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# Construction of Innovative Teaching Mode of Civil Engineering Materials Based on Human-computer Interactive Multimedia Teaching

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**Abstract:** The rapid advancement of modern information technology has facilitated the integration of human-computer interaction and multimedia technology into education, driving the transformation of traditional teaching methods while significantly increasing the amount of information accessible in classrooms. In the teaching of civil engineering materials, conventional methods face challenges such as complex content, difficulties in student comprehension, and limited practical teaching resources. A multimedia teaching model leveraging human-computer interaction offers a promising solution for these issues. This paper explores the construction of an innovative teaching model for civil engineering materials by integrating human-computer interaction, multimedia technology, and the teaching process. The research focuses on multimedia resource design, virtual simulation experiments, student self-directed learning platforms, and teaching outcome evaluation systems. Through practical applications and case studies, the paper highlights the model's benefits, addresses its challenges, and outlines potential future development directions.

**Keywords:** Human-computer interaction, multimedia teaching, civil engineering materials, innovative teaching model, virtual simulation.

## 1. Introduction

With the popularization of information technology, traditional teaching methods have been difficult to meet the needs of contemporary higher education. Especially in civil engineering-related majors, civil engineering materials courses use traditional theoretical explanations to make students feel boring, and the most important thing is that students can not feel the authenticity of civil engineering materials from the teaching process. In addition, traditional classroom teaching methods are easy to be limited by time, space and resources, and students' understanding of complex material properties and structures is abstract, which is difficult to achieve in-depth understanding through a single theoretical explanation. The development of human-computer interaction technology and multimedia means in contemporary society has brought great potential for teaching innovation in this field. Through the introduction of human-computer interaction technology and multimedia resources, teachers can more vividly and vividly demonstrate the complex concepts of civil engineering materials, enhance students' learning interest and understanding depth, integrate rich teaching resources, expand the teaching quantity and transmission of knowledge, and students can more deeply remember the teaching content and understanding degree in multimedia technology. By analyzing the professional characteristics of civil engineering and engineering management, Luo Ling et al. [1] deeply applied the connotation of hybrid teaching to the teaching of civil engineering materials, and tried to divide the courses into the selection of online platforms and the decomposition of offline courses, effectively improving the teaching effect of civil engineering materials courses. This paper studies the application of human-computer interaction and multimedia technology in the teaching of civil engineering materials, builds an innovative teaching model, and evaluates its effect in practical teaching. This model not only provides teachers with rich teaching tools, but also provides students with a more active and flexible learning environment.

## 2. Analysis of the Teaching Status of Civil Engineering Materials

### 2.1. Limitations of Traditional Teaching Modes

The course on civil engineering materials is a fundamental core subject for civil engineering majors, focusing on the performance, applications, and mechanical properties of various materials, such as concrete, steel, wood, and asphalt [2]. However, the traditional teaching approach predominantly relies on teacher-led oral instruction, which has significant limitations.

(1) Monotonous Content and Lack of Engagement:

The traditional approach emphasizes theoretical concepts and technical characteristics of materials. The material-heavy and concept-focused curriculum often feels monotonous and uninteresting to students. For instance, understanding the physical and chemical properties of materials and their application scenarios involves substantial theoretical knowledge. This reliance on textual and pictorial explanations fails to provide students with a tangible or intuitive grasp of the concepts, making it challenging for them to retain and apply the information effectively.

(2) Limited Student Interaction and Engagement:

Modern students often have minimal exposure to hands-on experiences with materials, which diminishes their active participation. This lack of interaction restricts their

enthusiasm and engagement with the subject. Without meaningful involvement, students struggle to connect with the material, further impeding their learning process.

(3) Insufficient Practical Opportunities:

The hands-on aspects of civil engineering materials education are constrained by limitations in credit hours and allocated time within university curricula. Experimental courses, which are essential for understanding material behavior, require significant resources, such as specialized equipment and diverse samples. However, in many institutions, experimental infrastructure is inadequate, resulting in limited hands-on opportunities for students. Consequently, practical skill development is insufficient, leaving students less prepared for real-world applications [3].

These limitations underscore the need for innovative teaching approaches that can bridge the gap between theoretical knowledge and practical application while fostering greater student engagement and understanding.

### 2.2. Analysis of Students' Learning Needs

Modern students increasingly prioritize an enriched learning experience, with high expectations for advanced information delivery and easy access to diverse resources through multiple channels. They seek to leverage modern scientific and technological tools to adopt diversified learning methods, aiming to improve learning efficiency and engagement.

