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Blended Teaching Reform Exploration of "Structural Design of Mechanical Equipment" Based on the Chaoxing Fanya Platform

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Abstract: "Structural Design of Mechanical Equipment" is a core course for mechanical engineering majors, characterized by strong engineering relevance, comprehensiveness, and practicality. However, the traditional teaching model suffers from a disconnect between theory and practice, insufficient student participation, and a unitary assessment approach. Based on the Chaoxing Fanya Platform and the Xuexitong mobile application, this paper explores the path of online-offline blended teaching reform, using the course as a vehicle. The study implements practices in curriculum content restructuring, online resource construction, flipped classroom implementation, and diversified assessment. It forms a four-in-one teaching model: "online preview – classroom discussion – after-class extension – project-driven learning." Teaching practice shows that this model effectively enhances students' learning initiative and engineering practical abilities, providing a valuable reference for blended teaching reform in mechanical engineering core courses.

1. Introduction

With the in-depth advancement of the Education Informatization 2.0 initiative, the deep integration of information technology with education and teaching has become a key direction for higher education reform. The online-offline blended teaching model breaks the spatial and temporal limitations of traditional classrooms. It effectively integrates the advantages of high-quality online resources with face-to-face classroom teaching, offering students a more flexible and personalized learning experience.

"Structural Design of Mechanical Equipment" is a core course for mechanical engineering majors. It covers the general principles and methods of structural design for mechanical equipment, as well as the structural design of typical equipment in machinery manufacturing (using machine tools as examples). The aim is to help students master the fundamental principles and methods of mechanical equipment structure design. However, the course has a large knowledge system, rich engineering cases, and high practical requirements. As a result, the traditional teacher-centred lecture model struggles to fully stimulate students' learning interest and effectively cultivate their engineering thinking and innovation capabilities. Against this background, this paper relies on the Chaoxing Fanya Platform and integrates the Xuexitong mobile teaching tool. It explores the blended teaching reform of this course to provide a reference for similar courses.

2. Current Course Status and Problem Analysis

The "Structural Design of Mechanical Equipment" course [1] covers a wide range of content, including:

(1) Introduction and preliminary remarks;

(2) Mechanical structure optimization design (basic concepts, topology optimization, size optimization, shape optimization, etc.);

(3) Typical part structural design (design principles for metal cutting parts, castings, welded parts, and metal plastic forming parts);

(4) Transmission system design (typical mechanisms, structural analysis of the CA6140 lathe transmission system, kinematic design of the main drive system, etc.);

(5) Spindle assembly design (overview, bearing structure and selection, shaft support positioning methods, structural design principles, and case analysis);

(6) Support member design (design requirements and materials).

The course currently relies heavily on video teaching resources, supplemented by homework exercises, with a large repository of multimedia materials already developed. However, an in-depth analysis reveals several prominent problems in the traditional teaching model.

First, there is a serious disconnect between theory and practice. Traditional classroom teaching focuses on delivering theoretical knowledge, but students lack opportunities to apply this knowledge to actual engineering problems. This results in a widespread phenomenon of "learning but being unable to use."

Second, student participation is insufficient. In large-class teaching, teacher-student interaction is limited. Students remain in a passive knowledge-receiving position for extended periods, making it difficult to effectively mobilize their learning enthusiasm and initiative.

Third, teaching resources are underutilized. Although the course has built relatively rich video resources, their organization and application are rather monotonous. The full pedagogical value of online resources is not being exploited.

Finally, the assessment method is monotonous. Traditional assessment relies mainly on final examination scores, lacking continuous tracking and evaluation of the learning process. Thus, it cannot comprehensively reflect students' learning outcomes.

3. Blended Teaching Reform Design

Grounded in the OBE (Outcome-Based Education) philosophy [2–4], this reform adopts a student-centered, outcome-oriented approach and follows the principle of "continuous improvement." The core idea is to build an online teaching resource repository based on the Chaoxing Fanya Platform, achieve the "spatial-temporal reversal" of knowledge delivery and knowledge internalization through flipped classrooms [5–6], promote the integration of theory and practice via project-driven learning, and implement full-process learning tracking through diversified evaluation [7].

The specific reform objectives include:

(1) Restructuring the course content system to better align with engineering practice;

(2) Constructing systematic online learning resources to support students' autonomous and personalized learning;

(3) Innovating classroom teaching modes to enhance student participation and depth of thinking;

(4) Establishing a diversified assessment and evaluation system to comprehensively reflect students' learning outcomes.

3.1. Online Resource Construction

We modularly split course knowledge points using the Chaoxing Fanya Platform. Each module is recorded as 10 to 20 minutes micro-lecture videos that highlight key points, difficult areas, and typical examples. We make full use of existing video resources while supplementing explanations of critical knowledge points.

After each chapter, online tests are set up, including multiple-choice questions, true/false questions, and short-answer questions. Objective questions are automatically graded by the system, while subjective questions are graded online by the instructor. This helps students consolidate knowledge in a timely manner.

In addition, we have collected and organized a typical engineering case library centred on actual equipment such as the CA6140 lathe. This closely combines theoretical knowledge with engineering practice. A course forum is also opened to encourage students to raise questions and share insights. Instructors provide regular online responses, thus forming a positive online learning community.

3.2. Teaching Implementation Process

This reform constructs a four-in-one teaching model: "online preview – classroom discussion – after-class extension – project-driven learning."

