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Research on the Blended Learning Model for the Course of Bridge Engineering Construction Cost Planning and Management in the Context of Big Data ——Using Plateau Complex Bridge Engineering as an Example

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Abstract: In response to the new requirements of Emerging Engineering Education for engineering management talents—namely, "understanding technology, mastering data, and being capable of management"—traditional cost management courses face issues such as a disconnect between theory and practice, as well as weak data literacy. Taking the cost control of constructing a high-pier, long-span steel truss girder bridge in a plateau region as a case study, this paper constructs a blended teaching model characterized by "online theoretical foundation, offline project-based practice, and big data thinking throughout." The reform pathway is elaborated from four aspects: curriculum content restructuring, teaching resource development, teaching implementation process, and evaluation system reform. Research indicates that the blended teaching model based on the OBE concept significantly enhances students' autonomous learning abilities, teamwork skills, and problem-solving capabilities. Moreover, the integrated teaching of BIM technology and cost estimation helps students master core cost management skills through "learning by doing" [1-2]. Practice demonstrates that this model effectively strengthens students' cost planning awareness and their ability to solve complex engineering problems, thereby providing a reference for curriculum reform in engineering management majors.

Keywords: Big Data; Cost Planning and Management; Blended Teaching; Plateau Bridge
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1. Introduction

"The world looks to China for bridges, and China looks to Guizhou." Amidst the towering mountains of Southwest China, numerous super bridges span natural chasms, showcasing not only China's technological strength in bridge construction but also raising higher demands for the cultivation of engineering management talents. The construction of high-pier, long-span arch-stiffened continuous steel truss bridges in plateau regions faces multiple challenges, including harsh natural environments, complex geological conditions, and difficulties in material transportation. The cost planning and control of such projects are highly dynamic and uncertain, creating an urgent need to cultivate interdisciplinary talents equipped with big-data thinking and whole-process cost management capabilities.

However, current university instruction in the course Construction Cost Planning and Management still faces three prominent issues: first, the teaching content overemphasizes theoretical budgeting and lacks training in the analysis of dynamic cost data during construction; second, the teaching cases are relatively outdated and fail to capture the complexities of cost control in plateau environments; third, the instructional approach remains predominantly lecture-based, leaving students with little hands-on experience in handling real-world engineering data. Therefore, transforming real-world engineering challenges into living teaching materials has become a critical task in curriculum reform.

In recent years, universities in China have actively explored reforms in engineering cost management courses. Chongqing Jiaotong University, guided by the "Two Roads" spirit, has developed a multi-module curriculum system integrating ideological and political education, foundational knowledge, bridge and tunnel engineering, and intelligent technologies. Guizhou Vocational College of Transportation has pioneered a "one bridge, one course, one team" model, developing specialized courses centered on typical bridge types. Zhanjiang University of Science and Technology, grounded in the OBE concept, has restructured the Engineering Cost Planning and Control course, employing case discussions and diversified assessment mechanisms to encourage students to take ownership of their learning [3-4]. Beijing City University has built a "whole-process cost management course cluster" based on real projects, aiming to effectively align graduates with the demands of whole-process cost management roles [5]. These practices offer valuable insights for this study. Building on this foundation, this paper focuses on curriculum reform in cost planning and management within the context of big data, aiming to explore new pathways for blended teaching models.

2. Current Teaching Status and Problem Analysis

2.1 Teaching Content Lags Behind Industry Development

At present, cost management courses in most universities still rely heavily on traditional textbooks, with teaching content focusing primarily on quota application and cost calculation, while lacking coverage of cutting-edge areas such as BIM 5D technology, big data cost analysis, and dynamic cost control [6-7]. According to the Undergraduate Professional Guidelines for Engineering Cost in Higher Education Institutions, although no specialized course modules have been specifically added, the integration of information technology with professional teaching has been achieved through laboratory open fund projects and digital project management courses. The application of BIM technology in engineering practice aligns well with this knowledge domain [8-9]. However, in the process of plateau bridge construction, cost variables such as reduced mechanical efficiency and labor idleness caused by high altitudes, large temperature differences, and complex wind field environments are rarely addressed in existing textbooks.