Survey results indicate that students show a strong preference for practical and interactive teaching methods, particularly in courses that involve the application of complex technologies and materials. This preference is driven by the need for a deeper understanding of challenging concepts and processes. Specifically, the ability to enhance comprehension through simulation and visualization tools has emerged as a critical demand. These tools allow students to bridge the gap between theoretical knowledge and practical application, providing a more intuitive grasp of material properties, behaviors, and applications.

By addressing these needs, educators can create a more engaging and effective learning environment, aligning teaching methods with the expectations of a technology-driven generation.

## 3. Overview of Multimedia Teaching Mode Based on Human-computer Interaction

### 3.1. Overview of human-computer interaction and multimedia technology

Human-Computer Interaction (HCI) refers to the process of information exchange between humans and computers through multiple input devices. In the field of education, human-computer interaction technology mainly provides students with more intuitive and interactive learning experience through virtual reality (VR), augmented reality (AR), touch screen, voice recognition and other technologies [4].

Multimedia technology uses computers to integrate text, pictures, audio, video and other media to form rich teaching content to help students better understand and master knowledge. In the teaching of civil engineering materials, through multimedia technology, the internal structure, mechanical properties and construction process of complex materials can be visualized.

### 3.2. Construction objectives of teaching model

Through the richness and interactivity of multimedia resources, it can enhance students' learning interest and promote in-depth understanding of knowledge. The use of virtual experiment and simulation software to make up for the traditional teaching resources and time constraints, optimize the integration of classroom teaching and experimental teaching. Through the virtual experiment and simulation system, students can obtain experimental experience similar to the real environment in the absence of actual operating conditions, and improve their hands-on ability and problem solving ability.

## 4. Application of Multimedia and Human-Computer Interaction Technology in the Teaching of Civil Engineering Materials

### 4.1. Multimedia Teaching Resource Design

Multimedia technology plays a crucial role in enhancing the teaching of civil engineering materials by enabling the creation of dynamic and visually rich teaching resources. These resources can integrate tools such as three-dimensional modeling, animation simulations, and real-world video demonstrations within multimedia courseware to provide a more engaging and effective learning experience.

Using 3D modeling software, instructors can illustrate the microstructure of materials. The aggregate distribution within concrete can be modeled to show how it affects material strength and durability. The grain structure of steel can be displayed to explain its mechanical behavior under different stress conditions.

These visualizations help students grasp the internal composition of materials and its direct relationship to their performance. Animation simulations can vividly depict the deformation and fracture behavior of materials under various loading scenarios. Compression failure in concrete can be animated to show stress distribution and crack propagation. Fatigue failure in steel can be demonstrated to explain how repetitive loading leads to material failure.

These animations provide students with an intuitive understanding of complex mechanical properties and failure mechanisms that are difficult to convey through static images or verbal descriptions.

The teaching material can be delivered in multiple forms, including graphics, videos, and animations, to cater to different learning preferences. By incorporating multimedia technology into the design of teaching resources, educators can effectively address the challenges of abstract concepts and theoretical content, transforming the classroom into a more interactive and enjoyable learning environment.

### 4.2. Virtual Simulation Experiment Platform

A virtual simulation experiment platform, built on computer simulation technology, provides an innovative teaching approach well-suited for courses that emphasize practicality but face constraints in experimental resources [5]. In the civil engineering materials course, students can utilize a virtual simulation platform to design concrete formulations with varying ratios of components such as cement, aggregates, water, and additives. This platform allows them to:

Explore Material Properties, Adjust the proportions of materials to create unique concrete formulations. And simulate the impact of these ratios on key properties, such as compressive strength. Use a virtual laboratory to test the performance of the designed formulations under simulated load conditions. Analyze results to understand how specific mixture adjustments affect concrete strength and durability.

This hands-on virtual approach enhances students' understanding of material composition and provides valuable insights into optimizing concrete for different engineering applications.

### 4.3. Interactive learning platform

The learning platform based on human-computer interaction can provide students with independent learning and feedback opportunities. On the multimedia teaching platform, students can participate in real-time online tests, and the system automatically generates personalized learning feedback and suggestions according to the answers of students. Through voice recognition and AI technology, students can interact with virtual tutors to obtain targeted question answers and learning guidance, enhancing the flexibility and autonomy of learning [6].

