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Exploration and Practice of Teaching Reform in Mechanical Principles Course Guided by the Cultivation of Students' Application Ability

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Abstract: Mechanical engineering majors, as typical majors in applied undergraduate universities, have unique advantages in curriculum innovation and construction due to their strong specialization and practical operability. By analyzing the pain points and issues of mechanical principle courses for students majoring in mechanical engineering at present, and through long-term planning by the teaching team, an innovative practical education system for mechanical principle courses has been constructed and put into practice. Specifically, it includes creating an innovative teaching model for mechanical principles courses that is student-centered, teacher led, and connects the first, second, and third classrooms. Complex knowledge points in the course are introduced and decomposed through practical engineering cases; The implementation of the course is based on solving practical engineering problems, allowing students to have a clear understanding of the evolution process of institutional machinery and cultivating their practical application ability to solve complex engineering problems; Build an online video resource library for prerequisite courses related to this course, and require students to complete self-directed learning and pass relevant tests through selection by the course instructor, inspiring students to enhance their internal drive for self-improvement; Student works with practical significance in the course learning process, through continuous improvement, encourage students to participate in subject competitions, and systematically enhance the ability of mechanical engineering majors in applied undergraduate universities to apply interdisciplinary knowledge to solve complex engineering problems. At the same time, ideological and political education, innovation and entrepreneurship education, and mechanical principles courses are closely integrated, and salt dissolves in water.

1. Introduction

The development of emerging industries has made engineering practical problems increasingly complex, requiring mechanical engineering students to have the ability to apply interdisciplinary knowledge to solve engineering practical problems [1]. At the same time, it aims to equip them with

a broad foundation of mechanical engineering knowledge and application abilities, cultivate innovative consciousness, and enable them to engage in design, manufacturing, research and development, management, engineering and technical services in related industries such as mechanical (engineering) equipment and regional agricultural engineering equipment. Therefore, in the process of curriculum construction, teachers need to guide students to integrate the basic knowledge of mechanical principles engineering with professional knowledge to generate innovative consciousness, so as to have the ability to apply interdisciplinary knowledge to solve practical engineering problems [2,3].

2. Basic Information of the Course

Mechanical Principles is generally aimed at students majoring in mechanical engineering at our university. It is offered in the second semester of their sophomore year, with a total of more than 300 students per semester. As a fundamental course for the major, it is closer to engineering reality than basic courses, has a wider research scope, and is more adaptable than professional courses. It mainly plays the role of connecting the preceding and the following [4].

According to the undergraduate talent training program and course objectives, the teaching objectives of the Mechanical Principles course are as follows: the knowledge objectives are to master the basic knowledge of mechanism structure analysis, mechanism kinematics analysis, and machine dynamics analysis, and to learn typical mechanism analysis and design, as well as mechanical transmission system design; The ability goal is to have the ability to transform theoretical research into practical problems, the ability to analyze and design typical mechanisms, the ability to innovate, the ability to model, and the ability to analyze interdisciplinary issues, forming the ability to analyze and solve complex engineering problems; The quality goal is to cultivate rigorous and standardized engineering literacy, objective and rigorous scientific thinking, the spirit of striving for excellence as a great country craftsman, the patriotism of serving the country with science and technology, and to cultivate qualified builders and reliable successors of the socialist cause with comprehensive development of morality, intelligence, physical fitness, aesthetics, and labor, thus achieving the three-dimensional integrated educational goal of knowledge imparting, ability cultivation, and value shaping [5].

3. Curriculum Study Students Face Major Problems

In terms of course learning, students are required to master a certain amount of prerequisite basic knowledge. However, at this time, students mainly show a general level of mastery of prerequisite basic knowledge, weak abilities in computer-aided design, theory to practice, and software modeling. Therefore, they lack the ability to transform research models into practical problems and solve complex engineering problems [6].

Therefore, most students believe that mechanical principles are too difficult. According to regular questionnaire surveys, the main reasons why students think mechanical principles are too difficult are manifested in the following four aspects: the course knowledge points are relatively complex and difficult to understand; It is difficult to apply the basic engineering knowledge involved in the course to practice; Students' learning experience often involves a sense of accumulation of knowledge points rather than a sense of systematic design, which makes it difficult for students to exercise their systematic thinking effectively; At the same time, the characteristics of the course itself require students to master some basic knowledge related to the prerequisite courses, and students cannot accurately and effectively review the prerequisite courses.