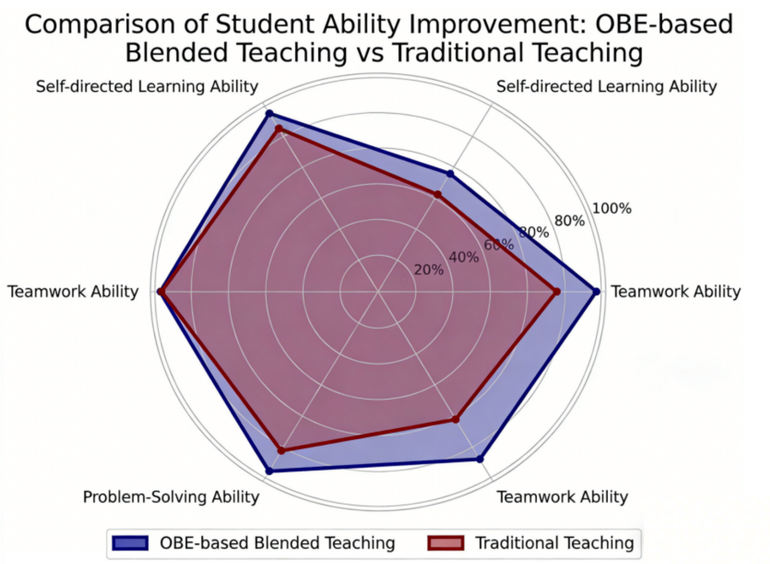
2.2 Teaching Cases Are Disconnected from Engineering Practice

The cases used in course instruction are mostly simplified exercises with limited data scales and single variable settings, making it difficult to accurately simulate the complexity of real engineering projects. Taking plateau steel truss bridges as an example, the cost planning for such structures involves multiple factors, including steel price adjustments, quota revisions for plateau regions, and the impact of special climatic conditions—all of which require analytical training based on massive amounts of real data. Currently, however, students generally lack access to real-world engineering data. Relevant research indicates that although students hold differing views on the role of building information modeling in cost overrun management, most agree that it is significantly effective in the early stages of projects.

2.3 Insufficient Cultivation of Students' Data Literacy

In the era of big data, cost managers are expected to possess comprehensive capabilities in data collection, processing, analysis, and visualization. However, current courses emphasize manual quantity takeoff and software operation while neglecting the cultivation of skills in deep data mining and pattern discovery. Students may "know how to calculate" but are not proficient in "analyzing data"; they may "understand software" but fail to grasp "the engineering logic behind the data." Research by Liu Fang et al. [1] confirms that blended teaching based on the OBE concept can significantly enhance students' autonomous learning abilities, as shown in Figure 1, providing strong support for curriculum reform.

Figure 1 Teaching Mode Competence Comparison Radar Chart



3. Construction of the Blended Teaching Model

To address the aforementioned issues, this paper takes a high-pier, long-span steel truss bridge (arch-stiffened continuous steel truss structure) in a plateau region as a running case study and constructs a blended teaching model integrating "online + offline + big data" as a trinity.

3.1 Teaching Design Framework

This model follows the design framework of "one main thread, two spaces, and three integrations":

One Main Thread: A real-world case of cost planning and control for complex plateau bridge construction runs through the entire course, forming a complete project thread from construction scheme comparison and resource allocation optimization to dynamic cost monitoring.

Two Spaces: The online space supports theoretical learning and data perception functions, including micro-lecture videos, virtual simulation experiments, and a big data case repository. The offline space facilitates case discussions and project-based practice, enabling knowledge internalization and skill enhancement.

Three Integrations: Integration of theory and practice, integration of technology and economics, and integration of online and offline learning, reflecting the organic connection among the education chain, talent chain, and industry chain.

