Research on the Innovation of Applied Talent Cultivation Models in the New Era from the Perspective of Industry-Education Integration: A Case Study of BIM Curriculum Reform

Siyu Chen*, Peng Liu

Kunming University of Science and Technology Oxbridge College, Kunming 650000, China

*csysiyu@163.com

Abstract. In the context of the transformative demands of the digital era, higher education institutions are confronted with the significant challenge of aligning academic training with industrial needs. This study proposes a novel Four-Stage Collaborative Model for Industry-Education Integration, grounded in the principles of "demand orientation, competency core, and collaborative education", to address the persistent theory-practice divide in applied talent cultivation. The proposed framework is centred on the reform of the BIM curriculum, integrating interdisciplinary modules through a systematic pathway. Empirical evidence demonstrates that this model significantly reduces graduate adaption periods and enhances innovation capabilities, and student teams achieve over 90% award rate in BIM-related competitions. The integration of authentic real-world projects and hybrid pedagogies has been identified as a key factor in addressing the skill gaps that have been identified in global engineering education. These gaps include, but are not limited to, fragmented disciplines and passive learning methods. This research offers a replicable blueprint for cultivating future-ready talents, advancing the goals of the New Engineering Education initiative in China and global digital transformation agendas.

Keywords: Applied Talent Cultivation, Digital Transformation, Industry-Education Integration, BIM Curriculum Reform

1   Introduction

The rapid advancement of digital technologies, including artificial intelligence (AI) and Building Information Modelling (BIM), has transformed industries such as architecture, engineering, construction and operation (AECO). This transformation has resulted in a demand for professionals who possess interdisciplinary expertise and adaptive problem-solving skills (Smith et al., 2023)[1]. BIM, as a core driver of digital transformation, requires seamless integration of design, sustainability, and project management principles (Chen et al., 2022)[2]. However, traditional educational models, characterised by rigid disciplinary silos and passive learning methods, fail to equip graduates with

the competencies needed for modern AECO workflows (García & Müller, 2021; UNESCO, 2023)[3][4]. This mismatch leads to diminished employability and stifled innovation.

Globally, educational reforms are placing a premium on the integration of industry and education to address skill gaps. For instance, the EU's Digital Education Action Plan (2021)[5] places emphasis on digital literacy and interdisciplinary collaboration, while China's New Engineering Education initiative (2020)[6] advocates for curricula that align with technological advancements. Despite these efforts, challenges persist, including an over-reliance on theoretical learning and a lack of emphasis on practical skills, the use of passive teaching methods that stifle critical thinking, and an inadequate integration of emerging technologies, such as AI-driven design with ethical training.

The present study puts forward a novel proposal for an integrated model that combines industry and education through the reform of a BIM curriculum that is underpinned by interdisciplinary approaches. The model's integration of real-world projects, adoption of hybrid strategies (e.g., competition-driven learning, AI-enhanced instruction), and fostering of multidisciplinary synthesis are designed to cultivate talent capable of addressing complex engineering challenges. The research responds to global calls for high-quality applied education and offers insights into disciplines in the context of global technological disruption.

2   Critical Analysis of Traditional Education Models

Conventional educational models are confronted with a multitude of issues and difficulties, including a lack of cross-disciplinary integration, theory-practice disconnect, insufficient digital and intelligent competencies, and single teaching methods. Traditional engineering education is characterised by disciplinary barriers, which hinder its ability to meet the complex needs of modern industry. For instance, the focus of conventional BIM courses on building modelling skills overshadows integration with structural engineering, sustainable design, and cost management (Chen et al., 2022)[2]. This fragmentation of knowledge hinders students' ability to synthesise knowledge across different disciplines, consequently impeding the development of new engineering talent. As García and Müller (2021) highlighted, 78% of European engineering graduates reported difficulties in collaborating with professionals from other disciplines, attributing this gap to fragmented curricular structures[3]. In Japan, Lee and Watanabe (2020) found that universities prioritising single-discipline expertise produced graduates ill-prepared for interdisciplinary teamwork in Industry 4.0 environments[7]. BIM courses encompass multiple fields, such as design and construction, but conventional teaching methods emphasise theory and lack practical opportunities. A survey in India found that 65% of students were unable to apply theory to real-world projects due to a lack of practical training (Gupta & Patil, 2022)[8]. 82% of construction companies worldwide report that graduates' theoretical knowledge is rarely translated into practical skills (UNESCO, 2023), making it difficult for them to adapt to the workplace[4]. The prevailing focus in traditional BIM courses on basic modelling has come at the expense of more advanced topics such as AI-optimised design and VR simulation.