## 5. Implementation and Case Analysis of Innovative Teaching Model

### 5.1. Take the teaching of civil engineering materials in a university in Yunnan as an example

Virtual concrete experiment: Through virtual simulation experiment, students designed a variety of different proportions of concrete in class, and tested the compressive strength in the computer simulation software. The experimental results are consistent with the expectations in the theoretical course. Through the simulation experiment, the students have a deep understanding of the influence of different material ratios on the performance of concrete, and then they enter the real laboratory of the school for on-site test mixing, adjustment, maintenance and other processes, and then carry out the compressive test in the pressure testing machine. The results are similar to the simulated results, but due to the different environments under real conditions, the results are similar to the simulated results. The result is a difference in experimental results, and students understand that there is a difference between theoretical and practical results. The second time, the steel mechanics simulation experiment was done: on the virtual platform, the students simulated the tensile experiment of steel. The process of steel deformation and fracture under different stresses and environmental conditions is shown through animation and simulation, so that students can better understand the stress of materials in practical engineering.

### 5.2. Teaching effect evaluation indicators

In order to evaluate the teaching effect of the multi-media teaching mode based on human-computer interaction, the university has established a comprehensive evaluation system, from the learning effect of students to the participation of students to the final survey of students' satisfaction with teaching. Through regular tests, final exams and experiment reports, the students' mastery of knowledge is evaluated. Through data analysis on the online platform, students' participation in classroom and after-school learning is assessed, such as online test scores, lab completion, etc. Through questionnaire survey, students' satisfaction with the teaching mode and improvement suggestions were collected to further optimize the teaching plan.

### 5.3. Feedback from Students and Teachers

Following the introduction of the innovative teaching model, students expressed that the multimedia-based approach significantly boosted their interest in civil engineering materials. They particularly highlighted that the virtual simulation experiments enhanced their understanding of complex theoretical concepts.

Teachers also provided positive feedback, noting that the new teaching mode improved classroom efficiency. They observed a notable increase in students' experimental skills and their ability to learn independently, indicating the effectiveness of this interactive and engaging teaching method.

## 6. Advantages and Challenges of Multimedia Teaching Model Based on Human-computer Interaction

### 6.1. Advantage Analysis

Visual and interactive: multimedia technology makes the teaching content more vivid, and through human-computer interaction, students can directly participate in the learning process and enhance the learning experience.

Flexibility and autonomy: Virtual experiments and online learning platforms allow students to personalize learning according to their own learning pace, improving learning efficiency.

Practicality and safety: Virtual experiments replace some high risk or difficult to achieve real experiments, not only reduce the cost of the experiment, but also improve the safety of the experiment.

### 6.2. Challenges

Technical support and resource development: The implementation of this model requires a lot of technical support and resource development, such as the construction of virtual experiment platform, the production of multimedia resources, etc., which requires a large investment of human and financial resources.

Teacher training and adaptation: For teachers who are used to traditional teaching methods, how to master and apply new technologies to teaching is a challenge.

Students' technical ability: Some students may have difficulties in using virtual platforms and multimedia tools, and how to provide effective technical support and training for students is also a problem that needs to be solved.

## 7. Future Development and Prospects

As information technology continues to advance, the multimedia teaching model based on human-computer interaction holds significant promise for the teaching of civil engineering materials. In the future, this model can be further enhanced by integrating emerging technologies such as artificial intelligence, virtual reality, and augmented reality. These innovations can deepen the level of immersion and interactivity, creating even more engaging and dynamic learning experiences for students.

Additionally, the development of resource-sharing

platforms and open educational resources will play a key role in the future of this teaching model. By building cloud-based resource libraries, both teachers and students will have access to a wealth of teaching materials anytime and anywhere. This will not only promote the digitalization of the learning process but also facilitate the growth of smarter, more flexible educational environments.

# 8. Conclusion

The innovative teaching model for civil engineering materials, which integrates human-computer interactive multimedia technology, addresses many of the limitations of traditional teaching methods. It offers students a more flexible, interactive, and personalized learning experience. By incorporating virtual simulations, 3D model displays, multimedia courseware, and other tools, this model effectively bridges the gap between theory and practice, enhancing both teaching quality and learning outcomes.

However, challenges such as the need for robust technical support, resource development, and teacher training remain and must be further addressed. Looking ahead, as technology continues to evolve, the human-computer interactive teaching model is poised to play an increasingly important role in the teaching of civil engineering materials and other engineering disciplines, further transforming the educational landscape.

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