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Original Paper

The Application of Smart Course Construction Based On the COST Model in the Teaching of "Civil Engineering Materials"

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Abstract

The course "Civil Engineering Materials" adheres to a student-centered approach, aiming to cultivate "new engineering" applied talents with "practical ability engineering thinking, and craftsmanship spirit". Through smart course construction, the COST model is used to realize the theoretical and practical path of integrating artificial intelligence into education and teaching, to build a comprehensive teaching system that includes knowledge imparting, ability training, ideological and political integration, and quality improvement.

Keywords

civil engineering materials, smart course, teaching reform

1. Introduction

Artificial intelligence technology is reshaping the global education landscape, and its applications have evolved from auxiliary teaching tools to core drivers of educational change. To cope with this educational revolution, extensive research has been conducted on the deep integration of artificial intelligence into education and teaching. Among them, smart education is the advanced stage of digital education development, and smart curriculum construction is an important means to improve teaching quality and efficiency. It can achieve the sharing of teaching resources, optimization of teaching processes, and improvement of student learning outcomes through information technology.

In recent years, many scholars have been committed to developing teaching models based on smart curriculum platforms, by introducing virtual simulation experiments, online testing, multimedia courseware, and other means to enhance students' learning interests and practical abilities. For example, Li Nianqiang (2025) proposed using artificial intelligence technology combined with the application of knowledge graphs to optimize teaching content, improve students' learning efficiency, and explore the

construction of intelligent courses for professional basic courses. Zhao Zhiqiang (2025) proposed a method for constructing innovative classroom teaching models in the context of smart classrooms, and after practical testing, pointed out that this method has the advantages of high student participation and high teaching efficiency compared to traditional knowledge-based teaching models. In terms of combining traditional teaching methods with the construction of smart courses, Hu Hui'e (2023) proposed that the teaching system of professional basic courses should start from teaching effectiveness, decompose teaching content according to teaching objectives, reconstruct the teaching system, and adopt blended online and offline teaching to achieve the integration of content, technology, and teaching, so that students can transform from passive learning to active learning. Duan Enen (2024) proposed the teaching model of "flipped classroom+smart curriculum", which significantly improves teaching effectiveness through the full process design of pre class preview, classroom interaction, and post class review. Domestic scholars have also conducted extensive research on the optimization and integration of teaching resources, particularly in areas such as virtual simulation experiments, 3D modeling, and animation demonstrations, achieving significant results. For example, Li Jiefeng (2024) developed a civil engineering experimental teaching system based on virtual simulation technology, which effectively compensates for the shortcomings of traditional experimental teaching by combining virtual experiments with actual experiments.

The construction of smart courses has become a hot research area at present. Significant achievements have been made in the construction of smart course platforms, innovation of teaching modes, and optimization of teaching resources. However, further research is still needed in areas such as teaching evaluation and feedback mechanisms, personalized learning support, etc.

This article is based on the COST model for instructional design, focusing on the construction of the "Civil Engineering Materials" smart course with "associative thinking, precise analysis, and cross integration", which has important theoretical and practical significance.

2. Teaching Ideas for the Course of Civil Engineering Materials

The COST instructional design model integrates the four core contents of content, others, self, and tasks into the design of students' learning experience, environment, and methods, helping students effectively establish internal connections between knowledge (Chen, 2025). Students can deepen their understanding of knowledge and develop advanced thinking abilities through interaction and dialogue with others. By engaging in self dialogue, students can enhance their ability to reflect and learn independently. With the assistance of information technology, students achieve the learning goal of solving problems or completing complex tasks, in order to develop higher-order thinking and problem-solving abilities.

Based on the COST teaching design model, the smart course construction plan for Civil Engineering Materials is implemented from the following aspects, as shown in Table 1.

Table 1. Implementation of COST Teaching Design Model

COST Teaching Design	Implementation	Design Objectives
Interactive learning with learning content（C）	Construction of diversified online resources Construction of multivariate graph	Effectively display multimedia learning materials Reduce students' cognitive load Establish knowledge connections and construct a logical framework for learning content
Interactive learning with others（O）	Application of artificial intelligence technology Application of virtual digital human technology Collaborative learning among students	Externalizing knowledge structure to promote team collaboration skills development Timely feedback and personalized coaching provided
Self-talk learning（S）	Application of Artificial Intelligence Technology	Knowledge visualization assisted personalized learning Personalized resource push to achieve precise teaching
Task-based or practical learning（T）	Virtual simulation experimental platform Design of Complex Tasks Based on Problem Graph	Developing teamwork and problem-solving skills Enhance practical skills in engineering projects

3. Innovative Methods and Approaches for the Smart Course of Civil Engineering Materials

3.1 Enrich the Construction of Digital Teaching Resources on Course Platforms

In the self built course of "Civil Engineering Materials" on the Fan Ya learning platform, there are diverse digital teaching resources, including courseware for various knowledge points, teaching design, self-made micro lesson videos, experimental operation videos, engineering case libraries, course ideological and political libraries, journal libraries, textbook libraries, expanded material libraries, including online question banks for various question types, etc.

3.2 Constructing a "Quality Ability Knowledge" System Structure Based on Multivariate Graph

By combining knowledge graphs with problem graphs, ability graphs, and ideological and political graphs, the construction of multiple graphs can help students better understand the hierarchical structure and correlation of knowledge. The course will use knowledge graph technology to structure

and visualize the core knowledge of civil engineering materials courses, helping students comprehensively understand the connections between various knowledge points. Through visualized knowledge graphs, students can quickly access relevant content and advanced knowledge, enhancing the systematicity and coherence of learning. The problem map helps students clarify the key and difficult points of knowledge, identify and solve problems by sorting out the core issues in the course of civil engineering materials. Building a competency map closely integrates knowledge points with ability points, enabling students to clearly identify corresponding ability requirements in the process of learning knowledge, which helps students transform knowledge into practical abilities. By combining knowledge and ideological and political elements to construct an ideological and political map, we guide students to understand the social value, ethical responsibility, and engineering mission of the course content, and promote their comprehensive development.

