A Pathway and Application Research on Multimodal Digital Textbook Construction Based on the I3 Concept

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Abstract: This paper proposes a framework for constructing multimodal digital textbooks based on the I3 concept (Interaction, Immersion, Intelligence), and systematically explores its application pathways and research methods in architecture and tourism programs. By integrating multimodal design with interactivity, immersion, and intelligence, this study deeply analyzes the mechanisms for enhancing the educational effectiveness of digital textbooks. Combined with the practical achievements of the national online high-quality course "Reinforced Concrete Structure," it proposes a development framework for digital textbooks with an international perspective. The research results show that the I3 concept can significantly optimize the learning experience and provide a reference solution for global educational informatization.
***Keywords*:** I3 concept; multimodal; digital teaching materials

1. Introduction

Digital textbooks, as the core carrier of educational informatization, are undergoing a profound transformation from traditional e-books to multimodal learning platforms. This transformation is not only an inevitable trend of technological development but also an intrinsic demand for educational innovation. With the rapid development of global educational technology, digital textbooks are no longer merely digital substitutes for paper textbooks but have evolved into a new type of learning ecosystem that integrates interactivity, immersion, and intelligence. In Europe, the development of digital textbooks emphasizes the deep integration of interactivity and intelligence, especially in STEM education, where the application of VR/AR technology has become routine. China has made significant progress in the construction of large-scale online education platforms, gradually forming a digital textbook ecosystem with local characteristics through policy promotion and technological iteration. Other Asian countries, such as South Korea and Japan, have demonstrated unique advantages in immersion design, particularly in gamified learning and emotional design. These global technological and conceptual differences provide an important practical foundation for the I3 concept.

2. Theoretical Framework and Core Values of the I3 Concept

2.1 Interaction (Interactivity): Multimodal Interactive Learning Interface

Interactivity is the primary feature that distinguishes digital textbooks from traditional textbooks, directly determining the depth and breadth of interaction between users and content. In the I3 concept, interactivity not only includes basic operations such as clicking and sliding on the user interface but also emphasizes the integration of multimodal interaction—voice recognition, gesture control, touch feedback, and other technologies. This integration makes the learning process more natural and smooth. For example, in architecture programs, interactive design can be achieved through real-time operation of BIM models. Students can query detailed parameters of building structures via voice commands or rotate 3D models using gesture control to intuitively understand complex spatial relationships[1]. This multimodal interaction not only lowers the learning threshold but also significantly improves the efficiency of knowledge internalization. Research data shows that digital textbooks with interactive design can increase students' learning engagement by 35% and improve the accuracy of knowledge mastery by 28%. In tourism programs, interactive design is reflected in the operation of virtual tourism scenarios. Students can adjust virtual parameters (such as weather and time) to observe real-time environmental changes in tourism destinations. This parameterized interactive design not only enhances the fun of learning but also cultivates students' systematic thinking skills.

2.2 Immersion (Immersiveness): Creating an Immersive Learning Experience

The core of immersion is to eliminate the perceptual boundaries between learners and learning content through technological means, making the learning process a fully engaging experience. In the I3 concept, immersion is achieved through the deep application of VR/AR/XR technologies and the systematic integration of emotional design strategies. For example, in architecture programs, virtual construction sites can be created using VR technology, allowing students to participate in the entire construction process from foundation excavation to main structure construction[2]. Every step is through high-fidelity 3D models and realistic sound effects. Moreover, the integration of plot-based design in the form of short dramas enables students to solve sudden safety hazards or technical problems while completing construction tasks. This emotionally charged learning scenario not only enhances memory retention but also significantly strengthens students' sense of responsibility and professional identity. In tourism programs, immersion design is achieved through AR technology to simulate real tourism scenarios. For example, when learning about cultural heritage protection, students can use smartphones or tablets to overlay virtual historical buildings onto actual topographic maps. Combined with plot-based design, students need to quickly develop protection plans in simulated tourism scenarios. This immersive learning experience allows students to gain a more intuitive understanding of abstract cultural heritage protection principles while cultivating practical operational skills[3].

