Academic Journal of Management and Social Sciences
ISSN: 2958-4396 | Vol. 11, No. 2, 2025

Exploration and Practice on Cultivation of Digital Architecture Talents in Application-Oriented Universities

Lihui Rong

Dianchi college, Kunming Yunnan, 650500, China

Abstract: Under the background of digital transformation in the construction industry, the cultivation of civil engineering talents in private colleges and universities is confronted with challenges such as "emphasizing theory over practice" and "insufficient depth of school-enterprise cooperation". This article takes the flexible industry-education integration mechanism of private colleges and universities as the entry point to explore the talent cultivation path of digital architecture that integrates "theory + technology + practice" in a trinity. The research aims to jointly build an intelligent construction industry college through school-enterprise collaboration, construct an "enterprise demand-oriented curriculum system", embed BIM/VR technology into the "Building Information Modeling" course to carry out project-based teaching, and promote learning and teaching through subject competitions. Introduce a data-driven personalized learning model. By collecting multi-source data such as modeling operations and VR training behaviors, construct a learning ability assessment model, dynamically adjust teaching content and resource recommendations, and achieve stratified cultivation of "basic type - improvement type - innovative type" students.

Keywords: Integration of Industry and Education; Talent Cultivation; BIM and Virtual Simulation.

1. Introduction

1.1. Research Background

In recent years, the application of new-generation information technologies such as industrial internet, Building Information Modeling (BIM), and Artificial Intelligence (AI) in the construction sector has continuously matured, driving the industry's gradual shift from traditional operational models toward intelligence and informatization. Some large and powerful construction enterprises have established integrated digital platforms to incorporate cross-departmental and cross-business-line data resources into a unified management system, thereby significantly enhancing the collaborative efficiency of the entire value chain. On this basis, the application of BIM technology is no longer confined to the design phase but is gradually extending to construction and operation & maintenance links, forming a combined approach with innovative technologies such as digital twin and 5G remote construction. This makes project management more refined and visualized, and creates new space for cost reduction, efficiency improvement, and engineering quality enhancement. From an overall trend perspective, the construction industry's investment in digitization and the depth of its application continue to increase, laying a solid foundation for large-scale popularization and technological upgrading in the future.

China's "new infrastructure" policy promotes the implementation of technologies such as smart cities and digital twins, and civil engineering talents need to possess interdisciplinary capabilities. Digital technology: It is necessary to master Building Information Modeling (BIM) technology, be capable of conducting 3D modeling, virtual construction and other operations, and achieve visual design and management of engineering projects. At the same time, one should be familiar with big data and Internet of Things technologies in order to achieve equipment interconnection, data collection and analysis in civil engineering projects. For instance, data such as the structural safety and energy consumption of buildings can be monitored in real time through Internet of Things sensors. Innovative thinking: Be capable of applying new technologies and methods in projects and proposing innovative solutions to enhance the intelligence level and efficiency of civil engineering. For instance, digital twin technology can be utilized to optimize the construction process of buildings, reducing waste and errors. Possessing strong practical operation skills, capable of applying theoretical knowledge to actual projects, proficient in using various digital tools and equipment, and able to solve technical problems encountered on site[1].

Private colleges and universities account for 28% of the total number of higher education institutions in China, but there is a common problem of "emphasizing theory over practice" in civil engineering-related majors .Compared with public universities, private colleges and universities are more flexible in the integration of industry and education.

1.2. Research Significance

At present, the cultivation of civil engineering talents in domestic universities still mainly relies on traditional discipline education. Private universities have unique advantages in flexibility and integration of industry and education, but there is insufficient theoretical and practical research on related innovative cultivation models. Through systematic research, a trinity training path of "theory + technology + practice" can be explored, providing a reference for similar universities.

Comparative value: Public universities should focus on academic research, while private universities should concentrate more on applied innovation to form a differentiated training orientation.

For the cultivation of research and innovation talents in private colleges and universities, it is necessary to focus on breaking through problems such as insufficient depth of school-enterprise cooperation and limited practical resources.

By analyzing how to construct an "enterprise demand-oriented curriculum system", "dual-qualified teaching staff" and "project-based practice platform", the methodology for cultivating applied talents can be improved, and the organic connection between the education chain, talent chain and industrial chain can be promoted.

2. Current Situation and Challenges of Civil Engineering Talent Cultivation in Private Colleges and Universities

2.1. Curriculum System

Most private colleges and universities closely follow market demands and have set up civil engineering, architecture, engineering management and other civil engineering-related majors. Some colleges and universities have also added emerging professional directions such as intelligent construction and prefabricated buildings in accordance with industry development trends. In terms of the curriculum system, the structural model of "public basic courses + professional basic courses + professional courses + practical courses" is generally adopted. Public basic courses cover general education courses such as mathematics, English and ideological and political education, aiming to cultivate students' basic qualities[2]. The professional basic courses include core basic courses in civil engineering such as mechanics and materials science. Specialized courses are further subdivided according to different professional directions, such as structural design and construction technology courses in the civil engineering major.

