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Discussion on the Teaching Reform and Practice of "Civil Engineering Materials" under the Background of "New Engineering"

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Abstract: As a fundamental course in civil engineering, the reform and practice of "Civil Engineering Materials" are crucial for the development of the civil engineering discipline. This paper addresses previous teaching shortcomings and integrates the new requirements of "New Engineering" construction. It explores the reform of teaching methods for "Civil Engineering Materials" in five areas: optimization and integration of teaching content, adjustment of experimental content, application of online learning platforms, cultivation of students' innovative abilities, and optimization of assessment methods. The paper offers constructive suggestions for the future development and practice of the course.

Keywords: New Engineering; Civil Engineering Materials; Applied; Teaching Reform.

1. Introduction

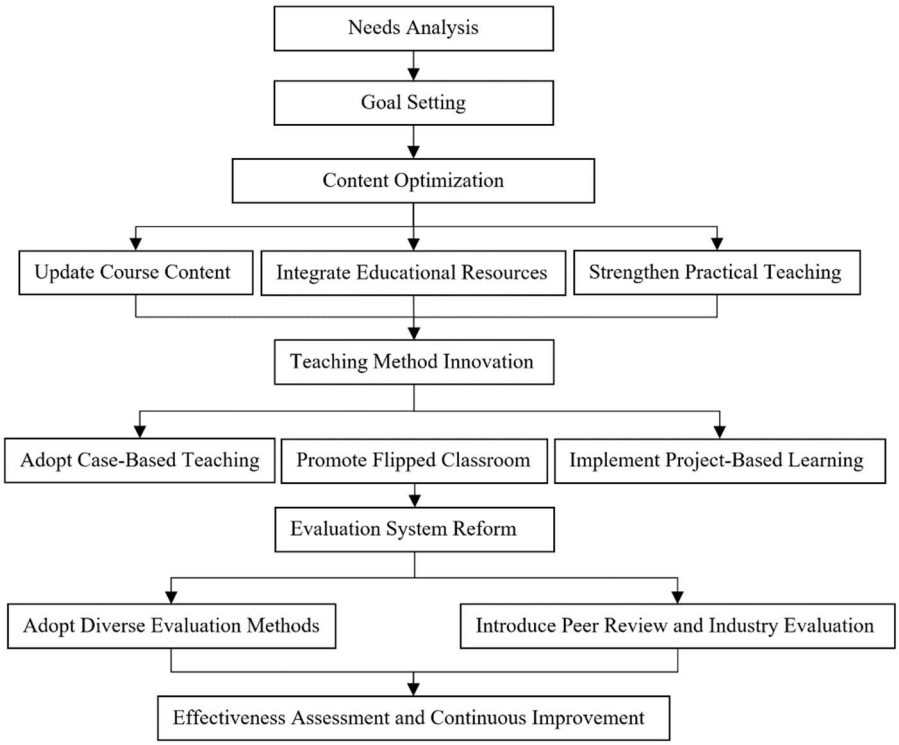

Figure 1. Flow chart of teaching reform and practice

"New Engineering" majors are enhancements to traditional engineering disciplines, incorporating intelligent manufacturing, artificial intelligence, robotics, and more. These emerging industries and new economies demand high-quality, versatile "New Engineering" talents with strong practical and innovative abilities and international competitiveness [1]. Although civil engineering is not classified under "New Engineering," its development endows this traditional engineering field with new connotations. As a fundamental course in civil engineering, "Civil Engineering Materials" lays the foundation for subsequent professional courses and research work. It equips students with the ability to select and use civil engineering materials effectively in their future professional roles. The course aims to provide an understanding of the raw materials and production processes of commonly used materials in civil engineering, familiarize students with the basic properties and applications of these materials, and develop their basic knowledge and experimental skills. The course comprises 48 class hours, including 32 hours of theoretical teaching and 16 hours of

experimental teaching [2]. However, the theoretical content is complex, the total class hours are insufficient, and the content is heavily text-based, making it easy for students to become bored and retain weak memories of conceptual content. Additionally, the course includes many experimental projects, which, if all are covered, can lead to a superficial understanding, making students feel that the experiments are merely formalities and not deeply grasping the important content. In response to this, based on our school's actual teaching situation, the teaching reform of this course has been discussed from the following five aspects.

2. Optimization and Integration of Teaching Content

As a local applied undergraduate college, our school's teaching direction for "Civil Engineering Materials" focuses on cultivating practical abilities. Therefore, we primarily use the textbook edited by Jiao Baoxiang. However, to meet the evolving needs of the civil engineering discipline, it is essential to strengthen the learning of basic theoretical knowledge, enabling students to develop a broader and deeper professional knowledge base for further study in other subjects. Consequently, the original teaching content has been adjusted to enhance students' understanding of common civil engineering materials. Due to limited class hours, the teaching content on wood and synthetic polymer materials, which have a narrow application range and strong professional attributes, has been removed. Instead, the focus on the basic properties of civil engineering materials and the hardening mechanism of concrete has been increased. Considering the overlap with content covered in "Civil Engineering Testing and Reinforcement," the proportion of material on the destruction mechanisms of metal materials and concrete has been reduced. For the study of new civil engineering materials, students are divided into groups to research the latest advancements and present their findings in an 8-10 minute group report using PPT. This approach not only enriches students' understanding of new materials but also enhances their literature review skills. Given the continuous development and updating of civil engineering materials, it is crucial to emphasize updated standards and specifications. For instance, the National Standardization Administration Committee issued GB 175-2023 "General Portland Cement" on June 1, 2024, which canceled 32.5 strength cement [3]. Therefore, the teaching content, especially regarding concrete mix design, needs to be updated accordingly. Although bilingual teaching is currently challenging, English can be incorporated into the course as much as possible. Titles and key professional terms can be presented in both Chinese and English, and English abbreviations should be explained to students, such as P.O. for Portland Ordinary cement and HRB for Hot-rolled Ribbed Bars [4]. This approach not only helps students remember the meanings of English abbreviations but also enhances their mastery of professional English vocabulary. Through the optimization and integration of teaching content, the knowledge system of "Civil Engineering Materials" will be more comprehensive, meeting the current requirements of the civil engineering discipline for foundational professional knowledge.