Pre-class phase: Instructors release preview tasks through the Chaoxing Fanya Platform, including watching designated micro-lecture videos, completing pre-class quizzes, and reading relevant case materials. Students use fragmented time before class to complete the preview. Meanwhile, instructors monitor students' learning progress and knowledge mastery through platform data.

In-class phase: The classroom is no longer dominated by knowledge lecturing but adopts a flipped classroom format. Instructors first spend 5–10 minutes on a quick review to sort out core knowledge points. Then, they organize students to engage in group discussions and problem inquiries around engineering cases. For example, when teaching "Spindle Assembly Structure Design," the CA6140 lathe spindle assembly is used as a case to guide students in analysing its structural characteristics, bearing selection basis, and positioning methods. Classroom discussions encourage students to question, debate, and share, with instructors providing timely guidance and summaries.

Post-class phase: Extension tasks are released via the platform, including case analysis reports, simulation exercises, and group project discussions. After students submit their assignments, instructors grade them online and provide feedback.

Project-driven teaching: This runs throughout the semester, driven by real engineering problems. Students are divided into several project teams, each focusing on a design topic related to mechanical equipment structure. Students gradually complete scheme design, structural analysis, optimization, and improvement during the course. Finally, they submit design reports and present their outcomes.

3.3. Assessment and Evaluation

The reformed assessment system emphasizes the combination of formative and summative assessment:

Online learning performance (20%): Based on video viewing completion, chapter test scores, and discussion participation.

Classroom performance (15%): Includes attendance, participation in group discussions, and question-answering.

After-class assignments (20%): Evaluates the quality of homework and case analysis reports.

Project design (25%): Examines the innovativeness of the design scheme, structural rationality, report standardization, and presentation effectiveness.

Final examination (20%): Adopts a closed-book format to assess students' comprehensive ability to apply knowledge.

Such a multi-dimensional evaluation approach can more objectively reflect students' learning process and capability development.

4. Effects of Teaching Reform Practice

After one semester of blended teaching practice, the reform effects have begun to emerge.

Student participation and learning initiative: Data statistics from the Chaoxing Fanya Platform show that the completion rate of micro-lecture videos exceeded 90%, and the average participation rate in chapter tests exceeded 85%. The number and quality of student contributions during classroom discussions significantly improved compared with traditional classrooms. The proportion of students who actively asked questions and raised queries increased markedly. This indicates that online preview and classroom flipping effectively stimulated students' intrinsic learning motivation.

Engineering practical ability: Project-driven teaching provided students with valuable opportunities to apply theoretical knowledge to real problems. In completing project design tasks, students needed to comprehensively apply knowledge from multiple modules, such as structural optimization design, transmission system design, and spindle assembly design. This effectively promoted the integration of knowledge. The project presentation session also fully exercised students' scheme design and engineering communication abilities.

Teaching satisfaction: A survey conducted after the course showed that the majority of students approved of the blended teaching model. They believed that online preview helped them understand course content in advance and enter the classroom with questions. Classroom discussions enhanced teacher-student and student-student interaction, and project-driven tasks gave learning a greater sense of purpose and achievement. Overall teaching satisfaction improved significantly compared with previous traditional classrooms.

5. Reflection and Prospects

During the reform practice, several urgent issues have come to light:

First, students' autonomous learning abilities vary considerably. Some students lack good self-directed learning habits, and online preview becomes a mere formality. This affects the depth and effectiveness of classroom discussions.

Second, the workload for online resource construction is heavy, and quality requirements are high. Developing high-quality micro-lecture videos, case libraries, and test banks requires substantial time and effort. It is difficult for a single instructor to complete systematic resource construction in a short period.

Third, the issue of fairness in group cooperative learning cannot be ignored. In project-driven teaching, there may be differences in contribution levels among group members. How to fairly evaluate each member's performance remains a challenge in practice.

In response to these problems, subsequent reform will continue to improve in several aspects:

Strengthen learning guidance and supervision: Use platform data to track students' learning behaviours in real time, provide timely reminders and individualized tutoring to those who fall behind, and gradually cultivate their autonomous learning ability.

Promote co-construction and sharing of teaching resources: Rely on course teams and interinstitutional cooperation to jointly build and improve online teaching resource repositories, thereby reducing the burden on individual instructors.

Optimize group evaluation mechanisms: Introduce intra-group peer evaluation and individual contribution assessment to ensure that project scores truly reflect each member's learning outcomes.

Continuously integrate curriculum ideology and politics: Organically incorporate scientific and technological achievements, craftsmanship spirit, and innovation culture from the field of mechanical equipment into teaching content, achieving the unified integration of knowledge delivery and value guidance.

6. Conclusions

This paper, taking the "Structural Design of Mechanical Equipment" course as the vehicle, explores blended teaching reform based on the Chaoxing Fanya Platform. Through measures such as online resource construction, flipped classroom implementation, project-driven teaching, and diversified assessment, it establishes a four-in-one teaching model: "online preview – classroom discussion – after-class extension – project-driven learning." Practice shows that this model can effectively enhance students' learning initiative and engineering practical abilities, providing a useful reference for the blended teaching reform of core courses in mechanical engineering. In the future, we will continue to optimize and improve upon the existing reform outcomes, constantly enhance course teaching quality, and strive to cultivate mechanical engineering talents that meet the demands of the new era.

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