Teaching Reform of Double-center & Three-cycle Hybrid Mechanical Specialty

Xue Xusheng, Li man, Cao Xiangang, Mao Qinghua, Wang Chuanwei, and Fan Hongwei

***Abstract*—The ability of college students to discover, propose and solve engineering problems in machinery has become an essential part of a contemporary college education. Therefore, the teaching reform focusing on cultivating College Students' ability to propose and solve engineering problems has become an essential part of a college education. Taking mechanical students as an example, this paper constructs a teaching content and method with "students" and "theory, engineering" as the double centres, combined with "pre-class", "in-class" and "after class", in which the teacher put forward the relationship between curriculum knowledge points and mechanical engineering problems, guide students to discover actively, learn and apply curriculum knowledge points, and put forward practical solutions to engineering problems in combination with mechanical engineering related issues. To achieve the goal of teaching engineering problems based on theoretical knowledge and practical operation, we should combine the "Internet plus" modern teaching tools to create "Online & Offline" mixed interactive courses and high-quality curriculum resources, forming the circular multi-dimensional closed-loop teaching mode of "student, theory, engineering" cycle, "pre-class, during-class, after-class" cycle and "before class test, instruction, after class test" cycle, which the students' ability to master knowledge points in the teaching process.**

***Index Terms*—Mixed teaching, multi-dimensional closed-loop teaching mode, comprehensive ability training.**

I. Introduction

Since the release of China's "made in China 2025" in 2015, the manufacturing industry has more clearly defined the development path from a "large manufacturing country" to a "powerful manufacturing country". It is proposed that by 2025, the overall quality should be significantly improved, the innovation ability should be substantially enhanced, and the labour productivity of personnel in manufacturing-related industries should be substantially improved. The manufacturing industry should take a new step in integrating industrialization and informatization [1]. As a primary speciality for developing the manufacturing industry, machinery speciality has become an essential object of education reform, such as talent team and teacher level.

In recent years, to improve, standardize and guide the continuous innovation of machinery speciality, the state has improved the evaluation method of engineering education certification in machinery speciality and strengthened the evaluation. Domestic colleges and universities seize the opportunity to meet the training requirements of talents and teachers in innovation and problem-solving. It has successively researched the construction of machinery speciality based on the certification standard of engineering education speciality, and put forward professional construction measures in the aspects of curriculum system, teacher team construction and students' creative ability training [2]. Aiming at cultivating students' ability to solve complex engineering problems, an electromechanical comprehensive experimental teaching reform method aiming at solving complex engineering problems is explored [3]-[5]. Seeking to cultivate students' creative ability and practical application ability in mechanical courses, this paper explores taking science and technology competition as the carrier and puts forward teaching reform plans to improve mechanical students' practical ability and innovative ability [6]-[8]. To improve the teaching effect of mechanical courses, a hybrid teaching model of learning situation analysis, teaching design and teaching implementation is formed [9]-[11]. Aiming at the characteristics of abstract contents, a wide range of courses, and a strong combination of theory and practice, the paper explores the solution of engineering problems, aiming to cultivate student' engineering application and innovative thinking ability. The multi-dimensional teaching method of "basic line teaching, practice teaching, online innovative thinking teaching" is explored with the internet plus teaching mode and formed a technique to stimulate innovative thinking [12]-[15].

It can be seen that to cultivate talents with a solid professional foundation, strong innovation ability and practical ability, domestic colleges and universities have strengthened research and reform in talent training methods and means, curriculum content design. However, there is less research on the internal relationship and combination methods between curriculum, practice and engineering. Classroom knowledge is the professional foundation for students' ability, practice is the cognition of principles, and solving engineering problems is the practical application. Therefore, how to give full play to the inherent relationship between the three and students and cultivate talents who can learn for life and innovate and develop has become an

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important research content of the text. In summary, with the help of the internet platform, we were “students” and “theory, engineering" as the double centers, and were three cycle of the professional training orientation of “students, major, engineering”, the curriculum design method of “pre-class, during-class, after-class” and the classroom description of “before class test, instruction, after class test”, which formed the new mixed curriculum teaching method.