3.3 Introducing Virtual Digital Human Technology

We plan to introduce iFlytek's virtual digital human technology, utilizing various artificial intelligence technologies such as speech synthesis, video synthesis, and virtual human image synthesis, to transform the original boring engineering case text materials or technical specifications of related building materials into teaching videos hosted and explained by virtual digital humans. While linking engineering cases with knowledge points, digital humans can also promptly answer students' practical questions, making teaching interaction more vivid and effective. Efficient interaction can significantly improve students' learning interest and learning outcomes.

3.4 Introducing a Virtual Simulation Experimental Platform

Based on the virtual simulation training platform, we plan to introduce a trial version of the virtual experiment platform, which covers the main experimental content of civil engineering materials as well as laboratory experiments that are not offered, such as asphalt material related experiments, so that students can conduct material performance testing in a virtual environment. Virtual experiments not only break the limitations of experimental resources, but also provide students with rich opportunities for practical operation, further enhancing their hands-on ability and innovative thinking.

3.5 Utilizing Artificial Intelligence Technology to Support Innovative Curriculum Teaching

The course will provide personalized learning services through AI technology driven intelligent agent systems. Intelligent agents will conduct real-time analysis based on students' learning data and push the most suitable learning resources, helping students obtain customized content according to their learning situation, thereby improving learning efficiency and ensuring that every student can master course knowledge at an appropriate learning pace. At the same time, the course will guide students to engage in self-directed learning and knowledge application through a task driven teaching approach. By designing targeted learning tasks, students can solve practical problems in practice and cultivate innovative abilities. The task guided mode not only enhances students' sense of participation, but also improves their learning motivation and practical ability. Each task will track learning progress through

the platform and adjust teaching content in real-time to meet the personalized needs of students.

3.6 Innovation of Teaching Evaluation and Feedback Mechanism

The course will adopt an intelligent evaluation mechanism, using big data and AI technology to collect students' learning data in real time, analyze learning progress, test scores, etc., and generate learning reports. Based on students' performance, generate feedback information, provide personalized learning suggestions, help students make up for their shortcomings, and improve learning outcomes. In addition, teachers can adjust teaching strategies based on the results of intelligent assessments to ensure that each student's learning receives precise support.

4. Course Innovation Effect

Under the background of "new engineering" and "Internet plus" education, the course of Civil Engineering Materials closely adheres to "student development as the center", combines the vision of the school and talent training goals, proposes a "practice and inquiry" hybrid teaching mode, and adopts multi-dimensional interaction, independent learning and other methods to improve the learning effect of the course.

4.1 Personalized Learning Support and Intelligent Resource Provision

In response to the diverse learning foundations and differentiated needs of student groups, the course will provide personalized learning support through a smart platform. Using artificial intelligence technology, course content will be dynamically adjusted based on students' learning progress and weak areas. AI teaching assistants will accurately analyze students' learning behavior and grades, generate personalized learning suggestions and recommended resources, ensuring that each student can master the course content at an appropriate learning pace.

4.2 Knowledge Graph Driven Teaching System

The course combines the knowledge graph of "Civil Engineering Materials" to integrate the course content into a structured and visual knowledge network, helping students better understand the inherent connections between knowledge points and achieve associative thinking. By constructing a three-dimensional structure of "quality ability knowledge", the knowledge graph clearly displays the relationship and application scenarios of each knowledge module, helping students build a complete knowledge framework. In addition, knowledge graphs can be combined with artificial intelligence technology to dynamically adjust learning paths and recommend relevant learning resources, enabling students to more efficiently grasp course content and gradually achieve cross disciplinary integration.

4.3 Practice Oriented Teaching Mode Combining Blended Learning and Virtual Experiments

By combining online and offline blended learning modes, the course provides flexible learning methods. The online section includes micro lesson videos, online tests, interactive discussions, etc., to enhance students' self-learning ability; The offline part enhances students' practical operation ability and problem-solving skills through classroom interaction, virtual digital human interaction, Q&A and

discussion. The course will also utilize virtual experiments and simulation platforms to make up for the lack of experimental projects. Students will be able to conduct material experiments and application simulations in a virtual environment, enhancing their practical skills and engineering experience.

4.4 Intelligent Teaching Management and Precise Teaching

Through an integrated intelligent teaching platform, the course can not only track students' learning progress and status in real time, but also automatically adjust teaching content and methods based on students' learning data, implementing precise teaching. This management model not only improves the teaching efficiency of teachers, but also ensures that each student can receive timely and effective learning support according to their individual needs, thereby optimizing teaching resources and enhancing overall learning outcomes.

5. Conclusion

Civil engineering materials, as a core foundational course in civil engineering and related majors, aims to cultivate innovative talents in the course construction. It aligns with the national "Golden Course" inspection standard of "one degree for both sexes" and continuously optimizes the course construction through various teaching reform methods such as comprehensive application of practical exploration mixed teaching, engineering case teaching, and information technology teaching. Currently, this course has initially formed a course feature with the goal of cultivating innovative applied talents. In subsequent teaching, teachers should teach according to their aptitude, innovate and innovate at the same time, and cultivate more innovative applied talents for the region and industry.

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