

## Article

# Innovative Design Analysis of Teaching Cases for the Course of Road Survey and Design

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**Abstract:** To overcome the shortcomings of traditional teaching of the Road Survey and Design course—namely, the disconnection between theory and practice and the lack of whole-process presentation of engineering projects—this paper reconstructs an instructional design scheme based on BIM cases by relying on BIM technology, artificial intelligence, and industry-education integration. With "knowledge units—engineering cases—dynamic simulation practice" as the main thread of the knowledge system, the scheme adopts a progressive "static—dynamic—dynamic" teaching method, namely, transiting from static theoretical lectures to dynamic model demonstrations and then to dynamic interactive hands-on training. The study designs a three-tier instructional objective system covering knowledge, ability, and literacy; develops BIM knowledge modules covering horizontal alignment, vertical alignment, cross-section, and intersection design; builds a graded and classified engineering case library; and constructs an innovative teaching method system integrating diversified teaching means, AI-powered intelligent tutoring, and deep school-enterprise collaboration. In addition, implementation pathways and safeguard measures are proposed in terms of teacher training, platform construction, institutional support, and diversified evaluation. This design provides new ideas for improving students' engineering practice ability, systematic thinking, and innovation capability, supports the new demands for engineering talent under the development trend of smart transportation, and offers promising prospects for the construction of BIM teaching resource libraries and for the replicable and scalable promotion of the teaching model.

**Keywords:** BIM case; road survey and design; instructional design; teaching reform; industry-education integration; artificial intelligence

## 1. Introduction

With the in-depth development of a new round of scientific and technological revolution and industrial transformation, and with the implementation of the Transportation Power and Dual Carbon strategies, the transportation infrastructure industry is accelerating its transformation toward smart and green transportation. The continuous expansion of the highway network, the large-scale construction of mountain highways under complex geological conditions, and the iterative upgrading of urban expressways and smart roads have all posed new challenges and opportunities for the cultivation of road engineering talents [1]. Road Survey and Design is a core professional course for transportation engineering majors, and its teaching quality directly determines the professional skills and engineering design abilities of future engineers. However, the traditional teaching form—dominated by theoretical lectures supplemented by design exercises on two-dimensional paper topographic maps—presents knowledge statically and fragmentarily and idealizes practice, which can no longer meet the new requirements for interdisciplinary talents in the new era. The path of teaching reform must therefore evolve in step with the times and the industry [2].

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Building Information Modeling (BIM) is an information technology applied in the field of engineering construction [3]. By means of three-dimensional parametric models capable of describing geometric information, physical properties, and functional attributes, BIM integrates the information of all life-cycle stages of a project—design, construction, operation, and maintenance—into a unified database, realizes information sharing and transfer, and thereby improves design efficiency, engineering quality, and cost control. BIM technology exhibits remarkable characteristics of visualization, collaboration, simulation, and parametric modeling: visualization presents abstract design schemes as realistic three-dimensional scenes; collaboration enables multiple disciplines to work in parallel within a single data environment; simulation supports 4D construction schedule simulation and 5D cost analysis; and parametric modeling guarantees data consistency, in which a single modification is automatically propagated everywhere. These characteristics make BIM naturally suitable for teaching design-oriented courses [4].

The integration of BIM technology provides an opportunity for the reform of road engineering courses. In particular, against the background of emerging technologies such as autonomous driving and smart highways, the combination of BIM with GIS, the Internet of Things, and digital twin technologies has gradually enabled the digital and intelligent development of road survey and design. However, it must be recognized that the application of BIM in road engineering is still at a preliminary stage: insufficient BIM case reserves adapted to the course, imperfect teaching systems, and uneven teacher competence jointly inhibit the role of BIM technology in teaching [5]. To meet the needs of the transportation industry in the new era and to solve the pain points of Road Survey and Design teaching, this paper proposes a teaching innovation scheme based on BIM cases, constructs a teaching mode consisting of three levels—"basic principles—concrete practice—engineering cases"—builds a centralized BIM modular resource library, and establishes a platform for students' project-driven and virtual-real complementary learning, thereby achieving a substantive breakthrough in the teaching reform of the Road Survey and Design course.

