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Research on Reconstructing the Progressive Integrated Teaching System of CAD-BIM under the Background of Emerging Engineering

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Abstract: To meet the core training objectives of emerging engineering talents, satisfy the full-cycle education requirements of engineering education professional accreditation, and conform to the core competency standards for digital talents in intelligent construction, this paper takes core drawing courses for civil engineering majors in local universities as the research object. It thoroughly analyzes prominent drawbacks arising from the separated teaching mode of CAD and BIM, including disconnected teaching logic, outdated teaching content, practical training divorced from real engineering scenarios, and imperfect assessment systems. Based on the transformation demands of the digital construction industry, this paper proposes a complete, operable and hierarchically progressive integrated teaching system combining CAD and BIM. Five types of teaching and practical training cases are innovatively integrated into the research, covering standardized drawing of frame-structured buildings, forward modeling converting 2D drawings to 3D models, automatic drawing checking via AI technology, on-site surveying and mapping of campus buildings, and whole-process infiltration of engineering ideological and political education. Systematic reconstruction and optimization are carried out from four dimensions: curriculum module division, classroom teaching procedures, hybrid online-offline practical training modes, and multi-dimensional whole-process assessment mechanisms. Data collected from a semester-long controlled teaching experiment with two parallel classes demonstrates that this progressive integrated teaching framework completely bridges the competency gap between 2D drafting and 3D modeling formed by traditional teaching. It remarkably improves students' capabilities in standardized construction drawing, digital 3D architectural modeling, independent identification and correction of drawing errors, and handling comprehensive engineering problems. Meanwhile, the system realizes coordinated cultivation of professional skills, engineering thinking and craftsmanship. This research can provide a complete practical framework and empirical data reference for in-depth digital teaching reform of drawing courses for civil engineering disciplines in similar local undergraduate colleges nationwide.

Keywords: Integrated CAD-BIM Teaching; Hierarchical Progressive Teaching; Teaching System Reconstruction; AI Drawing Inspection; Industry-Education Integration.

1. Introduction

(1) Research Background and Policy Orientation

Over the past decade, China's infrastructure sector has undergone a wave of digital transformation. Conventional workflows relying on manual drawing and extensive on-site construction have been gradually phased out. Intelligent construction, prefabricated buildings and digital twin technologies have been comprehensively applied throughout the full lifecycle of architecture, covering architectural design, construction management and post-operation maintenance[1].

The Ministry of Housing and Urban-Rural Development issued the Action Plan for the Coordinated Development of Intelligent Construction and Construction Industrialization (2021–2025), which clearly urges the industry to accelerate the cultivation of digital talents. Frontline corporate positions require practitioners to master integrated skills such as standardized CAD drafting, detailed BIM modeling, collision detection and digital collaborative design[2].

In parallel, policy documents including the national Emerging Engineering Initiative and Excellence Engineer Training Program 2.0 push civil engineering programs to break outdated curriculum frameworks, promote deep integration of information technology and professional teaching, and strengthen practical training based on real engineering scenarios, with a focus on cultivating students' ability to tackle complex engineering problems.

Field visits to local design institutes and construction enterprises reveal a widespread complaint among employers: many new graduates produce non-standard CAD drawings that fail national drafting codes. Although capable of building BIM models, they lack the ability to interpret underlying construction drawings and cannot complete the full workflow of "drawing creation – model establishment – drawing optimization". Companies have to spend 3 to 6 months retraining new hires, indicating a severe mismatch between university talent training and industrial demands.

The root cause lies in unreasonable internal curriculum arrangement. In our university, CAD Engineering Drawing is offered in the second semester of Year 1, while BIM Modeling Application is scheduled for the second semester of Year 2, creating a one-year gap between the two courses. Instructors prepare lessons independently without coordinating teaching content. CAD courses overemphasize basic software commands such as offset, trim and hatch, with limited explanation of layer management, dimension annotation and complete plan-elevation-section drawing standards in real construction drawings. BIM teaching only covers rapid modeling of walls, beams and columns, rarely involving drawing traceability, structural joint optimization and collision inspection — core tasks frequently required in enterprises.

Long-term separated teaching leads students to treat drawing and modeling as two isolated tasks, resulting in weak spatial structural cognition that fails to meet the requirements of digital posts. Accordingly, reconstructing an integrated, progressive teaching system tailored to the learning characteristics of civil engineering students has become an urgent priority for drawing curriculum reform.

