ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202505_8(5).0048

Research on Practical Teaching Reform in Construction Courses Based on BIM+ Technology

Lihui Rong

Dianchi college, Kunming 650500, China

Abstract

Driven by intelligent construction and industrial digital transformation, the teaching mode of traditional construction courses is facing severe challenges, which are mainly manifested as the teaching content lagging behind the development of technology, the practical scene is out of line with the actual project, and the students' comprehensive decision-making ability is weak. This study takes BIM+ technology as the core, integrates emerging technologies such as the Internet of Things, virtual reality and big data analysis, reconstructs the practical curriculum system, forms a new teaching resource for practical teaching, and co-builds a virtual simulation platform for engineering teaching with school-enterprise cooperation. The theoretical model and practical application analysis of BIM+ technology enabling construction teaching are proposed. It is of great practical significance to elucidate the mechanism of technology integration on the training of engineering thinking and form a model of "post course competition certificate" which can be popularized.

Keywords

BIM+ Technology; Practical teaching; Teaching reform; Virtual simulation.

1. Introduction

With the transformation and upgrading of the construction industry, the corresponding talent demand has changed from labor intensive to skill intensive, requiring practitioners to have high practical ability, innovation ability and engineering quality. In order to meet the market demand and improve the practical ability and innovative spirit of civil engineering students, application-oriented colleges and universities must carry out practical teaching reform.

In order to improve the practical teaching efficiency of civil engineering majors and improve the practical operation ability of students, application-oriented colleges and universities combine their own professional characteristics and advantages to train application-oriented talents with innovative ability and practical operation ability, so as to meet the development needs of the industry. The training of innovative and high-quality applied talents is closely related to practical teaching. With the development of Internet technology, the combination of practical teaching and modern information technology, as the internal driving force of reform, is of great significance to the training of innovative applied talents. For local application-oriented undergraduate colleges, how to closely combine national and local economic and social development, restructure and optimize the practical teaching curriculum system, the integration of practical teaching resources, and the reform of practical teaching mode are important contents of the reform of civil construction practical teaching.

2. BIM Technology Features and Advantages

Analysis of existing problems in the practical teaching of civil engineering majors: At present, the separation of theory and practice still exists in the training process of civil engineering majors, the disconnection between the practical teaching process and the production process,

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202505_8(5).0048

no cross and penetration between different disciplines, the practical ability and innovation ability of students have not been effectively improved, and the ability to deal with practical engineering problems is insufficient. The systematic design of practice curriculum is not enough, and the practice lacks hierarchy. Practical teaching resources are relatively scarce, and some teachers lack practical experience. Teaching facilities are outdated and practical teaching equipment can not be updated in time, resulting in personnel training can not meet the needs of economic development in the modern market. The construction site is a big security hazard, the practice base is unstable, the teaching mode is single, the teaching cost is high, the teaching time is long and other problems also lead to the traditional civil engineering professional practice teaching effect is not good.

BIM features visualization, parameterization, digitization, collaboration, optimization, and simulation. The soul of BIM is information, the result is the model, the tool is the software, and the focus is collaboration. The application of BIM technology subverts the traditional single linear communication mode, and realizes the diversified communication mode with model and information as the center.

Virtual simulation teaching presents the situation in virtual teaching through various information technology means and methods, and establishes an immersive virtual teaching environment on this basis, and integrates well-designed education concepts, education content and education strategies into it, which is an innovation to the traditional teaching mode.

BIM technology + virtual simulation technology is applied to the practical teaching of construction courses to improve the practical ability of civil engineering students and their ability to solve practical problems.

3. Content of Practical Teaching Reform

Private colleges and universities need to take the integration of production and education as the link, practice and innovation as the starting point, through school-enterprise collaboration, interdisciplinary integration, competition-driven and teacher optimization, to build a civil engineering innovative talent training ecology that adapts to the era of smart construction, and ultimately achieve a high degree of fit between talent training quality and industry demand.