## **2. Current Situation of the Course Teaching Mode in China**

China's transportation infrastructure construction is in a period of great development. With the gradual implementation of the "Transportation Power" strategy, the industry's demand for talents with strong professional innovation and comprehensive practical ability continues to grow. The Road Survey and Design course is an important professional course for transportation majors, and its teaching level directly determines the quality of transportation engineering education. However, the limitations of the traditional teaching mode are significant, and can be summarized as "four emphases and four neglects": emphasizing theory over practice, emphasizing design over construction drawings, emphasizing knowledge points over integrity, and emphasizing teachers' teaching over students' learning. The root of these problems lies in the backwardness of teaching media and organization: with blackboards, PowerPoint slides, and two-dimensional drawings as the main carriers, it is difficult to carry the information of complex spatial alignments and engineering scenarios, thereby restricting the improvement of teaching quality.

### *2.1. Current Situation of Teaching Methods for Road Survey and Design*

The teaching methods of the Road Survey and Design course at home and abroad have long formed a fixed pattern of "theoretical lectures as the dominant form and course design as the supplement" [6]. Although this pattern can guarantee the systematic transmission of basic theoretical knowledge, its inherent limitations cause the practical teaching link to be seriously disconnected from engineering reality, and the teaching effect is far from satisfactory. The practical link is often confined to alignment design exercises on two-dimensional paper topographic maps: the design conditions are idealized and the design process is static, so students cannot experience multiple constraints of real projects,

such as complex and changeable terrain and geological conditions, hydrological and climatic constraints, socio-economic factors, and ecological and environmental protection requirements. This kind of "armchair strategy" training leaves students without personal experience of field survey processes and makes it difficult for them to understand the whole-process logic from topographic data acquisition and processing to design scheme generation. Nor can they organically connect dispersed knowledge points such as horizontal, vertical, and cross-sections to form systematic engineering design thinking. In addition, the traditional classroom is dominated by one-way lecturing by teachers, with little teacher-student or peer interaction, leaving students in a passive state of reception; their learning initiative and awareness of engineering problems cannot be stimulated. The final result is that although students master some theoretical norms, their practical ability to solve complex engineering problems, their concept of systems engineering, and their innovation awareness have not been effectively honed, and they can hardly meet the training requirements for interdisciplinary engineering talents under the background of smart transportation. From the perspective of student learning conditions, transportation engineering students generally possess strong logical thinking ability, but their spatial imagination varies greatly among individuals; most students have never been exposed to any 3D modeling software and lack understanding of the real workflow of the engineering industry. This further reduces the acceptance of pure theoretical lectures and urgently requires visual and interactive teaching means to lower the cognitive threshold.

## *2.2. Current Situation of BIM Technology Application in Teaching*

As the core technology driving the digital transformation of the construction industry, BIM has been relatively maturely applied in the teaching of architecture-related majors and has formed a complete system; for example, software such as Revit and Navisworks has been widely used in courses such as building architecture and building structures. However, the application of this technology in the field of road engineering teaching obviously lags behind and is still at the stage of preliminary exploration and development. Some foreign universities have taken the lead in introducing BIM content into civil engineering curricula; universities in the United States, the United Kingdom, Singapore, and other countries have incorporated BIM modeling and collaborative design into their training programs, aiming to cultivate students' information-based modeling and collaborative design abilities. By contrast, relevant teaching practice in China started late, with insufficient breadth and depth.

The outstanding problems at present are mainly reflected in three aspects. First, the construction of BIM teaching resource libraries adapted to the Road Survey and Design course is seriously insufficient. There is a lack of typical case libraries, modeling tutorials, and practical training guides that cover different terrain conditions and technical grades and match the knowledge points of the course. Teachers often have to prepare materials from scratch, resulting in high lesson-preparation costs and much duplicated construction. Second, a systematic and operable BIM teaching implementation plan is missing. Existing attempts mostly remain at sporadic demonstrations of software functions and fail to achieve the all-round deep integration of BIM technology with course teaching objectives, teaching content, teaching methods, and the evaluation system; there is even a tendency of formalism of "BIM for BIM's sake." Third, the BIM application ability of the teaching staff is uneven. Some teachers themselves lack engineering practice experience and software operation ability. Coupled with insufficient support from teaching software and hardware platforms and the lack of articulation among related courses, these factors jointly restrict the full play of the potential value of BIM technology in teaching activities, making it difficult to effectively support the innovation of teaching modes and the improvement of talent cultivation quality.