4. Curriculum Features and Innovation

The innovative design of the Mechanical Principles course mainly constructs a practical education system for innovative teaching, including the creation of a student-centered, teacher led, and integrated teaching innovation model for the Mechanical Principles course that connects the first, second, and third classrooms. It guides students to improve their derivative works of the course and allows the subject teachers to lead teams to participate in subject competitions. At the same time, the competition works are decomposed into theoretical and practical teaching of the course, and the scattered and complex basic knowledge of mechanical principles is connected through student works. Realize the close integration of knowledge and ability elements in theoretical teaching, practical teaching, and subject competitions, and systematically enhance the ability of mechanical engineering majors in applied undergraduate universities to apply interdisciplinary knowledge to solve complex engineering problems. At the same time, ideological and political education, innovation and entrepreneurship education, and mechanical principles courses are closely integrated, and salt dissolves in water.

4.1. Curriculum Practice

In response to the main problems faced by students, the course teaching team has put forward an innovative teaching design centered on student development and guided by the cultivation of application abilities after a long period of conceptualization, and has carried out certain teaching practices. By building a basic teaching platform and using practical engineering cases to introduce and decompose complex knowledge points in the course, such as introducing the transplanting mechanism and seedling tray adjustment mechanism of agricultural machinery rice transplanters in the teaching process of the organizational composition section, specific knowledge points related to the practical application of engineering and the content of this section can be excavated. Based on this, students can understand why they are learning and what they can do after learning, and systematically improve their ability to connect theory with practice and engineering literacy.

To address the issue of difficulty in accumulating and reviewing pre course content for students' learning of certain chapters, an online video resource library related to this course is constructed. Prior to class, the teacher will screen and publish pre course basic course clips related to this course content through an online teaching platform. Students are required to complete self-learning and pass relevant tests, so that they can review pre course knowledge related to mechanical principles courses in a targeted manner. While strengthening the learning of this course, students can reduce their learning burden and inspire their self-improvement drive. By integrating online teaching resources, building self built online SPOC courses, and combining course teaching objectives and corresponding indicator points, we aim to achieve comprehensive and multi-dimensional training for students.

In terms of course design, emphasis is placed on improving students' ability to abstract modeling, starting from solving practical engineering problems, allowing students to have a clear understanding of the evolution process of mechanisms and machines, and cultivating their practical application ability to solve complex engineering problems. Inspire students' thirst for knowledge, transform passive acceptance of indoctrination into active inquiry based learning, provide students with more freedom of choice and development needs, enhance their learning interest and engineering technology innovation ability, and solidify the foundation for cultivating applied innovative talents.

For student works that have practical significance in the course learning process, the teacher guides students to improve them, actively participates in subject competitions, and closely links the dispersed and complex basic knowledge of mechanical principles with engineering practical

problems through student works. To realize the close integration of course teaching, practice teaching and discipline competition, and improve the ability of mechanical students to solve complex engineering problems with interdisciplinary knowledge.

4.2. Students Evaluation and Feedback

In terms of course assessment, it breaks away from the traditional approach where final exam scores account for a large proportion and process assessments tend to be formalized. The grading criteria mainly consist of four parts, covering classroom interaction and homework after class; Group discussion/flipped classroom (with high scores for both); Stage testing/exploratory mechanism principle design (with high scores for both); final exam. By reducing the proportion of final exam scores and strengthening process assessment, enable students to improve their knowledge and ability simultaneously.

According to a questionnaire survey of the course experimental class, students have a good evaluation effect on the achievement of course objectives and corresponding graduation requirements (>98%). Most students believe that their self-learning ability, system scheme design ability, and mechanical principle systematic design ability have been improved through learning the course of mechanical principles. Students have a high satisfaction evaluation of the teaching process of the instructor (>97%).

At the same time, the course incubation works competition has achieved outstanding results, winning more than 20 provincial and above awards, and participating in more than 200 subject competitions. Some students who have spare capacity have significantly improved their ability to use systematic thinking to solve practical engineering problems. Relying on discipline competitions, we can realize the seamless connection between in-class practical teaching and extracurricular innovative activities, build a sustainable innovative teaching closed-loop system, and constantly improve students' practical ability.

5. Conclusions

Through the construction and practice of an innovative practical education system guided by the cultivation of application abilities in the course of mechanical principles, we aim to solve the problems encountered by students in traditional teaching methods, such as complex and difficult course knowledge points, difficulty in accumulating and reviewing pre course content in some chapters, difficulty in systematic thinking of mechanical principles, and difficulty in applying basic engineering knowledge in practice. The close integration of knowledge and ability elements in theoretical teaching, practical teaching, and subject competitions has been achieved, systematically enhancing the ability of mechanical majors in applied undergraduate universities to apply interdisciplinary knowledge to solve complex engineering problems. In the future, based on student feedback, we will continuously improve the teaching methods, innovative design methods, and other aspects of the curriculum. We will strive to achieve continuous improvement according to the students' acceptance level, and strive to drive synchronous optimization and innovation of other professional courses, so as to provide more high-quality mechanical application-oriented talents for the industry.

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