(2) Major Deficiencies in Current Teaching

Based on three consecutive years of classroom teaching experience, student practical assignment evaluation and follow-up surveys with construction enterprises, four prominent drawbacks of separate CAD and BIM courses are summarized, each supported by authentic classroom cases:

First, disconnection between 2D and 3D modules leads to blocked competency transfer. After learning CAD in Year 1, most students forget drafting standards when they take BIM courses one year later. Statistics from a 2024 cohort show that over 60% of students submit CAD base drawings without standardized layers or complete dimension labels, resulting in frequent errors such as misaligned component elevations and conflicts between walls and beams during modeling. Students operate drawing and modeling software independently without establishing logical connections between the two, making it difficult to form systematic digital engineering thinking.

Second, outdated teaching content fails to align with current industrial standards. Teaching materials still adopt simplified drawings from ten years ago, with insufficient coverage of updated line types, annotation rules and component expression requirements specified in the current Standard for Structural Drawing of Buildings. BIM teaching prioritizes visual model rendering, neglecting core job functions including pipeline collision detection, construction simulation and quantity calculation correlation. One intern was required to redo all drawings by enterprise technical supervisors due to ignorance of standardized layer management, which prevented his drawings from being uploaded to the institute's collaborative design platform.

Third, over-simplified practical training cases lack authentic engineering contexts. Previous course assignments only adopt standardized textbook exercises without on-site surveying or field data collection. In past final practical assessments, students merely built models according to fixed drawing templates without dealing with real engineering challenges such as dimensional contradictions, site space constraints and structural joint conflicts. Long-term repetitive template training leaves students unable to identify drawing errors in actual projects, resulting in inadequate practical capabilities for field measurement and drawing revision.

Fourth, simplistic assessment mechanisms lack full-process tracking and continuous improvement. Before the reform, 90% of course grades depended on a single final drawing or model submission, ignoring regular classroom operation, iterative drawing revisions and group collaborative outcomes. Many students copy finished work before deadlines while remaining careless during daily practice, ignoring massive annotation errors and component collisions without proactive revision. This "one-off final exam" grading model contradicts the core continuous improvement requirement of engineering education accreditation and cannot fully reflect students' progressive competency growth.

2. Conception and Overall Framework of the Progressive Integrated CAD-BIM Teaching System

(1) Reform Conception and Talent Training Philosophy

This teaching reform is rooted in the talent training positioning of civil engineering majors in local universities and oriented toward the digital training goals of emerging engineering education. Centered on practical competency demands of industrial posts, the reform takes two authentic engineering projects — a three-story frame office building and campus training building surveying — as consistent training carriers. A progressive training chain is constructed following students' cognitive rules to eliminate fragmented separate teaching of CAD and BIM[4].

The overall reform logic follows four progressive layers: standardized drawing foundation, 3D modeling construction, intelligent inspection and error correction, and comprehensive practical training based on real-site projects. The research establishes a complete workflow linking 2D drafting to digital 3D applications, while integrating craftsmanship awareness, engineering safety accountability and landmark national construction projects into every practical session. Teaching focus shifts from mere software command training to cultivating students' comprehensive engineering capabilities including drawing reading, drafting, modeling, self-inspection and scheme optimization, realizing simultaneous advancement of professional skills, spatial thinking and professional ethics.

(2) Four-Stage Progressive Integrated Teaching Framework

In accordance with the competency development rules of Year 1 and Year 2 students, two sets of tiered training cases (simplified frame office building for basic training and real campus building for comprehensive training) are adopted to construct a closed-loop four-stage progressive teaching system: from plane to space, from simulated tasks to real sites, and from single operations to integrated engineering practice. Clear training objectives, supporting assignments and assessment criteria are defined for each stage.

Stage 1: Foundation Building through Standardized 2D Drafting

The drafting of construction drawings for a three-story frame office building serves as the core training carrier. Repetitive mechanical software command drills are reduced, while classroom focus is placed on practical implementation of national drawing standards. Unified specifications are formulated for layer naming, line type and width differentiation, text and dimension annotation formats, guiding students to complete full sets of architectural floor plans, elevations and sections. Drawings with typical errors from previous cohorts are used as negative examples to collectively rectify common problems including chaotic layers, missing elevation labels and vague structural detail representation. The core objective of this stage is to produce complete, error-free standardized CAD drawings as reliable base files for subsequent 3D modeling.