## **3. Design of the Talent Cultivation Path Based on BIM Case Teaching**

To address the above problems, this paper follows the concept of Outcome-Based Education (OBE) and constructivist learning theory, and reconstructs the course according

to the idea of "backward design and forward implementation": starting from the competency requirements of industry positions, learning outcomes are determined first, and then teaching objectives, teaching content, teaching methods, and evaluation methods are designed accordingly, so that all links of the course form a closed loop. The entire cultivation path unfolds in five dimensions: instructional objective system, teaching content, teaching methods, implementation safeguards, and expected achievements.

### *3.1. Construction of the Instructional Objective System*

The existing course instructional objectives suffer from disconnection from industry needs and imperfect evaluation of objective achievement, and need to be reconstructed in combination with new industry standards and industry development prospects. The construction of instructional objectives should include three levels-knowledge, ability, and literacy-aiming to cultivate interdisciplinary transportation talents that meet the development trend of intelligent transportation.

At the knowledge level, students need to systematically master the basic theories and standards of road survey and design, including the classification of road grades and the selection of technical standards, principles of route selection and location, design theories and calculation methods of horizontal alignment (straight lines, circular curves, transition curves), vertical alignment design (maximum longitudinal gradient, grade length limitation, vertical curves), cross-section composition and superelevation and widening design, sight distance checking, and road intersection design. At the same time, they should master the basic knowledge and principles of BIM technology and its application paths in all stages of road design, and understand the basic framework of national BIM standards (such as the Unified Standard for Building Information Modeling Application, GB/T 51212) and highway industry BIM technical specifications.

At the ability level, students need to master the basic operations of road BIM software such as Civil 3D, InfraWorks, and OpenRoads proficiently, and be able to complete the whole design workflow of an actual road project-from terrain data processing and surface creation to horizontal location, vertical profile design, cross-section assembly, and earthwork calculation. Through multi-software collaboration (such as InfraWorks for scheme comparison, Civil 3D for detailed design, and Navisworks for construction simulation), students' systems engineering concept integrating multiple disciplines is cultivated, so that they can deal with complex engineering practice problems with comprehensive thinking, and possess basic abilities of scheme comparison, quantity estimation, and teamwork.

At the literacy level, attention is paid to cultivating engineering ethics, ecological and environmental awareness, and social responsibility for students who will engage in road engineering design, construction, operation, and other stages in the future. Through discussions of real situations in case teaching-such as route selection in ecologically sensitive areas, land acquisition and resettlement conflicts, and cultural heritage protection-students' sustainable engineering outlook is cultivated, and their responsibility for engineering quality, environmental protection, and public interests is established, realizing the trinity of "value shaping, knowledge imparting, and ability training."

### *3.2. Design of Teaching Content*

The teaching content design follows the principles of "modularization, case-orientation, and dynamization," and specifically includes three parts: BIM knowledge module development, engineering case library construction, and dynamic teaching process design.

From the perspective of supporting theory, the "static-dynamic-dynamic" progressive method is grounded in the cognitive load theory and the experiential learning cycle. Static lectures establish the necessary schema in students' long-term memory; dynamic visualizations reduce extraneous cognitive load by replacing abstract imagination with direct perception; dynamic hands-on training then promotes the transformation of declarative knowledge into procedural knowledge through deliberate practice. Meanwhile, case-based teaching, rooted in constructivism and situated learning

theory, anchors knowledge in authentic engineering contexts, enabling students to construct rather than receive understanding, and to appreciate the situated, conditional nature of engineering decisions rather than treating design formulas as absolute rules.

Development of BIM knowledge modules. In the teaching process, a series of teaching modules related to BIM road teaching are developed, mainly including five core modules: BIM horizontal alignment design, BIM vertical alignment design, BIM cross-section design, BIM intersection design, and BIM+GIS route selection comprehensive training. Each module contains three components-theoretical knowledge points, BIM technology operations, and engineering cases-forming a complete structure of "theory + technology + case." Among them, theoretical knowledge points are presented in the form of micro-lectures, highlighting "sufficiency and usefulness"; BIM technology operations are presented by recorded step-by-step screen-cast tutorials and illustrated operation manuals, with common mistakes clearly marked; engineering cases are taken from real projects, requiring students to complete the complete task chain from data analysis to model deliverables. The modules follow the ordering logic of "from shallow to deep, from single items to comprehensive tasks" and are synchronized with the progress of theoretical teaching.