3.1. Content reconstruction and optimization of practical teaching curriculum system

Based on professional groups, application-oriented colleges and universities reconstruct the curriculum system of practical teaching, solve the problems of insufficient systematic design of practical courses and the lack of hierarchy of practical teaching, pay attention to the relevance and integrity of professional classes, promote interdisciplinary integration, and strengthen the cultivation of innovative ability through discipline competitions. The curriculum system of practical teaching is reconstructed based on professional groups, including basic practice, special practice, comprehensive practice and extended practice (discipline competition), and practical teaching is integrated into curriculum ideology and politics. Pay close attention to the development of the industry, dynamically grasp the demand for talents in the civil construction industry, adjust the goal of talent training, and formulate teaching goals from the top down: from the market demand of the industry, to the school level, to the professional level, and then to the course level, so as to clarify the goals achieved by each practical teaching. The teaching design is based on the practical activities such as course experiment, course design, practice training and graduation design.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202505_8(5).0048

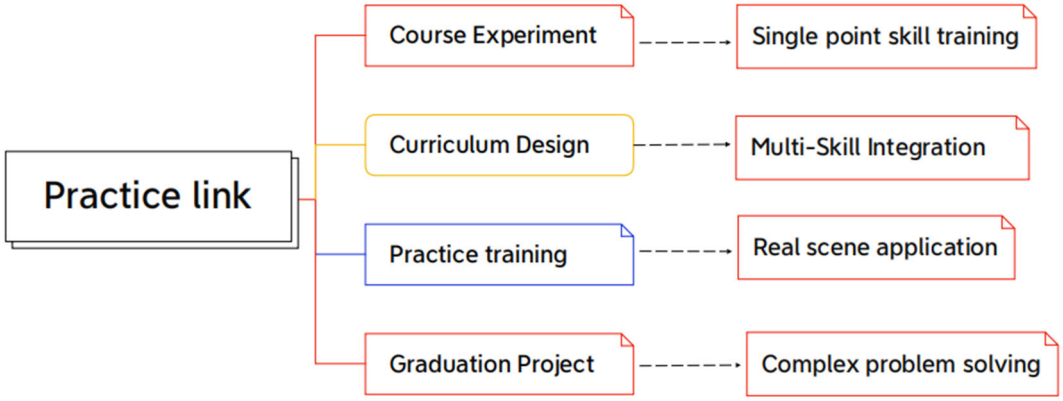

Figure 1. Practical teaching system

3.2. New teaching resources of practice teaching are formed

Integration, transformation and upgrading, the formation of multi-dimensional innovative teaching resources, and then through the lightweight teaching cloud platform to cloud local resources, combined with the new teaching and training room hardware equipment, to complete integrated, shared, experiential teaching. With a complete professional BIM model as the carrier, combined with VR, AR and other information technology means, and the whole construction process and professional case resources integrated into it. At the same time, engineering simulation application is carried out based on actual engineering projects, which becomes the basic resource for course learning and classroom teaching of architecture majors. Course resources can be cross-disciplinary and implemented into the entire training system.

Centering on engineering majors in colleges and universities, BIM+ technology is used as the core to create new interactive teaching resources. Meanwhile, traditional teaching resources are integrated, reformed and upgraded to form multi-dimensional innovative teaching resources. Then, local resources are cloud-based through lightweight teaching cloud platform, combined with hardware equipment in new teaching and training rooms to complete integrated, shared and experiential teaching. Finally improve the quality of professional personnel training in colleges and universities.

Stand-alone resources usually refer to data or models that are created, stored, and used separately in traditional mode, such as stand-alone CAD drawings, structural calculation files, or equipment parameter tables. It is characterized by decentralized management and lack of coordination, which may lead to the problem of information island. Prior to BIM adoption, many projects relied on such resources, which were inefficient and prone to version conflicts.

BIMXR (BIM + Extended Reality) resources combine building information models with extended reality technologies such as AR/VR/MR For immersive design review, construction simulation or operations training. The subcategory "BIMXR form" may refer to specific technical applications, such as VR virtual roaming: experiencing a building space through a headset.

AR field guidance: Overlay model information to the real site to assist construction.MR Hybrid Collaboration: Allows remote teams to work together in a blend of virtual and real environments.