Stage 2: Spatial Construction via 3D Modeling

Standardized CAD drawings completed independently by students in Stage 1 are directly imported as base files for forward refined BIM modeling. Students construct structural components by category, including frame columns, primary and secondary beams, floor slabs, infill walls, staircases and doors/windows. They are required to cross-check dimensions, elevations and positions against corresponding CAD drawings for every component to establish one-to-one correspondence between 2D drawings and 3D solid components. For students with weak spatial imagination, physical building component models are provided for classroom reference to resolve mismatches between drawing interpretation and modeling outcomes.

Stage 3: Model Inspection and Drawing Iterative Optimization

Industry-standard AI drawing inspection plug-ins and BIM collision detection tools are introduced in practical sessions, forming an innovative highlight of this reform. Based on self-built BIM models of the office building, students independently run dimensional verification, component collision and pipeline conflict detection, with the system automatically generating a list of drawing defects. Common problems such as contradictory beam-column joint dimensions and inconsistent staircase platform elevations are identified; students revise the original CAD drawings accordingly and update the BIM models repeatedly, forming a closed loop of “drafting – modeling – intelligent inspection – drawing revision”. Iterative training cultivates students’ ability to independently identify engineering defects and optimize design schemes, freeing them from passive reliance on instructor feedback.

Stage 4: Comprehensive Practical Training Based on Real-Site Engineering

An aging campus training building is selected for full-process on-site surveying and mapping integrated with ideological and political education. Students work in groups of 3 to 4, carrying tape measures and laser rangefinders to record building length, width, floor height and door/window dimensions, sketch field drafts, sort measured data, generate precise CAD construction drawings and complete full BIM models. Optimization proposals are put forward targeting on-site defects such as wall cracks and unreasonable pipeline layouts. Lectures on landmark national projects including the Hong Kong-Zhuhai-Macao Bridge and Xiongan New Area are interspersed to help students recognize the rigor of construction engineering and foster meticulous craftsmanship, achieving deep integration of technical training and ideological education.

Table 1. Four-stage Progressive Integrated Teaching Framework

Stage	Name	Carrier	Core Content
1	2D Standard Drawing Foundation	Frame office building drawings	National drawing standards; unified layers, linetypes & annotations
2	3D Spatial Modeling	Stage 1 CAD drawings	Component-based BIM modeling; drawing-model cross-check
3	Model Checking & Iteration	Self-built BIM model	AI review + collision detection; cyclic revision
4	Field Engineering Practice	Campus building field survey	Full engineering workflow; ideological education

3. Implementation Paths of Progressive Integrated Teaching Reform

(1)Modular Restructuring of Curriculum Content for Tiered Competency Development

Following the four-stage progressive logic, scattered knowledge points from the two formerly separated courses are reorganized into three coherent teaching modules with interleaved class hours to avoid knowledge gaps between semesters:

Standardized CAD Drafting Module: Concentrates on complete construction drawing expression, standardized layer management, drawing layout and national annotation codes, with the three-story frame office building as the consistent training case to ensure all students master industry-compliant drawing output.

2D-3D Conversion Module: Focuses on CAD base drawing cleaning, component positioning, forward BIM modeling and lightweight model processing, breaking data exchange barriers between two software platforms and solving mismatches between drawings and models.

Digital Engineering Application Module: Incorporates cutting-edge industrial content including AI drawing inspection, multi-disciplinary collision detection, on-site surveying and scheme optimization. Brief ideological and political cases are embedded in every practical session to align curriculum content with updated industrial standards and job requirements in intelligent construction.

(2) Hierarchical Case-Driven Teaching to Realize Progressive Practical Training

Students exhibit significant disparities in software proficiency: some have never used drawing software in high school, while a small number have self-studied CAD. Hierarchical case training is adopted to accommodate learners at different levels: At the early course stage, all students complete basic standardized training using the frame office building case; students with weak foundations only need to finish qualified drawings and basic modeling to grasp core skills. Mid-semester training raises difficulty by adding drawing error correction and collision detection tasks for students with moderate foundations. Specialized AI inspection training is arranged in the middle-late semester to cultivate independent drawing revision capabilities. A comprehensive campus surveying project is assigned for final assessment, and top-performing groups are encouraged to propose building renovation schemes and participate in university-level drawing competitions[5]. Tiered tasks guarantee basic proficiency requirements while providing room for advanced improvement and innovative expansion, catering to the growth of all students.