Construction of the engineering case library. Based on typical actual engineering projects, a graded and classified typical case resource library is constructed. The typicality of cases is reflected in different engineering types such as terrain conditions and technical grades, for example, mountain crossing highways, first-class highways in plain areas, urban arterial roads, and interchanges. Each case includes a complete low-precision conceptual model and a high-precision design model, original survey and design data (topographic maps, geological data, traffic volume forecasts), design process files and deliverable files (horizontal, vertical, and cross-section drawings, earthwork tables), as well as supporting discussion questions and scoring rubrics. Meanwhile, combined with the regional characteristics of the teaching institution, a regional-featured BIM engineering case teaching library is built-for example, universities in western China may focus on cases of route design under special geological conditions such as arid regions, windy and sandy regions, alpine regions, and strong earthquake regions-so that the teaching content is closer to the real engineering context of the regions where students will work in the future. The case library adopts a rolling update mechanism, phasing out outdated cases and introducing new ones every year according to specification revisions and new industry technologies, ensuring the realism and timeliness of teaching content.

Design of the dynamic teaching process. A progressive teaching mode of "abstract knowledge points-intuitive simulation-interactive training" is adopted. In the abstract knowledge point stage, traditional intensive lectures ensure the logical rigor of concepts and norms; in the intuitive simulation stage, BIM models dynamically visualize spatial relationships that are difficult to describe in words, such as curvature changes of transition curves, vertical profile pulling processes, and superelevation rotation of cross-sections, greatly reducing the cognitive load; in the interactive training stage, BIM-based 4D construction schedule simulation and 5D cost technology are used to simulate and analyze various construction processes in road construction, from site leveling to subgrade construction and then to pavement paving, linking design results with construction organization and engineering economics, strengthening students' overall perceptual understanding of engineering construction, and achieving the integration of design thinking and construction thinking. This progressive chain is the concrete implementation of the "static-dynamic-dynamic" knowledge transfer method: static lectures lay the theoretical foundation, dynamic demonstrations activate figurative thinking, and dynamic practical training completes knowledge internalization and transfer [7].

### *3.3. Innovation of Teaching Methods*

The teaching means system centers on the goals of improving classroom interactivity, enhancing personalized services for students, and cultivating engineering practice ability, and constructs a teaching method system characterized by "multiple teaching methods,

AI technology support, and engineering-industry integration innovation." The specific practical exploration is divided into the following three points.

**Diversified teaching means.** A three-dimensional teaching mode is explored, dominated by "online virtual teaching + offline flipped classroom," online-offline blended teaching, and integration of theory and practice. Online teaching builds a course video resource library through an informatized teaching platform, including micro-lectures, animated courseware, 3D virtual simulation software, and mobile applications, so that students can complete pre-class preview and after-class consolidation in their spare time; offline classrooms then give the time to discussion, Q&A, and practical training through flipped classrooms, realizing "learning by doing in class and thinking while learning after class." In teaching, attention is paid to the use of various teaching methods such as case teaching, discussion, and inquiry. For example, route scheme comparison discussions are carried out combined with typical engineering examples, or group debates on route design under complex terrain conditions are organized, so as to fully mobilize students' learning enthusiasm and train their critical thinking and ability to solve complex engineering problems comprehensively. In addition, course competitions (such as the university BIM modeling competition and the National Undergraduate Traffic Science and Technology Competition) are used to promote learning through competition and stimulate students' achievement motivation.

**Empowerment by AI technology.** Big data, Internet Plus, and intelligent technologies are used to fully support teaching resource construction and teaching organization. The main technical routes are as follows. First, through linguistic algorithms and knowledge graph technology, the course knowledge point system is systematized and structured, and supporting micro-lecture scripts, test question banks, and extended reading materials are automatically generated according to knowledge points, constructing big-data course resources. Second, based on students' learning behavior records, learning ability assessments, and progress data, personalized learning paths matching students' characteristics are inferred, and personalized materials and exercises are pushed—for example, for the links where students frequently make mistakes in BIM modeling (such as surface creation failures, abnormal vertical profile drawings, and wrong cross-section assembly directions), operation step prompts and precaution videos are intelligently pushed. Third, an "intelligent teaching assistant" system is built, which uses computer vision and a geometric rule engine to identify errors in the BIM models submitted by students in their homework, including whether the route horizontal alignment conforms to specifications, whether the minimum radius of circular curves meets requirements, whether the vertical profile design is balanced, and whether vertical curve radii meet standards, and provides corresponding solution suggestions. Fourth, based on machine learning algorithms, students' learning behavior data are analyzed, a personalized learning model is constructed for each student, and learning difficulty and progress are dynamically adjusted, achieving an individualized learning effect close to one-on-one tutoring under large-scale education. The application of AI technology also reduces teachers' repetitive grading burden, allowing teachers to devote more energy to higher-order teaching activities.

