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Research on the Construction and Application of Network Resource Base of Civil Engineering Materials based on Hybrid Teaching Mode

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Abstract: With the deepening development of educational informatization, blended teaching models have gradually become an important means to enhance course teaching effectiveness. This paper takes the "Civil Engineering Materials" course as the research object and explores the construction and application practice of a blended teaching model based on a network resource repository. By analyzing the current status and challenges of course teaching, it proposes research objectives such as building a multi-dimensional network resource repository, innovating the blended teaching model, and improving the teaching evaluation system. Research indicates that the establishment of a network resource repository and the implementation of a blended teaching approach have notably enhanced student learning outcomes and the teaching capabilities of educators., providing practical references for the reform of civil engineering materials course teaching.

Keywords: Blended Teaching, Network Resource Base, Civil Engineering Materials, Teaching Reform.

1. Introduction

Blended learning, as a teaching paradigm, effectively combines traditional face-to-face classroom instruction with digital online learning to create a student-centered approach that leverages the strengths of both modalities[1]. This integration aims to foster personalized learning experiences and facilitate deep knowledge construction[2]. Empirical studies have shown that blended learning can significantly enhance student academic performance, as evidenced by improved exam scores and increased learning engagement[0]. Moreover, it promotes the development of students' self-directed learning skills and collaboration, which are crucial for their overall educational growth[3]. Its defining characteristic lies in transcending the constraints of isolated teaching environments by merging fragmented online resource utilization, autonomous exploration, and profound interaction along with practical operationations in offline classrooms, forming a comprehensive teaching loop from "pre-class-during-class-post-class" [3], thereby enhancing teaching efficiency and learning outcomes. This study uses the course "Civil Engineering Materials" as a vehicle, exploring how to improve teaching effectiveness and cultivate students' professional skills and vocational qualities through the development of an online resource repository and the implementation of blended learning.Organization of the Text

2. Current Situation and Existing Problems of Course Teaching

The course on civil engineering materials serves as a fundamental technical cornerstone for majors in civil engineering, architecture, and others [4], encompassing the composition, properties, testing methods, and practical applications of numerous materials, including inorganic cementitious materials, concrete, steel, and decorative materials [5]. Traditional teaching faces the following difficulties.

Fragmentation of content and lack of logic: The course encompasses a diverse range of materials, yet the knowledge points seem disconnected. Specifically, the explanation of performance indicators, testing methods, and engineering applications for cement, steel, asphalt, and other materials stands alone, without a cohesive thread linking them together. Consequently, students often grapple with the challenge of merely memorizing information without understanding its broader context.

The disconnection between theory and practice is a significant issue, particularly in the field of material properties where understanding is often dependent on experimental verification, such as concrete mix design and steel tensile testing. Traditional classroom settings, constrained by time and space, often fail to provide students with direct observation of these experimental processes and real-world engineering applications, thereby limiting the cultivation of practical skills.

Students lack sufficient motivation for independent learning due to the abstract course terminology and complex data. While traditional lecture-based teaching has its place, it often struggles to engage students actively in the learning process, potentially leading to a lack of interest and a deficit in the ability to explore and solve practical problems.

3. Three-dimensional Construction and Hierarchical Architecture of Network Resource Base

3.1. Development of Micro-videos on Knowledge Points with Students as the Main Body

Breaking the traditional resource construction model of "one-way teacher output," the course syllabus is divided into 12 knowledge modules (such as "Cementitious Materials" and "Construction Steel"), and further refined into 5-8 core knowledge points (such as "Mechanism of Cement Agglomeration and Hardening" and "Steps in Concrete Mix Design"). Students are organized into groups of 3-5 to

independently select knowledge points and produce 3-5 minute micro-videos through methods like literature review, animation creation, and on-site shooting. The video "Flash-Cement" produced by the 2021 cohort of Architecture students integrates cement production processes, performance characteristics, and industry development, presenting silicate cement knowledge in an engaging format. It has received many positive reviews during teaching and achieved good educational outcomes.

3.2. Visualization Engineering Testing Experiment Video System

For core testing items such as concrete slump tests and steel tensile tests, videos capture the entire process, from 'principle explanation' to 'instrument operation,' 'data recording,' and 'result analysis.' Techniques such as slow motion and close-ups are employed to highlight key steps, including measuring the expansion value of the Lees' clamp and comparing the impact of the water-cement ratio on concrete strength. For instance, the video on 'cement stability testing' offers a comprehensive explanation of the boiling method.rinciple to help students understand the relationship between experimental operations and material properties; the video on "comparative study of concrete strength at different water-cement ratios" visually presents the variable control and result analysis process, reinforcing students' understanding of factors affecting material properties.