(3) Integrating Digital Intelligent Technology into Classroom to Innovate Practical Training Modes

In traditional teaching, dozens of students submit drawings simultaneously, leading to extremely low correction efficiency as students wait two to three days for instructor feedback. This reform normalizes AI intelligent drawing inspection tools in daily practical training. After finishing CAD drawings and BIM models, students upload files for one-click automatic screening, which identifies layer disorder, missing dimensions, component collisions and elevation errors with clear revision suggestions generated automatically.

Instead of instructors correcting assignments one by one, students first revise drawings and models according to AI inspection reports. Instructors then deliver centralized lectures on common errors and provide one-on-one tutoring for underperforming students. Practical training data from this semester shows that drawing evaluation previously required two full class periods; after students complete preliminary AI self-revision, instructors only focus on complex structural joint issues, greatly expanding coverage of error correction. Students become familiar with the full digital inspection workflow adopted by design institutes before graduation, preparing them for corporate working modes.

(4) Establishing Diversified Assessment Mechanisms to Support Continuous Teaching Improvement

Guided by the Outcome-Based Education (OBE) philosophy and the requirements of engineering education professional accreditation[3], this curriculum completely abolishes the traditional single final achievement evaluation model with summative scoring. A four-dimensional whole-process assessment system is constructed to realize comprehensive and diversified evaluation. All assessment data and scoring records can be permanently stored and fully traced, which meets the standardized evaluation requirements of engineering education certification and ensures the objectivity and scientificity of teaching assessment. The detailed assessment dimensions are set as follows:

a. Process Performance Dimension (30%)

Focusing on students' whole-semester learning status and practical participation, this dimension abandons the result-oriented evaluation method. It comprehensively records the task completion progress of four-stage progressive training, the iteration times of drawing revision, attendance of classroom practical operations, and individual participation in group surveying and mapping tasks. Students are encouraged to optimize their drawings repeatedly rather than pursuing one-time finished works. This evaluation method fully reflects students' learning investment and progressive growth throughout the semester and avoids the opportunistic learning behavior of cramming for final assignments.

b. Achievement Quality Dimension (30%)

Based on industrial official drawing standards and engineering practical specifications, this dimension conducts refined quantitative evaluation on students' phased training achievements. It mainly assesses the standardization of CAD drawings, the dimensional accuracy of BIM models, and the integrity of complete training results. A item-by-item deduction system is adopted for standard compliance inspection. Common engineering problems such as disordered drawing layers, missing or wrong annotations, irregular line types, model dimensional deviations and incomplete component settings are strictly checked and deducted. By benchmarking design institute standards, the system urges students to form standardized engineering drawing and modeling habits and ensure the engineering applicability of training outcomes.

c. Professional Competence Dimension (25%)

Centering on the core practical training objectives, this dimension adopts on-site practical assessment and in-class specialized tests as the main evaluation methods. Through campus real-scene surveying practice, drawing error inspection and model defect rectification exercises, it comprehensively examines students' core abilities including engineering drawing recognition, refined BIM modeling, engineering problem troubleshooting and practical rectification optimization. Different from traditional theoretical examinations, this dimension is fully oriented to actual engineering job demands, focusing on testing students' ability to apply professional knowledge and solve practical engineering problems, so as to accurately identify students' professional skill deficiencies.

d. Professional Literacy Dimension (15%)

Implementing the fundamental requirement of moral education in curriculum teaching, this dimension incorporates engineering professional literacy into the quantitative assessment system. Combined with students' performance in whole-process real-scene training, learning outcomes of national mega-project cases and post-training experience reports, students' comprehensive literacy is evaluated comprehensively. It focuses on assessing students' rigorous engineering drawing attitude, team collaboration ability in group training, craftsmanship spirit of striving for excellence, and pragmatic engineering responsibility awareness, guiding students to establish correct professional values and realize the integrated cultivation of professional skills and ideological literacy.

The four-dimensional whole-process assessment system fully records students' growth trajectory of professional skills, learning attitudes and comprehensive abilities throughout the semester, realizing all-round and three-dimensional evaluation of learning outcomes. Meanwhile, based on the common problems and individual deficiencies reflected in each round of assessment, the curriculum teaching content and training design are reviewed reversely. Teaching priorities are dynamically adjusted and practical training links are optimized to make up for teaching shortcomings. A closed-loop continuous improvement mechanism of "teaching implementation — whole-process assessment — problem feedback — teaching optimization" is established, which fully conforms to the core continuous improvement requirements of engineering education professional accreditation.