However, there are still certain problems in the curriculum system. On the one hand, the update speed of the course content is relatively slow, making it difficult to quickly integrate the knowledge of emerging technologies such as BIM technology, the Internet of Things, and digital twins, resulting in a disconnection between the knowledge students have learned and the actual needs of the industry. On the other hand, the connection between courses is not tight enough, and there are phenomena of knowledge repetition or omission, which affects the construction of students' knowledge system. In addition, although the proportion of practical courses has increased, it is still relatively insufficient. Moreover, the content of practical teaching is mainly verification experiments, and there are relatively few innovative and comprehensive practical projects.

2.2. Construction of the Teaching Staff

In terms of the teaching staff, the teachers of civil engineering and architecture majors in private colleges and universities show the characteristics of polarization. Some teachers have rich practical experience in the industry and can introduce actual engineering project cases into classroom teaching to enhance the practicality and interest of teaching. Most of these teachers come from construction enterprises or other units with engineering practice backgrounds. Their practical experience provides students with valuable industry knowledge. However, there is also a considerable number of teachers who directly enter private colleges and universities to teach after graduating from colleges and universities. They lack practical engineering experience. In the teaching process, they mainly focus on theoretical instruction and have difficulty effectively guiding students to solve practical engineering problems.

From the perspective of educational background and professional title structure, among the teachers majoring in civil engineering in private colleges and universities, those with master's degrees account for a relatively large proportion, while those with doctoral degrees are relatively few. In terms of professional titles, lecturers and teaching assistants are the main types, while the proportion of high-level talents such as professors and associate professors is relatively low. In addition, due to the certain gaps between private colleges and universities and public ones in terms of salary and benefits, research conditions, etc., the stability of the teaching staff is relatively poor, and the phenomenon of high-level talent loss is rather serious, which is not conducive to the long-term development of the major and the continuous improvement of teaching quality.

2.3. Practical Teaching Link

To enhance students' practical abilities, private colleges and universities generally attach great importance to the practical teaching link and actively build on-campus training bases and off-campus internship bases. The on-campus training bases include building materials laboratories, mechanics laboratories, BIM training centers, etc., providing students with basic experimental and practical operation venues. Some BIM training centers in colleges and universities are equipped with advanced computer equipment and BIM software, which can meet the practical teaching needs of students such as 3D modeling and construction simulation[3].

In terms of the construction of off-campus internship bases, many private colleges and universities have established cooperative relationships with construction enterprises, design institutes and other units, providing internship opportunities for students. However, in the process of practical teaching, there are still some problems. The equipment update speed of the on-campus training base is relatively slow, making it difficult to meet the demands of teaching emerging technologies. The internship effects at off-campus internship bases vary greatly. Some enterprises, due to tight production tasks, are unable to provide students with sufficient practical opportunities and effective internship guidance, resulting in internships becoming mere formalities and making it difficult for students to truly get in touch with the core links of actual engineering.

2.4. Characteristics of Talent Cultivation and Social Recognition

Some private colleges and universities, in light of their own advantages and the demands of regional economic development, have developed certain characteristics in the cultivation of civil engineering talents. For instance, some private colleges and universities located in areas with developed construction industries have deeply cooperated with local enterprises to carry out order-based talent cultivation. They customize courses and training plans based on the demands of enterprises, which has enhanced students' employment pertinence and adaptability. Some universities also attach great importance to cultivating students' innovation and entrepreneurship abilities, offer innovation and entrepreneurship courses, and organize students to participate in various architectural design competitions and innovation and entrepreneurship contests, achieving certain results.

Overall, however, the social recognition of civil engineering and architecture talent cultivation in private colleges and universities still needs to be improved. Compared with public universities, private universities have disadvantages in terms of brand influence and social reputation, which leads some employers to have a prejudice against graduates from private universities majoring in civil engineering and architecture, and they tend to choose graduates from public universities when recruiting. In addition, the civil engineering-related majors in private colleges and universities are relatively weak in terms of discipline construction and scientific research achievements, which also affects their social recognition to a certain extent.