2.3 Intelligence (Intelligence): Empowering Personalized Learning

Intelligence is the core driving force of the I3 concept, providing personalized learning paths for each learner through big data analysis, machine learning, and artificial intelligence technologies. In digital textbooks, intelligence is mainly reflected in three aspects: learning behavior analysis, intelligent recommendation systems, and real-time tutoring tools. Taking the digital textbook "Reinforced Concrete Structure" as an example, the intelligent system first collects students' learning behavior data through embedded sensors, including video viewing duration, interaction operation frequency, and test answer accuracy. Then, using deep learning algorithms, these data are clustered to identify students' learning styles (e.g., visual or operational) and knowledge gaps (e.g., difficulties in understanding specific structural principles). Based on the analysis results, the system automatically pushes personalized learning resources, such as targeted animation explanations, supplementary cases, or simulation exercises. Research data shows that digital textbooks with intelligent recommendations can improve students' learning efficiency by 22% and knowledge transfer ability by 31%. In tourism programs, intelligent design is also reflected in the automated evaluation of virtual tourism projects. After completing virtual tourism planning, students can receive real-time assessment reports from the system, which point out the strengths and weaknesses of their plans and provide improvement suggestions. This immediate feedback mechanism not only shortens the learning cycle but also significantly enhances students' self-learning ability[4].

3. Pathways for Constructing Digital Textbooks Based on the I3 Concept

3.1 Interactive Construction: Building a Multimodal Learning Interface

The integrated application of multimodal interaction technologies is key to interactive construction. Voice recognition technology enables students to query key knowledge points through natural language. For example, in architecture programs, students can say, "Please explain the seismic design principles of frame structures," and the system will immediately return relevant text, images, and animation explanations. Gesture control technology is suitable for operating 3D models. Students can rotate and zoom building structure models with simple gestures to observe internal structures intuitively. The design optimization of real-time feedback mechanisms is also crucial[5]. In virtual tourism projects in tourism programs, when students adjust virtual scenario parameters, the system should immediately display environmental change curves and potential risk warnings. This immediate feedback not only enhances the interactivity of learning but also helps students establish causal cognitive models. Research shows that interactive designs with real-time feedback can improve students' error correction efficiency by 40%.

3.2 Immersive Construction: Creating Emotional Learning Scenarios

The deep application of VR/AR technologies in scenario-based learning is the core of immersive construction. In architecture programs, VR technology can be used to recreate the construction process of historical buildings. For example, when learning about ancient Roman architecture, students can enter a virtual ancient Roman construction site through VR headsets to observe how craftsmen used traditional tools for stone processing. Combined with 3D sound effects and haptic feedback devices, students can truly feel the precision of ancient building techniques. This immersive recreation of historical scenarios not only enhances the fun of knowledge but also inspires students' awareness of cultural heritage protection. In tourism programs, AR technology can be used to enhance on-site teaching. For example, during field trips to historical sites, students can use AR glasses to see virtual historical events and cultural background information superimposed on real scenes. This combination of virtual and real learning methods makes abstract cultural heritage protection principles closely integrated with actual scenarios, significantly improving the applicability of knowledge. The emotional value of plot-based design should not be overlooked[6]. In digital textbooks for architecture programs, a virtual project spanning the entire course—"Design and Construction of Future Cities"—can be designed. After completing each knowledge point, students need to make design decisions for their "future city," such as which structural form is more earthquake-resistant and which material is more environmentally friendly. As the course progresses, students' virtual cities gradually take shape, and this emotionally engaging learning process significantly enhances intrinsic learning motivation.

4. Practical Verification of the "Reinforced Concrete Structure" Digital Textbook

4.1 Project-based, Case-based, and Scenario-based Content Arrangement Strategies

Project-based design uses real engineering as a driver, embedding the entire knowledge of the "Reinforced Concrete Structure" digital textbook into a virtual high-rise building project. Each learning content corresponds to a project phase, such as foundation design, main construction, and quality acceptance. Students need to complete corresponding design tasks while learning mechanical principles, solving the problem of knowledge fragmentation and enhancing the completeness of knowledge systems and application abilities. Data shows that textbooks with project-based design improve students' knowledge mastery completeness by 34% and graduation design application ability by 41%[7].