II. Demand Analysis of Curriculum Reform

A. Industry Background Characteristics and Technological Frontier Demand

According to the industry background characteristics and scientific and technological frontier needs of mechanical students, combined with the ability training requirements of the national manufacturing industry for mechanical students, clarify the relationship between mechanical speciality and engineering practice, and study the internal professional training objectives and relationship of “student speciality engineering”.

B. Course Attribute Demand of Mechanical Specialty

Because of the characteristics that most mechanical courses pay equal attention to both principle and application, it is necessary to analyze the course content and the entry point of engineering problems before class, master the application of principle knowledge points in practice, and clarify the methods of practical ability to solve engineering problems after class. It is necessary to study the internal logical relationship of “pre-class, during-class, after-class”.

C. Curriculum Knowledge Structure Demand

According to the characteristics of many knowledge points and the strong relevance of the course content, this paper analyzes the structure and logical relationship of the course knowledge points, formulates the course explanation content and implements the before class test and after class test in combination with the online classroom, virtual experiment and other internet teaching platforms. It is necessary to study the overall implementation relationship of “before class test, instruction, after class test”.

III. Double Centre Three-cycle Hybrid Teaching Method

The ability to discover, propose and solve engineering problems in the mechanical field has become an important content of modern mechanical professional education. Therefore, the teaching reform focusing on cultivating the ability to propose and solve engineering problems has become an important part of professional education. For the cultivation of mechanical students, we should build a dual centre of “students” and “theory, engineering”, combined with the teaching content and method of “pre-class, during-class, after class”, then, the teacher put forward the relationship between curriculum knowledge points and mechanical engineering problems, guide students to actively discover, learn and apply curriculum knowledge points, and put forward practical solutions to engineering problems in combination with mechanical engineering related issues, to realize the teaching concept of solving engineering problems based on theoretical knowledge and practical operation. At the same time, we combined with "Internet plus" modern teaching tools, create “Online & Offline” mixed interactive courses and high-quality curriculum resources, forming a “student, theory, engineering” cycle, “pre-class, during-class, after-class” cycle and “before class test, instruction, after class test”. Circular multi-dimensional closed-loop teaching mode consolidates the knowledge points and engineering application ability in the teaching process. As shown in Figure 1, the multi-dimensional closed-loop teaching mode structure is established by taking the principle and application of a single-chip microcomputer of mechanical speciality as an example.

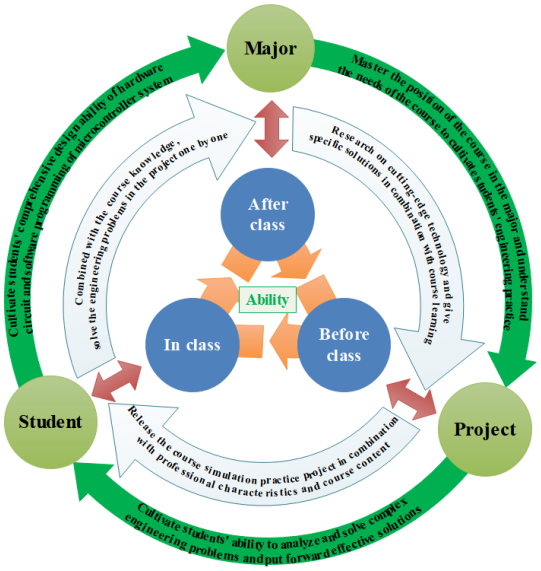

Fig. 1. Structure of multi-dimensional closed-loop teaching mode.

Taking the single-chip microcomputer principle and application of mechanical students as an example, "Student" refers to the student-centered course, which trains students to have the basic ability of hardware circuit comprehensive design and software programming development of microcontroller system. We combined with the training objectives, training contents, and the course's role in the training process of mechanical speciality, students can understand the engineering practice ability cultivated by the course and further understand the connotation of "Major" in the process of cultivating students' ability. The students can analyze the practical application problems of mechanical engineering, design comprehensive system hardware and software solutions, and understand the "Engineering" to be solved by the speciality. Finally, the students are trained to use typical microprocessor chips and peripheral circuits to carry out comprehensive engineering application ability of computer control, detection and measurement of electromechanical systems. Therefore, a dual centre and three cycle hybrid teaching model are established.