3. Specific Implementation Plan for Talent Cultivation

3.1. Design of School-Enterprise Collaboration Mechanism

The school and enterprises cooperate to jointly build an intelligent construction industry college and innovate the talent cultivation model through collaborative education. Dianchi University, leveraging the flexible mechanism of private colleges, has long adhered to the educational philosophy of school-enterprise cooperation. It has engaged in in-depth cooperation and exchanges with many enterprises, building a talent cultivation community featuring complementary advantages, co-construction of projects, sharing of achievements, and win-win benefits. In the early stage, we have already cooperated with Yunnan Construction Investment Group and others to jointly build the "Yunnan Prefabricated Building Technology Development and Application Research Center". The school has established in-depth cooperation with many enterprises such as China Academy of Building Research, Glodon Technology Co., LTD., Zhen 'an Technology Co., LTD., Sichuan Zhongke Chuanxin Technology Co., LTD., Kunming Luxun Digital Technology Co., LTD., and Shengshi Zhiyun (Yunnan) Software Co., LTD., achieving a series of results in scientific research, team building and other aspects. In accordance with the school's "14th Five-Year Plan", we will establish the Intelligent Construction Industry College in 2024. The establishment of the industry college will surely effectively promote the reform of the college's intelligent construction talent cultivation model, lay a foundation for the cultivation of high-end intelligent construction talents, and provide more high-quality applied talents for the construction industry.

Project library construction: Classified by difficulty (Basic level: Construction drawing drawing; Advanced level: BIM conflict detection. Students who complete projects can exchange credits for "Graduation Design" and "Professional Training".

The school will jointly create an innovative talent cultivation model based on the introduction of practical projects with cooperative enterprises in the practical exploration mode of interdisciplinary integration, innovative application of cutting-edge new technologies, and reform of teaching models. At the same time, it will build an expert database of enterprise mentors and jointly establish a teaching staff team with enterprises. Both sides will jointly formulate teaching and training plans in accordance with market demands and the theoretical growth and learning laws of students, to form a unique professional training feature. Students majoring in intelligent construction are taught theoretical basic knowledge by school teachers for 1 to 2 years. In 2 to 3 years, enterprise mentors will be introduced to conduct practical teaching through the project-based training system, and at the same time, a certain number of practical training hours will be added. Starting from the third grade, order-based training is carried out in different directions.

3.2. Digitalization Empowering Education

3.2.1. Application Path of BIM/VR Technology

Under the wave of digital transformation in the construction industry, BIM (Building Information Modeling) and VR (Virtual Reality) technologies have become the key forces driving industry innovation. They not only reshaped the traditional architectural design, construction and management models, but also brought new development opportunities to the field of architectural education. By deeply integrating BIM/VR technology into the teaching and training system, it is possible to effectively enhance students' professional skills and practical abilities, and cultivate high-quality talents that meet the demands of the industry. The following discusses in detail the specific application paths of BIM/VR technology from two core dimensions: course embedding and virtual simulation platform.

In terms of the planning of teaching content, the principle of progressing from the simple to the complex and step by step should be followed to construct a complete teaching chain of BIM/VR technology[4].

Basic modeling stage: Taking commercial complexes as a typical case, commercial complexes have the characteristics of complex functions, diverse Spaces, and numerous systems, making them an ideal carrier for testing the comprehensive application ability of BIM technology. Guide students to use Revit for full-disciplinary modeling, from the creation of components such as walls, doors, Windows, and stairs in individual buildings, to the layout of beams, slabs, and columns in structural engineering, and then to the installation of pipelines, cable trays, and equipment in mechanical and electrical engineering, to comprehensively master the BIM modeling process. During the modeling process, the parametric design concept is emphasized. Through parameter correlation and driving, the rapid modification and update of the model are achieved, thereby enhancing the design efficiency. Meanwhile, the collision check function is introduced to enable students to independently discover and solve design conflicts among various specialties and cultivate their awareness of collaborative design.

Advanced stage of VR rendering: After completing Revit modeling, import Lumion for rendering and visualization processing. The teaching content covers scene material editing, such as endowing the exterior walls of buildings with real stone and glass materials, and setting floor materials with different textures for the indoor floors. In terms of light and shadow simulation, by adjusting parameters such as daylight, sky light, and artificial lighting, a spatial atmosphere that conforms to the design intention is created. In the animation production stage, guide students to create perspective roaming animations, construction progress simulation animations, etc., to make static models "come alive" and enhance the appeal and persuasiveness of the design plan. Project-based assessment: A project-based assessment approach is adopted, with "full-process modeling of commercial complexes + VR effect presentation" as the major course assignment. Students need to work in groups and go through the entire digital design process of a construction project, from the collection of materials and scheme design in the early stage of the project, to BIM modeling, Lumion rendering, and finally to the final presentation of the results. The assessment criteria not only focus on the accuracy of the model and the aesthetic appeal of the rendering effect, but also emphasize the evaluation of teamwork ability, problem-solving ability and design creativity, comprehensively testing students' comprehensive abilities.

3.2.2. Competition Linkage Mechanism

Taking competitions as the starting point, we aim to stimulate students' enthusiasm for learning and their innovative potential, and further enhance their professional skills and competitiveness.