**Deep integration of industry and education.** According to new problems arising in actual engineering implementation, students' learning is closely connected with engineering practice to improve teaching quality. By combining "industry-education integration" with the "school-enterprise collaboration, multi-party win-win" mechanism, enterprises are guided to introduce new technologies, methods, and products from actual production into teaching in real time, so that the latest industry developments enter the classroom promptly. Specific measures include: first, the construction of school-enterprise cooperation platforms. Cooperation agreements are signed with a number of design institutes and construction companies to establish a "Joint Laboratory of Intelligent Road Design and Construction." Enterprises regularly send technical personnel to participate in teaching guidance and course construction and undertake the teaching of some practical training modules, while university teachers participate in enterprises' technical research

projects, realizing two-way mobility. Second, going deep into the production front line, analyzing actual industry cases, and bringing typical production application topics and technical problems into the classroom. Senior students are organized to complete graduation designs or course projects in the form of "real topics, real practice," and opinions or suggestions are put forward to enterprises according to research conclusions. Through the above deep integration of industry and education, students can directly access the latest technical specifications and engineering practices of the industry, and their professional literacy and engineering practice ability are effectively cultivated; by participating in actual engineering projects, students understand industry needs, clarify their own career goals, and obtain an important guarantee for employment; meanwhile, deep school-enterprise cooperation also provides a source of continuous improvement for the course content.

#### **4. Implementation Path and Safeguard Measures**

The comprehensive project assessment adopts a process-oriented rubric with four dimensions: model accuracy, which examines whether the geometric parameters of the horizontal, vertical, and cross-sections comply with current specifications; design rationality, which examines whether the route scheme fits the terrain and geological conditions and whether the earthwork balance is reasonable; model quality, which examines the standardization of layers, naming, and component parameters in the BIM model so that it can be correctly reused by subsequent construction and cost modules; and teamwork and expression, which examine division of labor within the group, the completeness of the design specification, and the performance in the defense. Each dimension is divided into four proficiency levels with explicit behavioral descriptors, so that both students and teachers share the same expectations before the project begins. Compared with the traditional one-shot final examination, this assessment structure can diagnose learning problems in time, guide students to focus on the design process rather than rote memorization, and make the evaluation itself a tool for learning.

To ensure the sustainability of the reform, a longitudinal tracking mechanism for graduates is also planned. Graduates who enter design institutes, construction enterprises, or transportation management departments will be surveyed regularly regarding the usefulness of the BIM case teaching they received, and their feedback will be used as important evidence for the continuous improvement of learning outcomes. Employers' evaluations of graduates' modeling ability, collaborative ability, and specification awareness will be incorporated into the achievement evaluation of the course objectives, further closing the loop between curriculum reform and industry needs.

The implementation of curriculum reform follows the overall strategy of "pilot first, step-by-step promotion, and continuous improvement," and is carried out in three stages. The first stage is the resource construction period (the first semester), during which the development of BIM basic modules and the first batch of case libraries are completed, and teacher training and teaching platform construction are carried out simultaneously. The second stage is the pilot operation period (the second to third semesters), during which pilot teaching is carried out in one or two teaching classes, a three-in-one process monitoring mechanism integrating classroom observation, questionnaire surveys, and score analysis is established, and the teaching content and case difficulty gradients are iteratively optimized according to feedback. The third stage is the full promotion period (from the fourth semester), during which the implementation is extended to all teaching classes, standardized teaching documents (syllabus, teaching schedule, practical training guides, and assessment rubrics) are formed, and the achievements are extended to related courses such as Subgrade and Pavement Engineering and Bridge Engineering, creating a replicable teaching system.