Lightweight resources Reduce model complexity through data compression and format conversion (e.g. GLTF, 3D Tiles), making it suitable for mobile or web viewing. Its subcategory "Lightweight resource form" may include:Web side model: Online visualization based on Three.js or Cesium.Mobile applications: Offline browsing supported by Autodesk Viewer.

Improved legacy resources refer to digital upgrades to older technologies such as 2D drawings or tables, such as:Smart PDF drawings: Embed hyperlinks or 3D views.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202505_8(5).0048

Parametric Excel tables: dynamically associated with BIM models.Point cloud data processing: Transform laser scan results into editable models.Integrated resources emphasize the integration of multi-disciplinary data, such as the integration of building, structural, mechanical and electrical models into a unified BIM model. The benefits are increased collaboration efficiency, reduced design conflict, and full life-cycle management.

3.3. School-enterprise cooperation to build a virtual simulation platform for engineering teaching

Engineering entity and virtual resource platform are combined with teaching materials to form a new teaching tool. The integration of three-dimensional teaching materials and resource platforms into the teaching process. Teaching based on BIM visual environment, virtual reality experiential teaching.

With the deep integration of information technology and education reform, the field of engineering education is undergoing a digital transformation from the traditional teaching mode to the combination of virtual and real. Combining engineering entities and virtual resource platforms with teaching materials to form a "trinity" three-dimensional teaching tool has become a key path to solve the pain points in engineering education such as insufficient equipment, difficult to carry out high-risk experiments, and difficult to understand abstract concepts.

4. BIM+ Technology Application in Practical Courses

4.1. Teaching application of BIM visual environment

Whole life cycle teaching scene construction.Design stage: Students use BIM software to model building structures. The platform automatically detects beam and column collisions and generates modification suggestions (for example, three pipeline conflicts were found in a teaching building project, saving 15% of rework cost).Construction stage: Combined with 4D progress simulation, students observe the impact of different construction schemes on the construction period through the time axis (such as comparing the difference in the use efficiency of the tower crane with the "reverse method" and "forward method").Operation and maintenance stage: Import sensor data to simulate the aging process of equipment, and train students to develop preventive maintenance strategies (such as energy efficiency optimization decisions for central air conditioning systems).

Integrated teaching of BIM and GIS.In the urban planning course, BIM model is connected to ArcGIS platform to realize the linkage teaching of macro terrain analysis (slope, sunshine) and micro architectural design. For example, a transportation hub project needs to meet the dual constraints of underground pipeline layout (BIM layer) and surrounding road network carrying capacity (GIS layer) at the same time.

4.2. Virtual reality experiential teaching innovation

Gesture recognition: In the practical training of automobile disassembly and assembly, students "grab" the virtual wrench to disassemble the engine through the Leap Motion gesture controller, and the system detects whether the installation sequence of parts is correct in real time.Force feedback device: Use the Haption force feedback arm to simulate welding operation resistance and trigger vibration warning when the torch Angle deviates from 30°.Eye tracking: Analyze the visual focus of students in VR training for circuit troubleshooting and identify knowledge blind spots (such as 80% of students ignoring fuse status detection).

4.3. Practical application case

Case 1:Course name Project whole process control virtual simulation training.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202505_8(5).0048

Under the guidance of the teaching and training assignment book, the virtual simulation and training platform for the whole process control of the engineering project is used, and the two majors of engineering management and engineering cost jointly conduct group practical training. With the actual engineering project as the main line, students act as different participating units to simulate the whole life cycle of the engineering project. It mainly includes bidding simulation and bidding document preparation, approach preparation stage, construction stage, completion settlement, etc., to cultivate students' comprehensive ability of "cost, construction and fine management".

Case 2:Course name CAD and Parametric Design.

Under the guidance of teaching practical training assignment, project driven teaching is implemented. Each group will have a set of drawings for practical training, including identifying drawings, solving problems in drawings, and then BIM model creation and site layout. To cultivate students' ability of drawing recognition, building and structure modeling, problem finding and problem solving.

Case3:The course name is based on BIM construction organization design.

Under the guidance of the teaching and practical training task book, project-driven teaching is implemented. According to the current construction organization design specifications, students analyze the actual project data, prepare construction organization design documents, and use BIM construction software to carry out VR simulation of construction scheme, construction scheme safety calculation, schedule preparation and schedule comparison analysis, and construction site three-stage design and comparison analysis.