3.3. Scenario-based Material Image Library and Engineering Case Library

To establish a comprehensive understanding, we will create a three-tier image library encompassing 'material appearance, testing process, and engineering application.' This will incorporate diverse scenarios, ranging from cement packaging bags and rebar rib patterns to UHPC bridge applications and autoclaved aerated concrete wall construction, thereby fostering an intuitive link between theoretical knowledge and practical engineering scenarios. In line with the industrial needs of North China, develop localized engineering case libraries, such as "Corrosion-resistant Steel Application in Caofeidian Industrial Zone," "Green Building Materials Standards in Xiongan New Area," and "Wall Material Optimization after Tangshan Earthquake Reconstruction." These libraries will analyze the basis for material selection, performance indicators, and implementation effects through text, images, and videos, reinforcing the core logic of "material performance serving engineering needs."

3.4. "Salt Water" Course Ideological and Political Case Library

In the course teaching, ideological and political elements are integrated from three dimensions: history, practice and innovation.

Historical dimension: Develop cases such as "A Century of China's Cement Industry" and "From' foreign cement 'to' Chinese standard '" to enhance students' national pride.

Practical dimension: Introduce negative case studies, including "Changchun Changsheng's Material Fraud in Vaccine Production" and "The Bridge Steel Corrosion Accident", to guide students to discuss the harm of lax material testing and establish the professional ethics of "quality first".

Innovation dimension: Showcase the groundbreaking scientific achievements of Feng Naiqian, the "father of Concrete" in China, alongside Academician Wang Guodong, the "guru of steel", to ignite students' passion for innovation within the realm of materials science.

4. Construction and Implementation Path of Mixed Teaching Mode

4.1. Pre-class: Problem-oriented Independent Learning

Teachers release preview tasks on the Learning Hub platform three days in advance, including required micro-videos, optional image libraries, and 5-10 automatically graded exercises. For example, in the pre-class task for "Concrete Mix Design," students watch the micro-video on "Water-Cement Ratio and Strength Relationship" and complete calculation exercises. The system automatically records incorrect answers and pushes out explanations of key points. Students submit questions through the discussion area, and teachers compile frequently asked questions to adjust classroom teaching priorities, achieving "teaching based on learning."

4.2. In Class: The Cultivation of Deep Interaction Ability

Knowledge Point Logical Linkage: Construct a material knowledge network with the main thread of "composition-structure-performance-testing-application." For example, in the chapter on "steel," explain how the crystal structure affects strength from the composition of Fe-C alloys, To transition to a detailed discussion on tensile testing methods, we can refer to the UNE-EN ISO 6892-1:2020 standard, which outlines the method of test at room temperature for metallic materials., and finally relate it to engineering applications such as beam and column reinforcement, helping students form a cognitive framework of cause-and-effect relationships.

Case-driven Group Collaboration: Select complex cases such as "wall cracking in residential buildings" and "concrete preparation for the Hong Kong-Zhuhai-Macao Bridge island tunnel project," and organize group discussions. Students need to consult image libraries and experimental videos, analyze problems by combining material properties, testing standards, and environmental factors, propose solutions, and develop their engineering problem-solving skills.

4.3. After Class: Stratified Expansion and Personalized Feedback

Set up tiered assignments in the form of "Basic Questions (Knowledge Point Reinforcement) - Advanced Questions (Case Analysis) - Innovative Questions (Material Improvement Design)," allowing students to choose based on their abilities. Leveraging the Learning Hub, educators can monitor key engagement metrics such as video viewing duration, assignment completion rates, and discussion participation. This data is instrumental in crafting personalized learning reports and in identifying areas where students may require additional support. By doing so, supplementary resources can be strategically provided to bolster weaker areas, ensuring a more targeted and effective educational guidance.

5. Implementation and Application Effect

The establishment of online resource libraries represents a breakthrough from the conventional approach where teachers solely construct resources. By involving students in micro-video production and case collection, it fosters a positive interaction between teaching, learning, and industry. When students create videos on 'Autoclaved Aerated Concrete Block Masonry Technology,' they actively refer to the 'Code for Acceptance of Construction Quality of Masonry Structures,' thereby gaining a profound understanding of construction processes. "learning by doing." This model not only enriches the resource library but also fosters students' abilities in information retrieval, summarization, and real-world application.

By dissecting knowledge points into micro-videos, experimental snippets, and various bite-sized resources, we cater to the demands of fragmented learning in the mobile-centric educational era; Concurrently, leveraging tools such as the "Material Performance Pyramid" and the "Engineering Application Flowchart" to construct a robust knowledge framework aids students in developing a coherent understanding. For instance, the micro-video module dedicated to "Cement" unfolds in the sequence of "production process," "hydration reaction," "performance testing," leading into "engineering applications", application," complemented by mind maps to present the connections between knowledge points, addressing the issue of traditional teaching where "only the trees are seen but not the forest." This approach has yielded good results in courses for civil engineering and architecture majors.

6. Conclusion

The constructed blended teaching model and online resource repository system effectively address the traditional teaching challenges of the "Civil Engineering Materials" course, providing a three-dimensional path for engineering curriculum reform: "resource co-construction-model innovation-ideological and political integration." Practical experience has shown that through student participation, deep technological empowerment, and seamless integration of ideological and political education, significant improvements have been achievedicant improvements in teaching quality and talent cultivation can be achieved. This experience can serve as a reference for similar curriculum reforms, promoting the transformation of teaching paradigms under the background of "Internet + Education.".

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