This is a salient example of the digital transformation of the industry, yet students are not being equipped with the key skills they need to adapt to technological iteration. The pedagogical approach in traditional classrooms, characterised by teacher-centred lectures, fosters a passive learning environment where students receive knowledge in a limited manner, lacking interaction and creativity. As demonstrated by Kim and Park (2021), passive lecture-based teaching methods in South Korea have been shown to reduce student motivation and problem-solving engagement by 40% in comparison to active learning approaches[9]. At the same time, the evaluation system relies on final exams, neglecting practical skills and comprehensive quality, further weakening the learning effect.

3   Framework for Curriculum Reform

3.1   Redefining Educational Objectives

Following the educational objectives of the new engineering discipline, the course has been meticulously designed to provide students with a comprehensive understanding of the theoretical underpinnings and practical applications of BIM technology. The course curriculum is structured to foster students' ability to apply their professional knowledge and skills to authentic engineering projects. The course content has been meticulously designed to align with Bloom's Taxonomy of Educational Objectives, which categorises teaching objectives into three progressive levels which are knowledge, skills, and values. The specific implementation strategies employed are illustrated in Figure 1. For each level of teaching objective, the course has developed precise, specific target indicators. Teaching activities are meticulously designed to progressively build upon these target levels, ensuring that the curriculum aligns with the new engineering education system's stringent requirements for cultivating civil engineering professionals. The curriculum emphasizes the development of essential qualities such as comprehensive professional knowledge, interdisciplinary integration skills, innovative thinking, an international perspective, and proficient teamwork skills.
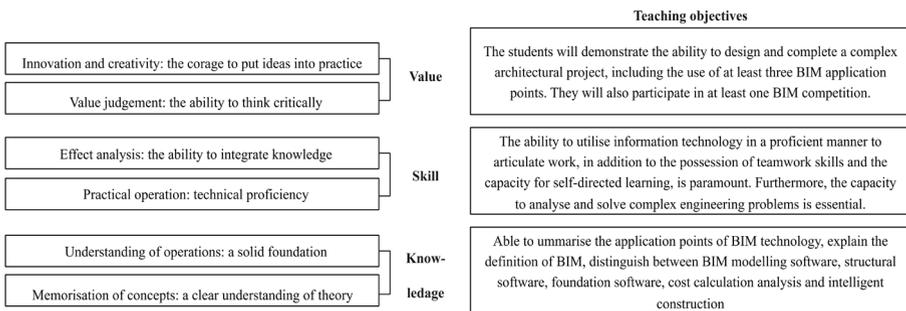

		Teaching objectives
Innovation and creativity: the corage to put ideas into practice	Value	The students will demonstrate the ability to design and complete a complex architectural project, including the use of at least three BIM application points. They will also participate in at least one BIM competition.
Value judgement: the ability to think critically		
Effect analysis: the ability to integrate knowledge	Skill	The ability to utilise information technology in a proficient manner to articulate work, in addition to the possession of teamwork skills and the capacity for self-directed learning, is paramount. Furthermore, the capacity to analyse and solve complex engineering problems is essential.
Practical operation: technical proficiency		
Understanding of operations: a solid foundation	Know-ledge	Able to ummarise the application points of BIM technology, explain the definition of BIM, distinguish between BIM modelling software, structural software, foundation software, cost calculation analysis and intelligent construction
Memorisation of concepts: a clear understanding of theory		

Fig. 1. New goals based on Bloom's taxonomy of instructional objectives.

3.2   Interdisciplinary Curriculum Design

In response to the aforementioned teaching objectives, this course has undergone an in-depth reform and reconstruction of the teaching content system to meet the educational requirements of the construction of the new engineering. The original curriculum system only included architectural modelling content and did not fully meet the educational objectives of the construction of the new engineering. The course has introduced interdisciplinary content emphasised in new engineering education, such as structural engineering, intelligent construction, green building, artificial intelligence, and ethics, thereby enhancing the richness, advancement, and cultivation of students' comprehensive qualities. In the teaching process, the course has moderately reduced the proportion of traditional architectural modelling and increased the proportion of interdisciplinary content accordingly. The course content is closely linked to real-world engineering projects, ensuring the organic integration of theory and practice.