Case4:Course name Construction scheme preparation based on BIM.

Under the guidance of the teaching and practical training assignment, we implement project-driven teaching, and apply BIM technology and applied learning to practical projects and solve practical problems. Let students know progress plan simulation and control, resource dynamic graph calculation analysis and rationality. How to design and save cost in the case of compact construction site. Judge the rationality of dangerous project and formwork scaffold design.

Case5:Graduation design based on BIM.

Under the guidance of the graduation design task book, take the actual project as the main line, the overall construction deployment of the project (determination of the duration target and construction procedures), and create the BIM based project model. Bim-based schedule planning and optimization (schedule planning procedures, project WBS and construction process division, process duration calculation process (according to construction quota or construction period quota to have a detailed calculation process), process logic relationship determination, schedule planning; BIM5D schedule optimization and simulation (schedule problems, schedule optimization, construction schedule simulation)

Case6:BIM based graduation design competition

Guided by the task book of BIM Industry Design Competition, the construction BIM modeling and application module aims to enable students to make full use of the professional knowledge they have learned through joint graduation design, combining virtual and practical, combining theory with practice, working in a team form, completing the tasks specified in the design task book, and helping students to improve their professional skills and develop their future careers. Improve students' understanding and application of construction knowledge, improve software operation skills and the ability to apply BIM to analyze and solve problems.

5. Summary

The deep integration of modern information technology and practical teaching is used to form new teaching resources, and the integration and optimization of traditional teaching resources

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202505_8(5).0048

is combined to form integrated teaching resources, which can be built into the basic resources for course learning and classroom teaching of architecture majors. The course resources can be cross-disciplinary and implemented into the entire training system.

The combination of engineering entity and virtual simulation platform forms a new teaching model. Integrating teaching practice and resource platform into the teaching process, combining theory with practice. Teaching based on BIM visual environment, virtual reality experiential teaching.The theoretical model and practical application analysis of BIM+ technology enabling construction teaching are proposed. It is of great practical significance to elucidate the mechanism of technology integration on the training of engineering thinking and form a model of "post course competition certificate" which can be popularized.

Acknowledgements

2023 Dianchi College of Yunnan University School-Level Education and Teaching Reform Research Project: Research on the Practical Teaching Reform of Construction Courses Based on BIM+ Technology (2023XJJG13).2025 Scientific Research Fund Project of Education Department of Yunnan Province, Research on the cultivation of intelligent construction talents in applied universities under the background of new engineering. (2025J1153)

References

[1] Xie F .Research on the Reform of Industrial Engineering Talents Training Mode for Intelligent Manufacturing[J].Journal of Natural Science Education,2024,1(4).

[2] Yujie LU,Hui GAO,Tianzhao HUO.Construction System and Teaching Scheme Design of Intelligent Construction[J]. Higher Architectural Education,2022,31(1): 8-14.

[3] Xia Chunqin, Liu Chuanjian. Exploration and Research on Training Model of innovative talents under the background of new engineering [J]. Experimental Science and Technology, 2019, 17(05): 64-67.

[4] Xu Ming, Hao Lina, Qu Mengmeng, et al. Thinking on the reform path of practical teaching of Civil engineering major in applied undergraduate College from the perspective of "three whole Education" : A case study of Civil Engineering major in Qiqihar University of Engineering [J]. Forestry Science and Technology Information, 2019,56(01):234-237.

[5] He Wu,Xujie Sun, Yang Yang, et al. Research and practice of cultivating civil engineering professionals in the School of Intelligent Architecture for "new engineering"[J].Higher Architectural Education, 2021, 30(1) : 10-16.

[6] ZHANG Yanfang, Wang Chengcheng, Liu Yang. Exploration on BIM practice teaching reform of Civil engineering majors based on OBE-CDIO concept [J]. Public Science and Technology, 2019, 25(08): 146-149+134.

[7] Xiang Xiannan. Reform and Practice of Practical Teaching of Civil Engineering major for New engineering -- A case study of Construction and Environment Major in Hunan City University [J]. China Educational Technology Equipment,2019,(22):129-131.