3. Adjustment of Experimental Content

As a local applied undergraduate college, the experimental course on civil engineering materials should focus on cultivating innovative practical abilities. Consequently, the original experimental content has been adjusted to enhance students' skills in testing the performance of civil engineering materials and their innovative abilities. Due to limited class hours, experiments on sintered porous bricks and petroleum asphalt, which have a narrow application range and strong professional attributes, have been removed. The proportion of content on the basic properties of cement and the design of concrete mix proportions has been increased, with a focus on testing the performance of concrete. During the experiments, students are divided into groups of 4-5 people. Given the significantly lower number of girls than boys in the civil engineering major, girls should be assigned to each group and serve as group leaders to ensure a reasonable division of labor. Since civil engineering materials are constantly updating and developing, relevant standards, specifications, and operating methods for experiments have also undergone significant changes, necessitating timely updates to experimental content. For example, the tensile strength of steel bars in the metal tensile test, which was originally rounded to 5 MPa when the tensile strength was between 200-1000 MPa, has now been changed to 1 MPa. Additionally, since 2023, the 32.5 strength cement in GB 175-2023 "General Portland Cement" has been canceled, so the cement used in corresponding experiments should be 42.5 strength or higher. For verification experiments, such as the cement mortar strength test, the strength of samples reserved one year ago can be compared with newly prepared samples, allowing students to more intuitively understand the impact of age on the hydration strength of cement. Through the optimization and adjustment of experimental content, the knowledge system of the experimental course on civil engineering materials will be more complete, with more prominent key points, meeting the current requirements of the civil engineering discipline for professional practical abilities.

4. Application of Online Learning Platforms

With the advancement of modern information technology, the use of digital media and mobile devices has become increasingly prevalent. Enhancing learning efficiency and the teaching process through new technologies is a current trend in educational research. "Learning Pass" is one such emerging tool. Utilizing the "Learning Pass" online learning platform provided by our school, we have developed an online learning platform for the "Civil Engineering Materials" course. This platform facilitates QR code sign-in, saving time on classroom roll calls, and offers rich content, including teaching videos, PPTs, online question banks, electronic lesson plans, teaching outlines, and experimental guides. Students can ask questions via bullet comments, and there is an interactive discussion area. Before class, rich teaching resources can be easily inserted into slides and pushed to students' WeChat at any time. After each chapter, online assignments can be distributed to the class, featuring various question types such as objective and subjective questions, voting questions, attachment answers, photo uploads, and voice replies. Since the implementation of the "Learning Pass" platform, it has significantly guided the teaching of "Civil Engineering Materials." With the platform's help, students can study independently without being constrained by the teaching space. To further enhance course interactivity, a

classroom questioning session has been designed, and random roll calls can be conducted through "Learning Pass." If students answer correctly or provide meaningful answers, even if incorrect, they will receive extra points for their usual performance. Accumulating three extra points, in addition to full attendance, will result in full marks for their usual performance, greatly increasing students' enthusiasm for answering questions in class. In addition to in-class and after-class office hours, a QQ study group has been established to ensure that students' questions can be answered promptly.

5. Cultivation of Students' Innovative Abilities

As the second foundational course in the university curriculum, "Civil Engineering Materials" is typically scheduled for the first semester of the sophomore year. This period is considered optimal for college students to engage in technological innovation, as the difficulty of courses increases in the junior year, and students also need to prepare for postgraduate entrance exams. Given that technological innovation projects such as the "Challenge Cup," "Innovation and Entrepreneurship," and "Internet+" often have limited funding, achieving innovation through civil engineering practice can be challenging. Therefore, focusing on civil engineering materials is a strategic choice. Research areas include the preparation of high-performance concrete, the resource utilization of construction waste, engineering disease prevention measures related to building materials, and enhancing the durability of building materials. Through participation in technological innovation projects, students' practical skills and research abilities will be significantly enhanced.

6. Optimization of Assessment Methods

Previously, before starting experiments, the instructor would explain the detailed content of the experimental guide and demonstrate the specific operation process. However, if students merely replicate the steps in the guide, it often results in uniform experimental outcomes and identical data in reports. Currently, students are required to preview the experimental guide in advance and are randomly questioned to assess their preparation. This approach encourages pre-experiment preparation and independent thinking. Students conduct experiments based on their understanding of the guide, fostering critical thinking. Experimental results must be accurate; if the results do not meet the requirements, students must analyze the reasons for the discrepancies and summarize the problems encountered, rather than altering the data. Additionally, the experimental process is assessed, including the standardization and seriousness of operations, cooperation among students, detailed data recording, material wastage, attention to experimental safety, care for equipment, and maintenance of laboratory cleanliness after the experiment.

7. Conclusion

With the continuous advancement of "New Engineering" construction, cultivating high-quality, versatile talents in civil engineering and enhancing students' practical abilities to solve engineering problems have become key research focuses for engineering colleges. The teaching reform and practice of the "Civil Engineering Materials" course will align with the "New Engineering" training objectives and the development of the civil engineering discipline. The course will continuously integrate the latest research findings into the teaching content and emphasize practical teaching based on theoretical foundations to develop students' problem-solving abilities. The ultimate goal is to produce professional technical talents with strong practical and innovative skills and international competitiveness, contributing to national and social development.

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