Furthermore, this course has established a cooperative relationship with BIM companies to facilitate in-depth integration of industry and education. The companies provide a plethora of teaching resources for the course, including numerous teaching cases, training software, and a substantial family library resource for students. These corporate resources significantly enrich students' learning resources and channels, assist students in becoming acquainted with industry resources in advance, and enhance their competitiveness in the employment market.

3.3   Implementation Pathway of Industry-Education Integration

The present study proposes a 'four-stage linkage framework for industry-education integration' which is shown in Figure 2, based on the principles of 'demand orientation, competency core, and cooperative education'. The implementation of this framework begins with an 'analysis of industry demand', which identifies key competency gaps through structured surveys and interviews with leading AECO industry companies. At the end of the analysis, a standardised job competency matrix will be generated. The subsequent phase of curriculum reconstruction is demand-oriented, involving the compression of traditional modelling courses and the integration of interdisciplinary modules such as Intelligent Construction Technology, Green Building and Carbon Accounting, and AI-driven Engineering Optimization. The dual-competency faculty development phase establishes a hybrid teaching model, involving the collaboration of corporate engineers as practical instructors with on-campus teachers to develop 'virtual-real' teaching resources, and the implementation of a joint teaching mechanism for teachers and corporate engineers to combine theoretical and practical teaching. Finally, the project-based assessment system employs competitions and authentic engineering projects as assessment tools, necessitating student participation in BIM competitions and the completion of real engineering tasks. Enterprise experts are involved in the evaluation of results, thereby establishing a closed loop of 'learning-competition-production'.
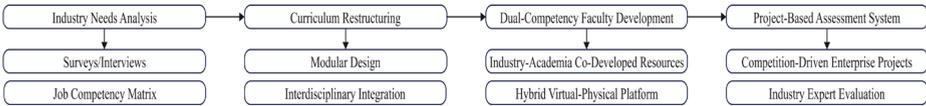
Industry Needs Analysis	→	Curriculum Restructuring	→	Dual-Competency Faculty Development	→	Project-Based Assessment System
Surveys/Interviews		Modular Design		Industry-Academia Co-Developed Resources		Competition-Driven Enterprise Projects
Job Competency Matrix		Interdisciplinary Integration		Hybrid Virtual-Physical Platform		Industry Expert Evaluation

Fig. 2. Implementation pathway of industry-education integration.

3.4   Innovative Pedagogical Strategies

In response to issues such as the substantial volume of teaching content, the paucity of opportunities for students to apply theory in practice, and the deficiencies in the assessment mechanism, this course adopts the principle of 'student ability development as the core'. It incorporates corporate cooperation, competition participation, and outcome orientation into the teaching system.

The course has established an industry-education integration partnership with BIM enterprises to collaboratively develop course content and resources and enhance professional training rooms. This industry-education integration model serves to deepen the connection between the educational establishment and the industry, introduce state-of-the-art market technologies and demands into the classroom, and enhance students' future employment competitiveness. The course employs a 'competition-driven' approach to stimulate students' interest in learning and improve their practical ability. Currently, there are more than 6 BIM-related competitions each year, and students are required to participate in at least one BIM competition. The enthusiasm and motivation of students for these competitions are evident, with many continuing to participate after the course has concluded. Competitions have been shown to enhance students' enthusiasm for theoretical knowledge, as well as their practical application and innovation capabilities. The course content is integrated with the latest industry technologies, including VR, augmented reality (AR), and AI. The teaching team employs AI technology to optimise building designs, predict structural analysis, and manage construction schedules. In practical projects, students utilise AI technology to carry out model recognition, automated modelling, intelligent planning of construction routes, and prediction of resource requirements, thereby enhancing their ability to apply intelligence and their competitiveness in employment. After the course, students are required to complete a complex architectural engineering project design. The project demands the comprehensive application of multidisciplinary knowledge, encompassing domains such as architecture, structure, quantity surveying, operation, and maintenance, culminating in the presentation of findings in the final class. The outcome-oriented approach enables a comprehensive evaluation of students' overall quality, encompassing their ability to apply theory, innovate, collaborate in teams, and engage in independent learning. The curriculum ideology is embedded within the course content, to nature students' patriotism and self-assurance in their future careers, instilling in them a spirit of perfectionism, and cultivating their professional ethics as engineers. The teaching process integrates the elements of curriculum ideology with specific chapters and knowledge points. The integration of curriculum ideology content is meticulously executed through narrative storytelling, case analysis, and classroom discussions, aiming for a seamless interconnection between ideology and professional knowledge, to exert a subtle influence. The

pedagogical approach of this course employs an integrated online and offline model, wherein the online platform serves as a repository for a plethora of teaching resources and learning materials, empowering students to undertake their learning tasks at their own pace and location. The online platform enables real-time monitoring of students' learning progress and performance by teachers, while offline teaching primarily encompasses the validation of online learning outcomes, the elaboration of key concepts, and the provision of answers to students' queries.

