team for the relevant teachers and students to conduct a questionnaire survey, the survey results show that the teaching of this course there are four aspects of the problem as follows: First, this course involves mechanical, control, electronic and other subject knowledge, the knowledge requirements of students is broader, the content of the chapters is relatively independent of the content, some of the content of the

students in the relevant courses have been studied, such as microcontroller, sensors, etc., but the student base is not the same, resulting in Teaching content is difficult to arrange; Secondly, this course is closely linked to practice, but students in the course of this course reflects the theoretical connection to practice, hands-on ability is poor, can not be flexible application of the knowledge learned; Thirdly, the lecture mode, teaching content, assessment mode is a single, resulting in low motivation for students to learn; Fourthly, this course is more theoretical teaching in the classroom-based teaching process, the knowledge is very fragmented, it is difficult for students to master so that the cultivation of students' knowledge "is a good thing", but it is also a good thing that students are not able to understand the content of this course. Fourthly, the teaching process of this course is mostly based on classroom theory teaching, and the knowledge points are very fragmented, which is difficult for students to grasp.

2.3 Ideas of course construction

In view of the above problems, this course reconstructs the teaching content, divides the teaching content into two major parts, adopts online and offline hybrid teaching mode, and explores a new assessment mode, focusing on process assessment. In order to stimulate students' interest in learning, the teaching content is fully integrated with disciplinary competitions. According to the teaching content, the National College Students' Advanced Drawing Technology and Product Information Modeling Innovation Competition, China Robotics and Artificial Intelligence Competition, Blue Bridge Cup National Software and Information Technology Professionals Competition, and Mechanical Innovation Competition are respectively integrated into the classroom teaching, and the practical teaching method is improved by the competition training method, and the competition standard is taken as a part of the diversified evaluation of the course, and the professionalism is carried out throughout the teaching of the course and the training of the competition. The whole process of teaching and competition training.

3 The implementation path of "race and education integration" teaching reform

3.1 Construction of online and offline hybrid courses

With the increasing maturity of information technology represented by the Internet, artificial intelligence and big data, online-offline blended teaching has become a new teaching pattern [10]. The online-offline hybrid teaching mode means that teachers provide learning resources such as teaching videos and knowledge point PPTs on online platforms, and students independently complete the learning of online resources outside the classroom, and obtain the corresponding credits after passing the examination [11].

In view of the characteristics of this course, which is characterized by a large number of contents and content, online and offline hybrid teaching is adopted. The online resources were constructed on the Super Star platform. The online course is mainly theoretical knowledge, while the offline course is mainly practical. The online course

includes the following contents: introduction to electromechanical systems, mechanical structure design, control system design, sensor technology, machine vision technology; the offline course is based on the discipline competition project to carry out project-based teaching, and the students work in groups to complete the design and production of an electromechanical product.

3.2 Integration design of competition content and teaching content

The course team is guided by the requirements of the competition, the relevant competition content is integrated into the corresponding teaching project of the course in a targeted manner, the competition project is used as a carrier for the integration of the teaching task design, the online learning resources to build the relevant competition resources, students master the relevant background knowledge in advance, and the implementation of the project is carried out offline, and the corresponding relationship is shown in Table 1.

Table 1. Correspondence between course teaching contents and competition contents

number	educational content	Integration of content	Competition Programs
1	Mechanical structure design	Mechanical design principles and computer-aided design technology	Mechanical Innovation Design Competition and National University Students' Advanced Drawing Technology and Product Information Modeling Innovation Competition
2	Control system design	Microcontroller and embedded system design	Blue Bridge Cup National Software and Information Technology Professionals Competition
3	Machine vision technology	Robot vision system construction	China Robotics and Artificial Intelligence Competition
4	Sensor technology	Sensor data acquisition and output	Mechanical Innovation Design Competition
5	Motor Drag Technology	Motor drive and control	Mechanical Innovation Design Competition and China Robotics and Artificial Intelligence Competition