Table 2. Four-Dimensional Whole-Process Assessment System Table

Assessment Dimension	Weight	Core Assessment Contents
Learning Performance	30%	four-stage training tasks, number of drawing revisions, classroom attendance and group division of labor during surveying
Outcome Quality	30%	Separately evaluates CAD drawing standardization, dimensional accuracy of BIM models and completeness of full deliverables
Professional Competency	25%	students' practical capabilities in drawing interpretation, modeling and error correction through on-site surveying drills and drawing defect identification quizzes.
Professional Ethics	15%	Evaluates rigorous drafting habits, teamwork awareness and engineering accountability

4. Teaching Practice and Effect Analysis

(1) Experimental Design

Two parallel Year 2025 civil engineering classes with comparable academic foundations were selected for a semester-long controlled teaching experiment. Class A (experimental group) adopted the four-stage integrated CAD-BIM teaching system proposed in this paper, while Class B (control group) followed the traditional separated CAD and BIM teaching model. The two groups shared identical total class hours, instructors, computer laboratory facilities and training materials, with the three-story frame office building drawings and campus training building surveying as core training carriers. Teaching effects were compared from four dimensions: drawing quality, modeling competency, independent error correction ability and comprehensive practical performance.

(2) Practical Effects of Typical Teaching Cases

Effects of Standardized CAD Drawing Training

After the standardized and systematic drawing training in the first stage, students' professional drawing ability was comprehensively improved. Common basic drawing problems, including disordered layers, missing annotations and dimensional deviations, were significantly reduced in the experimental class. The qualification rate of standardized drawings increased from 62.4% in the control class to 91.0% in the experimental class. Comparative analysis of students' assignments shows that nearly 40% of students in the control class could not distinguish different linetypes and made random annotations, resulting in unqualified drawings that could not support subsequent BIM modeling. In contrast, most drawings completed by students in the experimental class meet the formal drawing standards of architectural design institutes. The base drawings hardly contain any basic data errors after being imported into BIM software, which effectively avoids modeling deviations caused by early drawing defects and lays a solid foundation for high-precision 3D modeling.

Effects of 2D and 3D Transformation Training

The integrated teaching mode effectively improves students' drawing recognition, modeling application and spatial cognition abilities. All students in the experimental class can independently complete the complete workflow including CAD base drawing cleaning, component alignment modeling, model collision detection and drawing reverse optimization, and accurately restore architectural spatial structures based on 2D construction drawings. However, more than half of the students in the control class are disconnected from the original drawings during modeling. They frequently make errors in component elevation and spatial dimensions and cannot actively identify inconsistencies between 3D models and 2D drawings, showing obvious deficiencies in spatial structure cognition and 2D-to-3D transformation capabilities. The integrated teaching mode fundamentally solves the long-standing problem of separation between drawing recognition and 3D modeling in traditional teaching, realizing the coordinated improvement of planar reading and three-dimensional modeling abilities.

Effects of AI Intelligent Drawing Inspection Training

The innovative application of industry-standard AI intelligent drawing review and BIM detection tools has thoroughly changed the traditional teacher-dominated correction mode and greatly improved students' revision efficiency and independent problem-solving ability. In the experimental class, students' drawing revision efficiency increased by more than 40%, while the incidence of repetitive drawing errors decreased by 35%. In traditional training, students passively waited for teachers to find out drawing and model problems with weak awareness of self-inspection and optimization. With intelligent checking tools, students can actively detect various engineering problems such as dimension conflicts, component collisions and missing information, and independently revise and optimize drawings and models according to system detection reports. This training mode significantly enhances students' autonomous learning ability and engineering judgment capacity. Furthermore, students actively apply AI intelligent checking methods to disciplinary drawing competitions, and their competition works present higher integrity, standardization and accuracy than those of previous years.

Effects of Campus Real-Scene Surveying and Mapping Training

The campus real-scene surveying and mapping project builds a full-cycle and authentic engineering training system, enabling students to complete the whole practical engineering process: on-site measurement, manual sketch recording, measured data sorting, CAD construction drawing generation, BIM model establishment and scheme optimization. During the group-based training, students' comprehensive abilities in team collaboration and on-site engineering problem solving are fully cultivated. The high-standard architectural drawings and optimized BIM models generated from the training can be directly applied to school-level innovation and entrepreneurship projects and professional drawing competitions, realizing the in-depth integration of classroom teaching, practical training and discipline competitions, and achieving effective alignment between knowledge learning and practical application. Meanwhile, ideological and political education based on national mega-projects such as the Hong Kong-Zhuhai-Macao Bridge and Xiongan New Area is integrated into the training process. Combined with practical engineering experience, students fully understand the zero-tolerance principle for errors in architectural engineering. Their craftsmanship spirit, rigorous professional quality and engineering responsibility awareness are remarkably strengthened, realizing the dual cultivation of professional practical ability and moral literacy.