3.5   Multi-Dimensional Evaluation System

The course assessment adopts a multi-dimensional, whole-process evaluation system. The assessment method incorporates an evaluation of online learning content to assess students' independent learning abilities. Homework and online learning are part of the process evaluation, and if problems such as lagging in the learning process are encountered, the teacher will supervise the student's learning. Project design is part of the final evaluation. The evaluation process involves the utilisation of a comprehensive design work, which is employed to assess students' aptitude for the application of theoretical concepts and innovation. Furthermore, students are engaged in a mutual evaluation of projects, a practice that fosters enhancement in their learning enthusiasm and classroom activity.

4   Outcomes

During the internship programme, more than 89% of the supervisory staff provided a rating of "exceeding expectations" for the students, with high score in problem-solving agility and in digital tool mastery. The qualitative feedback indicated that the students demonstrated an ability to integrate BIM with sustainability analysis, and that they were able to reduce project revision cycles. This suggests that the students are prepared to meet industry demands, despite the absence of graduation data due to the pending of employment data. For instance, one supervisor noted, "Their proficiency in AI-driven building designs optimization surpassed entry-level standards." Competition outcomes further validate the efficacy of the reform. Before the reform, the students had not been awarded any BIM-related prizes. However, following the completion of the course, the students have demonstrated a high level of engagement in more than eight BIM competitions, attaining numerous first, second, and third prizes. This endeavour has culminated in the conferment of the title of 'Yunnan Province Young Post Expert' upon several of them. This significant increase from zero awards to consistent recognition highlights enhanced technical and innovative capabilities. Skill acquisition metrics substantiate this observation, that a significant proportion of the student body has demonstrated proficiency in the full spectrum of engineering project design, encompassing domains such as architecture, structure, quantity surveying, and construction. Furthermore, more than 92% of these students delivered projects combining BIM with carbon emissions analysis, demonstrating interdisciplinary mastery.

5   Conclusion

This study validates the pivotal role of industry-education integration and interdisciplinary curriculum reform in cultivating applied talents capable of thriving in the Fourth Industrial Revolution. The study proposes a pedagogical triad model, integrating technical rigour, ethical accountability, and industry co-creation, which enhanced students' technical proficiency, ethical awareness, and cross-disciplinary collaboration skills. This model challenges traditional, siloed curricula and offers a replicable blueprint for relevant disciplines.

However, it is important to note that sustained success requires addressing systemic challenges, including equitable access to technology and policy-driven school-enterprise cooperation incentives between educational institutions. In the future, the team will delve deeper into the development of more precise, personalised teaching models. These models will be utilised to enhance the quality of cultivating applied talents within the context of digital intelligence to providing high-calibre talent that will contribute to social and economic development.

Acknowledgement

References

1. Smith, A., Johnson, B., & Brown, C. AI-enhanced pedagogy in construction education: A U.S. case study. Journal of Construction Education and Research, 20(1), 45–63 (2023).
2. Chen, L., Wang, Y., & Zhang, H. BIM-driven interdisciplinary education in civil engineering: A case study of curriculum reform. Journal of Professional Issues in Engineering Education and Practice, 148(3), 04022007 (2022).
3. García, R., & Müller, T. Digital transformation in engineering education: Challenges and opportunities for interdisciplinary learning. European Journal of Engineering Education, 46(5), 789–805 (2021).
4. UNESCO. Global education monitoring report 2023: Technology in education—A tool on whose terms? UNESCO Publishing (2023).
5. European Commission. Digital Education Action Plan: Aligns with the study's call for interdisciplinary and digital literacy reforms (2021).
6. Ministry of Education of China. Guidelines for accelerating the development of new engineering education (2020).
7. Lee, T., & Watanabe, K. Rethinking engineering education for Industry 4.0: A Japanese perspective. International Journal of STEM Education, 7(1), 1–15 (2020).
8. Gupta, S., & Patil, V. Bridging the skills gap: Industry-academia collaboration in Indian engineering education. Higher Education Policy, 35(2), 345–367 (2022).
9. Kim, J., & Park, S. Enhancing student engagement through project-based learning in South Korean engineering curricula. Journal of Engineering Education, 110(4), 832–850 (2021).