A. Pre-Class

First, give students the review tasks of the required course leading knowledge. For example, guide students to prepare the leading knowledge of courses such as electrical and electronic technology, engineering testing technology, microcomputer principle and interface technology. Second,

take students' ability training as the center, take the main knowledge points of the course as the guidance, and formulate engineering practice projects in combination with professional characteristics and course content. For example, we proposed "automatic control of automobile power window", "anti-pinch system of automobile power window", "intelligent headlamp control system" and "monitoring and early warning of interior air quality" in the way of project approval, and other project topics, in which ideological and political contents such as intelligence, environment, safety, laws and regulations are added, which are carried out by students in the form of independent application projects.

B. During-Class

First, take the main knowledge points of the course as the mainline and the secondary knowledge points of the course as the radiation, arrange the form of classroom preview for students, prepare minor knowledge points, and "primary and secondary" in the classroom knowledge points are the teaching content to open the spiral interactive knowledge point teaching method between teachers and students. Second, taking knowledge points as the center and engineering practice projects as the goal, corresponding to knowledge points and engineering problems, so that students can understand the methods of solving engineering problems in the process of course learning, and improve students' self-learning, engineering problem understanding, innovative thinking and literature, and information retrieval. Then, in order to consolidate the mastery of curriculum knowledge points, the "before class test" is designed to check the ability of students' knowledge points in the last class and after class, and solve complex problems in time. The "during-class interaction" is the interaction between teachers and students, resulting in the thinking collision between knowledge points and engineering problems. The "after class test" is before class, check the students' mastery of the knowledge points of this class, timely feedback the complex issues, and form a circular course content learning method of "before class test, instruction, after class test".

C. After-Class

First, based on engineering practice projects, combined with the course content, guide students to gradually formulate technical solutions to engineering practice project problems through cutting-edge technology research. Second, we combined with course experiments and course interactive discussion, clarify the feasibility of engineering problem solutions. Then, according to the mastery and consolidation of course knowledge points, combined with online classroom resources, complete the course content test and related homework, and explain the test and homework content in the course of teaching, to achieve the purpose of profoundly mastering the course content.

IV. Evaluation Method of Comprehensive Capacity Output

The process of training students in double centre and three cycle hybrid curriculum teaching mainly includes the mastery of curriculum content, the application of curriculum knowledge points and the evaluation of engineering practice project solutions.

A. Evaluation of Course Content Mastery

Students' mastery of course knowledge points can be mastered in real-time through the before class test, the after class test, the chapter test, homework and classroom interaction.

B. Evaluation on the Application of Curriculum Knowledge Points

Students can master the application of curriculum knowledge points through comprehensive classroom experiments corresponding to the curriculum content. Through the application, writing and reporting of engineering practice projects, students can reflect on the use of knowledge points, investigate related cutting-edge technologies and put forward preliminary solutions.

C. Solution Evaluation of Engineering Practice Project

Through the feasibility report of engineering practice project written by students, master students' understanding of engineering problems, formulate project innovation points, build hardware and software platform of the single-chip microcomputer control system, and analyze the feasibility of the project through system simulation and test.

V. Summary

Aiming at the ability training of mechanical students in solving practical engineering problems, this paper puts forward a dual centre and three cycle hybrid teaching reform method, which is driven by engineering projects and centred on the comprehensive ability training of "students" and "theory, engineering", forming "students, majoy, engineering", "pre-class, during-class, after-class" and "before class test, instruction, after class test" three cycle structure, benchmarking engineering education certification and national strategic development needs, to realize the cultivation of students' deep understanding of the speciality, lifelong learning and mastery of knowledge, and putting forward correct solutions to mechanical engineering problems. After years of implementation, this method dramatically improves students' interest in professional courses and improves the quality of mechanical students. This method is suitable for the cultivation of mechanical students and has reference and application value for other engineering majors.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Xue Xusheng mainly studies the reform method of dual-center and three-cycle hybrid machinery major, and Li Man participates in the establishment and implementation of the reform method. Cao Xiangang and Mao Qinghua mainly implemented the reform method of dual-center and three-cycle hybrid machinery major in the Computer Control Technology course, and gave feedback on the implementation effect and provided suggestions for revision. Wang Chuanwei and Fan Hongwei mainly implemented the reform method of dual-center and three-cycle hybrid machinery major in the course Mechatronics System Design course, and gave feedback on the implementation effect and

provided suggestions for revision.

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