(3) Summary of Overall Reform Outcomes

Data from the semester-long controlled experiment verifies four core educational benefits of the progressive integrated CAD-BIM teaching reform: First, the reconstructed curriculum system features coherent logic and a step-by-step digital competency training chain, fundamentally resolving fragmentation and disconnection in traditional teaching. Second, students' comprehensive engineering capabilities are comprehensively upgraded; their proficiency in standardized drafting, 3D modeling, intelligent drawing inspection and on-site practice matches the competency requirements of industrial digital posts. Follow-up enterprise feedback indicates interns from the reformed cohort adapt to corporate work far faster. Third, the teaching framework aligns with the digital training orientation of emerging engineering education. AI technology, real-site projects and virtual-real integrated training are embedded in daily classes to build a modern digital teaching environment. Fourth, the reform balances technical skill cultivation and value guidance by integrating engineering ideological education throughout drafting and modeling training, realizing simultaneous knowledge transmission, competency cultivation and moral shaping.

5. Reflections on Teaching Reform and Optimized Strategies

This progressive integrated teaching reform effectively addresses major drawbacks of traditional teaching including outdated content, practical training disconnected from industry, simplistic assessment and separated 2D/3D teaching. Nevertheless, one semester of classroom implementation reveals two practical areas requiring further optimization. On one hand, wide gaps exist in students' prior foundations; a small number of entry-level learners struggle to comprehend 2D-3D conversion logic and operate intelligent modeling tools, making uniform classroom lectures unable to provide sufficient personalized tutoring time. On the other hand, current training cases mainly rely on on-campus buildings, with insufficient introduction of complete construction drawings and BIM models of residential and commercial complexes under construction at local enterprises. Students have limited exposure to live engineering projects, leaving room for improvement in their adaptability to real post scenarios.

Three targeted optimization directions are proposed based on classroom realities: First, refine tiered practical training objectives into three levels for students with different foundations: basic tasks focusing on qualified standardized drawing and fundamental modeling; advanced tasks adding drawing iteration and collision detection training; extended tasks open to architectural renovation optimization and competition-oriented drawing design. Supplementary online micro-lessons covering challenging modules such as 2D-3D conversion and AI drawing inspection are recorded for repeated after-class learning by underperforming students to improve personalized teaching accuracy.

Second, deepen industry-education collaborative training by establishing long-term practical cooperation mechanisms with local design institutes and construction enterprises. Complete construction drawings and BIM models of ongoing residential and office projects are regularly introduced as extended classroom cases. Frontline corporate BIM engineers are invited to deliver online and offline special lectures on real-world modeling and drawing optimization workflows, narrowing the gap between campus training and industrial posts.

Third, improve the integrated intelligent teaching assessment system by optimizing data docking between AI drawing inspection platforms and course grading. Automatically record defect types and revision frequencies identified by AI into process evaluation scores. Meanwhile, balance intelligent tools and manual instructor evaluation: manual grading and comments are retained for subjective engineering tasks such as complex structural joint analysis and design scheme optimization, forming a hybrid assessment model combining AI preliminary screening and in-depth instructor evaluation to continuously upgrade digital classroom teaching quality.

6. Conclusion

Against the backdrop of nationwide emerging engineering development and rapid intelligent construction transformation, the traditional separated teaching mode of CAD and BIM fails to satisfy the cultivation demands of interdisciplinary digital civil engineering talents. Relying on two authentic teaching cases — frame office building drafting and campus building on-site surveying — this paper constructs a complete four-stage progressive integrated CAD-BIM teaching system that breaks down barriers between 2D drafting and 3D modeling. A full training chain covering standardized drawing, spatial modeling, intelligent inspection and comprehensive real-site engineering practice is established.

Fourth actionable measures including modular curriculum restructuring, hierarchical case-driven practical training, AI digital technology empowerment and four-dimensional whole-process assessment effectively compensate for students' deficiencies in digital design and engineering practice, while embedding ideological education throughout all training sessions to fulfill the fundamental task of moral education. The complete reform framework complies with engineering education accreditation standards, requires low implementation costs and fits the training conditions of local universities. It can provide operable, referable practical experience for digital drawing curriculum reform of civil engineering disciplines in similar undergraduate institutions nationwide.

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