3.2 Design of Online Teaching Modules

1. Virtual Simulation Experiment. A "virtual simulation platform for dynamic cost control of plateau bridge construction" is developed to simulate the impact of unexpected events—such as sudden climate changes, material supply delays, and equipment failures—on students' cost control decisions. Students act as cost engineers in the virtual environment, developing adjustment plans in response to emergencies. The system provides real-time feedback on cost changes, enabling students to "preview construction schemes in a virtual space."

2. Big Data Case Repository Development. Based on actual plateau bridge engineering projects, cost data generated during construction (processed to ensure confidentiality) are collected and organized to establish a "big data case repository of bridge construction costs." This repository contains multi-dimensional cost data, including labor, materials, machinery, preliminary expenses, and management costs, across different construction stages, altitude conditions, and bridge structural types, providing support for students'data analysis training.

3.3 Design of Offline Teaching Modules

1. Flipped Classroom. Before class, students engage in online learning of relevant theoretical knowledge and complete preliminary data analysis. Class time is then dedicated to discussions focused on cost planning challenges. For example, for the hoisting scheme of a plateau steel truss bridge, data on machine-shift costs of various hoisting equipment and work efficiency under different climatic conditions are provided before class. Classroom discussion centers on "how to select the

optimal machinery combination."

2. Project-Based Learning (PBL). Students are divided into groups acting as "cost consulting advisory teams," engaging in project-based practice centered on cost planning tasks throughout the entire process of plateau bridge construction. Each group is responsible for one construction phase (e.g., foundation construction, pier construction, steel truss assembly, arch-stiffening installation), completing full-process tasks such as cost budgeting, process cost monitoring, cost overrun analysis, and corrective measure formulation. Research indicates that integrated BIM project practice helps cultivate students' cost overrun management skills.

3. Dual-Tutor System Involving Both University and Enterprise. Cost managers involved in plateau bridge construction are invited to serve as industry mentors, participating in classroom discussions online or offline to share practical cost control cases and strategies from real engineering projects. Practical experience from Zhanjiang University of Science and Technology demonstrates that the involvement of industry mentors effectively enhances students' practical abilities and professional identity.

4. Teaching Implementation Process — Taking "Cost Planning for Steel Truss Girder Hoisting on a Plateau Bridge" as an Example

4.1 Pre-Class Guided Learning (Online)

The instructor assigns learning tasks: watch the micro-lecture on "Economic Comparison of Steel Truss Girder Hoisting Schemes," consult the actual cost data of hoisting construction under similar altitude conditions in the case repository, and preliminarily complete the "Cost Estimation Form for Steel Truss Girder Hoisting Scheme of a Plateau Bridge."

4.2 In-Class Internalization (Offline)

Contextual Introduction: A real case is presented — "During the hoisting of a steel truss girder for a plateau bridge, sudden strong winds caused five consecutive days of work stoppage, resulting in a cost overrun of 500,000 yuan due to project delays." Students are asked to analyze the causes of the overrun and propose countermeasures as consulting advisors.

Group Discussion: Each group uses data from the case repository and knowledge acquired online to analyze the cost composition from perspectives such as idle labor costs, equipment downtime costs, and overhead allocation. They calculate various losses using Excel or simple data analysis tools and discuss preventive measures for similar situations in the future.

Results Presentation: Each group presents their analysis report in five minutes, focusing on the main causes of cost overruns, calculation bases, and corrective recommendations.

Expert Commentary: The instructor provides feedback by referencing practical engineering solutions and introduces cases such as "how Beidou satellite-based real-time positioning technology improves hoisting efficiency," deepening students' understanding of the relationship between technology and economics.

4.3 Post-Class Extension (Online + Offline)

Each group revises and improves their cost analysis report. On the virtual simulation platform, students attempt to adjust the hoisting plan (e.g., changing machinery types, adding backup equipment) and observe the resulting cost variation curves. They then draft a "Recommendations Report on Cost Risk Prevention and Control for Plateau Bridge Construction."