Mechanical Innovation Design Competition is a very important event for mechanical majors, which is carried out according to the theme given by the organizing committee, and design works in line with the theme. The competition focuses on cultivating college students' innovative design consciousness, comprehensive design ability and teamwork spirit; strengthening the cultivation of students' hands-on ability and engineering practice training, and improving students' ability to carry out practical work such as mechanical design and process production according to the actual needs through innovative thinking. The content of the tournament can be well integrated with the mechanical structure design module, sensor technology module and motor drag technology module of this course. The main contents of Blue Bridge Cup National Software and Information Technology Professionals Competition are: microcontroller design and development, embedded design and development, C/C++ program design. The content of the tournament is integrated with the control system design module of the course to

stimulate students' learning interest. The National College Students' Advanced Drawing Technology and Product Information Modeling Innovation Competition includes mechanical drawing knowledge, computer graphics knowledge and lightweight design, which is highly integrated with the mechanical structure design module of the course. The China Robotics and Artificial Intelligence Competition includes four categories: innovation, competition, application and mission challenge. The competition involves humanoid, wheeled, multi-legged and other forms of robots and mainstream artificial intelligence technologies. The competition mainly tests the knowledge of robot and artificial intelligence innovation design and application, task challenge, scenario-based application and other levels. The content of the competitions is highly relevant to the teaching content of this course.

3.3 Reform of assessment mode

Course assessment is an important part of teaching activities in colleges and universities, and it is an important means to test the quality of teachers' lectures and teaching effects, and to evaluate the level of students' professional knowledge and skills [12]. Mechatronics System Design is an important compulsory course for mechanical and electronic engineering majors, and it is a comprehensive course for students after they have the basic knowledge of the specialty. It is a cross-curriculum oriented to application and engineering practice. Theoretical content is extensive, systematic, and duplicated with the courses learned in the previous period. The content of more class time is less, and the ratio of theoretical time to practical time accounts for a large proportion, according to this feature, from a practical point of view, the relevance of the contents of the chapters and other courses studied, in order to avoid the repetition of the content of the teaching of the theoretical content of the course of modularized teaching, to improve the efficiency of theoretical courses and teaching effect, to save more class time to be applied to the practice of the course. The course used to take a closed-book assessment, but the final examination results alone, the evaluation of students is too single, combined with the characteristics of mechatronics courses for consideration, a single closed-book assessment form is not the best way . At the same time as the curriculum reform will be carried out, the course assessment method needs to be reformed. Students are required to complete the design and production of mechatronics products, and the works of the course are required to cover mechanical structure design and control system design, and have a certain degree of innovation.

The course evaluation content has also changed from a traditional theoretical course to one based on large assignments, which include the use of three-dimensional software to design tree-planting robots, fruit-picking robots, drones, stair-climbing robots, intelligent handling robots and so on. The project involves the design and preparation of technical information, the production of physical models, and the defense of the project.

The evaluation of this course focuses on process evaluation. The final grade consists of online course learning and offline course completion. The online course grading includes: task point completion, tests and assignments, activities and discussion participation, accounting for 40%; the offline course grading includes: by the performance of students in the process of project implementation, the performance of students in the

defense process, the introduction of the work materials (physical works, manuals, demonstration videos, etc.), accounting for 60%, the detailed allocation of grading is shown in Table 2.

Table 2. Grading scale for student performance

Online Course Ratings			Offline course ratings		
Task point completion	ests and Assignments	Activity and Discussion Participation	Performance during project implementation	Performance defense	Presentation of works
20%	15%	5%	30%	10%	20%

4 Effectiveness of the teaching reform of "integration of competition and education"

4.1 Course evaluation

The teaching reform of this course has been widely praised by students, who generally believe that their hands-on ability, comprehensive application ability and language expression ability have been greatly improved. Meanwhile, this course has been highly praised by teaching supervisors and peers.

4.2 Effectiveness of Students' Learning

Students have a good knowledge of mechatronics product design and production through this course. From the program design, to the virtual simulation design, and finally buy supplies, production and debugging of physical works and final defense. Comprehensive examination of students' theoretical knowledge level, practical hands-on ability, writing ability, teamwork ability, language skills, vocational norms and standard work ability, comprehensive application of the knowledge learned, to solve the actual production problems, and to lay a good foundation for students to realize the transformation of professional roles. Through the study of this course, students participating in the National University Students' Innovation Competition of Advanced Drawing Technology and Product Information Modeling, Mechanical Innovation Competition, RoboCom Robot Developer Competition, and the National Comprehensive Skills Competition for Applied Talents have won one second prize and two third prizes in the national competitions, as well as three first prizes and 12 second prizes in the provincial competitions.

5 Conclusion

The application of the race-teaching fusion method in the teaching of "Mechatronics System Design" course is an effective way to promote the improvement of students' comprehensive quality and vocational competitiveness, as well as an important method

to promote teaching reform and innovation. The teaching reform of "Mechatronics System Design" based on the "Race-Teaching Integration" model not only improves students' practical ability and innovative thinking, but also promotes the overall development of students' comprehensive quality. In the future, this teaching mode is expected to be applied in a wider range of fields and levels, contributing to the reform and development of higher education.

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