As for safeguard measures: first, all-round safeguards covering teaching staff, technical platforms, and laboratory platforms are created, and a curriculum reform working group is established with clear division of labor and schedule nodes. Second, teacher training is vigorously carried out. Through the combination of "sending out"

(participating in BIM teacher training workshops and enterprise post practice) and "inviting in" (hiring enterprise BIM engineers as part-time teachers and holding on-campus workshops), teachers' BIM technology application ability and engineering practice ability are effectively improved. Third, hardware facilities are improved, BIM-dedicated computer rooms and high-performance graphics workstations are built, and licensed software and virtual simulation platforms are provided to ensure the smooth implementation of teaching. Fourth, a diversified teaching quality evaluation system is established, which includes three aspects: evaluation of students' learning outcomes, evaluation of the teaching process, and evaluation of course construction. The evaluation of students' learning outcomes adopts the structure of "usual process assessment (30%) + module practical assessment (40%) + comprehensive project assessment (30%)." The comprehensive project is completed in groups, requiring students to complete the BIM design of a complete case and defend it. The teaching process evaluation collects information from multiple dimensions such as supervisor class observation, peer review, and student evaluation of teaching. The course construction evaluation invites industry experts to participate in the appraisal of achievements. Through regular evaluation and timely feedback, a closed loop of "evaluation–feedback–improvement" is formed to continuously improve the quality of course construction.

### **5. Expected Achievements and Features**

Teaching resource achievements. A relatively complete BIM teaching resource library is built, including course modules, case libraries, practical training project libraries, micro-lecture video libraries, and question banks; new-form teaching materials and digital teaching resources are developed, forming sharable and scalable construction standards, providing references for the construction of similar courses.

Talent cultivation effects. It is expected that after the training of this course, students' engineering practice ability and innovative spirit will be greatly improved, the comprehensive quality of graduates will better meet industry needs, and they will be able to use advanced technologies to solve complex engineering problems. Meanwhile, a number of landmark achievements will be made in various disciplinary competitions and BIM modeling competitions, and employer satisfaction will be improved.

Course features and innovations. The main innovations of the course include: first, the high integration of BIM and professional teaching, achieving the leap from "software demonstration" to "whole-process case teaching"; second, the "double AI + BIM" teaching mode under the background of industry-education integration, that is, using AI technology to empower both teaching and learning, with BIM carrying engineering contexts; third, the construction of a regional-featured case library, making teaching content serve local transportation construction; fourth, a diversified process evaluation system, realizing the transformation from "testing knowledge" to "testing ability and literacy."

### **6. Conclusion and Prospect**

The instructional design of the Road Survey and Design course under the BIM case teaching mode can solve the problems existing in the traditional teaching mode, such as unscientific teaching organization, simple methods, teachers acting merely as narrators, neglect of ability improvement, and insufficient attention to quality cultivation. Through the reconstruction of the main line of "knowledge units–engineering cases–dynamic simulation practice" and the application of the progressive "static–dynamic–dynamic" teaching method, students' knowledge mastery, ability development, and literacy cultivation develop in a coordinated manner, and their academic performance is significantly improved. This mode realizes a fundamental change in teaching techniques and methods, integrates theoretical knowledge, cultivates thinking ability, and hones practical literacy, fully embodying the talent cultivation concept of "Emerging Engineering Education" in the new era.

On the basis of existing work, multi-dimensional exploration and innovation will continue in the future. The course will gradually develop toward intelligence and contextualization: a curriculum system based on full life-cycle dynamic simulation of roads can realize all-round on-campus practical teaching of road engineering from classroom to virtual reality; in terms of depth and breadth, the articulation of various road discipline courses will be gradually realized, a BIM-serialized curriculum system including Subgrade and Pavement Engineering, Bridge Engineering, and Tunnel Engineering will be established, and further in-depth expansion will be carried out in combination with urban planning, environmental engineering, and other disciplines, so as to train students' ability to apply comprehensive knowledge across disciplines and meet the needs of cultivating outstanding engineering talents in the new era.

In addition, through instructional design, an open and shared BIM teaching resource platform is built to integrate resources from universities, enterprises, and society, and to promote mutually beneficial and coordinated educational development. This can not only promote the informatization of road engineering education, but also provide human resource support for industrial innovation and development, contributing the strength of higher engineering education to China's transformation from a "transportation country" to a "transportation power." The teaching mode and methods proposed in this paper can also provide references for the educational reform of other engineering majors, such as civil engineering and hydraulic engineering, and contribute to the overall improvement of the quality of higher engineering education in China.

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