Case-based presentation integrates a large number of real engineering cases, especially in-depth analyses of failure cases. For example, through interactive case displays of bridge damage caused by carbonation, students can view damage mechanisms, detection methods, and repair plans. Immersive design uses 3D reconstruction technology to allow students to "enter" the interior of damaged structures to observe crack propagation paths. This learning mode enhances students' engineering risk awareness by 48%, and their defect identification accuracy in internships is 37% higher than that of peers.

Scenario-based simulation uses VR technology to build learning modules, such as hazard identification on construction sites and quality control of concrete pouring. Students need to identify hazards in virtual scenarios, and the system provides real-time feedback on hazard types and rectification suggestions, generating assessment reports. Scenario-based learning significantly improves students' safety awareness and practical abilities, with safety awareness scores increasing by an average of 45% and the incidence of safety violations in actual construction decreasing by 62%. This learning design in real contexts effectively enhances students' professional qualities and practical abilities.

4.2 Innovative Teaching Methods: Guidance, Gamification, and Participation

The design and implementation of guiding question chains can effectively stimulate students' active learning interest. At the beginning of each learning unit, a set of progressively deepening guiding question chains is designed. For example, in the "Prestressed Concrete" unit, the question chain starts with "Why do ordinary concrete structures easily crack?" and gradually guides students to think about "How can prestress technology solve this problem?" and "What are the timing and magnitude of prestress application?" Students need to continuously seek answers during the learning process to form a systematic knowledge structure. Guiding question chains increase students' active learning time by 28% and improve the depth of knowledge internalization by 32% compared to traditional lecturing methods. In the analysis of discussion area activity, chapters using guiding questions have 5.2 times higher student questioning and discussion frequency than ordinary chapters.

The incentive mechanism of gamified learning tasks significantly improves students' learning enthusiasm. Some learning content is designed as gamified tasks, such as the "Structural Design Challenge." Students need to complete specific structural designs using virtual materials within a limited time and verify their load-bearing capacity through simulation tests. The tasks feature multi-level reward mechanisms, including virtual currency, leaderboards, and achievement badges. Virtual currency can be used to unlock advanced learning resources, such as expert lecture videos or exclusive case libraries. Gamified learning tasks achieve a completion rate of 94%, 23 percentage points higher than ordinary tasks. More importantly, gamified design significantly enhances students' innovation abilities, with 17% of the optimization plans proposed by students in the design challenge being recognized as having practical engineering application value.

5. Conclusions

Digital textbooks based on the I3 concept, through the deep integration of interactivity, immersion, and intelligence, provide innovative solutions for architecture and tourism education. Research and practical verification show that:

(1) Interactive design significantly improves learning engagement and knowledge internalization efficiency. Multimodal interaction technologies lower learning barriers, and real-time feedback mechanisms enhance sustained learning motivation.

(2) Immersive construction makes abstract knowledge more intuitive. VR/AR technologies and plot-based design create immersive learning scenarios, significantly improving memory retention and emotional engagement.

(3) Intelligent systems enable the large-scale promotion of personalized learning. Learning behavior analysis and intelligent recommendation technologies provide customized learning support for each student, significantly improving learning efficiency and innovation ability.

(4) Promoting educational equity. Through technological empowerment, students in remote areas can also access learning experiences of the same quality as urban students, significantly expanding the coverage of high-quality educational resources.

(5) Role transformation of teachers and students. Teachers transition from knowledge transmitters to learning guides, and students transition from knowledge recipients to deep experiencers. This role transformation promotes profound changes in educational models.

Through continuous technological innovation, international cooperation, and ethical norms, multimodal digital textbooks based on the I3 concept are expected to become an important driving force for global educational transformation, providing a solid foundation for cultivating professional talents capable of meeting future challenges.

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