5. Reconstruction of the Teaching Evaluation System

To meet the requirements of the blended teaching model, course evaluation has shifted from a "final-exam-decides-everything" approach to a whole-process, multi-dimensional assessment.

Formative Assessment (60%):

Online learning progress and quizzes (10%): assesses students' mastery of basic knowledge.

Quality of data analysis reports (30%): focuses on the accuracy of data processing and the rigor of analytical logic.

Group project outcomes and discussion performance (20%): emphasizes teamwork and problem-solving skills.

Practice from Zhanjiang University of Science and Technology [3-4] shows that using online quiz platforms to monitor students' learning progress in real time enables targeted teaching adjustments.

Summative Assessment (40%):

A major assignment titled "Cost Planning Scheme Design" based on real data is adopted. Students are required to complete a comprehensive design for a given plateau bridge construction scenario, including cost budgeting, process monitoring plans, and risk response strategies, with the focus on assessing their comprehensive application abilities.

6. Conclusion

In the context of big data, curriculum reform in bridge engineering construction cost planning and management is imperative. The blended teaching model, using complex plateau bridge engineering as a carrier—characterized by online theoretical foundation, offline project-based practice, and big data thinking throughout—can effectively address the disconnect between traditional teaching and practical application. Driven by real-world cases, students not only master the fundamental methods of cost planning but also develop their abilities to analyze and solve complex engineering problems. However, the implementation of this model places higher demands on instructors' practical engineering capabilities and information technology literacy. How to acquire and continuously update real-world engineering big data, and how to achieve seamless integration between online and offline teaching, remain issues that require further exploration.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Reference

[1] Liu, F. (2025). SPOC + Rain classroom based on OBE concept + Exploration of flipped classroom in teaching measurement and billing of construction projects. In Proceedings of the 2025 4th International Conference on Educational Innovation and Multimedia Technology (EIMT 2025). Atlantis Press.

[2] Wu, Y. W., Wen, M. H., Chen, C. M., & et al. (2016). An integrated BIM and cost estimating blended learning model—Acceptance differences between experts and novice. EURASIA Journal of Mathematics, Science and Technology Education, 12(5).

[3] Wan, L., & Bai, Y. (2022). Curriculum design and organization of application-oriented undergraduate engineering cost management based on BIM—Taking Zhanjiang University of Science and Technology as an example. Journal of Higher Architectural Education, 31(2), 137–144.

[4] Huang, M. C., Huang, J. G., Lan, R. S., & et al. (2022, June 8). University-level high-quality resource sharing course—Engineering cost planning and control (Engineering cost management). School of Architecture and Engineering, Zhanjiang University of Science and Technology.

[5] Zhang, W. H., Li, Z. G., Sui, Z. L., & et al. (2022). Implementation and application of whole-process cost management in the practice teaching of engineering cost major—Taking Beijing City University as an example. Theory and Practice of Innovation and Entrepreneurship, 5(18), 170–172.

[6] Jiao, L. D., Qin, M., Liu, G. F., & et al. (2019). An exploratory study on the "dual-main" teaching model in the teaching reform of engineering management majors—Taking engineering cost planning and control as an example. Modernization of Education, (66).

[7] Zhou, J. T., Zhang, H., Yang, J., & et al. (2025, April 2). Harnessing the "two roads" spirit to cultivate talents for mountainous regions—Chongqing Jiaotong University builds a talent support system for bridge and tunnel construction and maintenance in mountainous areas. China Education Daily.

[8] Wu, Y. F. (2024, March 13). "One bridge, one course, one team" assists in the construction of high bridges in mountainous areas. China Education Daily, p. 7.

[9] Luo, S., Hong, D., Du, B., & et al. (2025, November 27). The power of universities behind "bridges seeing Guizhou". Guizhou Daily.