Promoting learning through competitions: Closely integrate with authoritative industry events and comprehensive competitions such as the "National BIM Skills Level Examination", "Longtu Cup National BIM (Building Information Modeling) Competition", and "Internet Plus" College Students' Innovation and Entrepreneurship Competition, optimize and improve course assignments, and transform them into competition works. Carry out targeted intensive training based on the assessment priorities and scoring criteria of different competitions. For instance, in the "National BIM Skills Level Examination", emphasis is placed on the standardization and proficiency of BIM software operation. Specialized simulation examinations can be conducted to train students to complete high-quality modeling tasks within the prescribed time. For the "Longtu Cup National BIM Competition", it emphasizes the innovation and application value of the project, guiding students to explore innovative application scenarios of BIM technology in fields such as green buildings and intelligent operation and maintenance[5].

Mentorship guidance: A competition guidance team composed of professional teachers and enterprise engineers is formed to provide comprehensive guidance for the participating students. During the pre-competition preparation stage, the mentor team assists students in topic planning and scheme optimization. Provide technical support and experience sharing during the modeling and rendering process; During the achievement presentation session, guide students to create high-quality presentations and videos to enhance their defense skills. Through the mentorship system, students can receive professional guidance in competitions, increase their chances of winning awards, and at the same time deepen their understanding and application of BIM/VR technology.

Virtual simulation platform: Innovative safety training and scene simulation. Choose Unity or Unreal engine as the development platform. Both of these engines have powerful graphic rendering capabilities, physical simulation functions and interactive development interfaces, which can meet the high simulation requirements of the VR system for smart construction sites. In terms of technical implementation, the lightweight technology of BIM models is adopted. The large BIM models created by software such as Revit are optimized to reduce the amount of data and improve the loading speed and smooth operation of the models in the VR environment. Meanwhile, by integrating sensor technology and motion capture technology, natural interaction between users and virtual scenes is achieved, enhancing the sense of immersion.

3.2.3. Data-driven Personalized Learning

The teaching content of the course is dynamically adjusted according to the students' ability levels and knowledge weaknesses. For basic students, increase the intensive training courses of BIM basic operations, and push the video tutorials of Revit basic modeling skills and the corresponding practice questions. For innovative students, we introduce extended contents such as BIM forward design and VR interaction development, and recommend cutting-edge research cases in the industry and advanced plugin usage tutorials. In virtual simulation training, the number of specialized simulation training sessions for high-risk scenarios is increased for students with weak safety knowledge, and detailed interpretation materials of safety regulations are provided.

Build an intelligent learning resource recommendation system to precisely push resources based on students' learning behavior preferences and weak points. For students who prefer self-study, we recommend the complex project dissection and analysis documents in the BIM project case library and the discussion posts on the Lumion advanced rendering Techniques forum. For students who rely on teachers' guidance, one-on-one modeling problem-solving courses and VR practical operation review guidance are arranged. Meanwhile, based on the physiological data feedback from students during their practical training, when excessive learning pressure is detected, relaxation training videos and suggestions for adjusting the learning pace will be pushed.

Create a personalized learning path map for each student, clearly defining the learning goals and tasks for different stages. For example, in the early stage of BIM course learning, for students who are weak in parametric design, a learning path of "basic parametric learning parametric modeling practice of simple components parametric correlation design of complex models" is planned; During the virtual simulation training stage, an advanced plan of "common accident scene cognition emergency process simulation exercise Comprehensive response training for Sudden situations" is designed for students with slower emergency responses. Regularly optimize the learning path dynamically based on students' learning progress and ability improvement[6].

The data-driven personalized learning model has pushed the application of BIM/VR technology in architectural education to a refined and intelligent stage. Through the in-depth mining and application of learning data, the precise matching of teaching resources and the overall improvement of students' learning efficiency can be achieved. In the future, with the development of big data and artificial intelligence technologies, this model will be further improved, providing more powerful support for the cultivation of talents in the construction industry.

4. Implement a Guarantee and Evaluation System

4.1. Policy Guarantee Mechanism

There are complex landform phenomena such as the Western Yunnan Longitudinal Valley Area and the eastern Yunnan Karst landform area within Yunnan Province. Coupled with the frequent occurrence of natural disasters such as earthquakes, landslides, debris flows and mountain floods, the monitoring technology and construction strategies of its construction projects in such an environment are one of the research challenges in this field worldwide. Conducting scientific research and talent cultivation by leveraging emerging intelligent construction technologies is an important measure to achieve Yunnan Province's three strategic positioning of "becoming a model area for ethnic unity and progress, a pioneer in ecological civilization construction, and a radiation center facing South Asia and Southeast Asia".

This major takes serving Yunnan as its fundamental goal and mainly cultivates students to be engaged in intelligent construction, smart operation and maintenance management, intelligent safety detection and monitoring, and other related work.

Dianchi University will fully leverage its flexible institutional and mechanism advantages, actively introduce advanced technologies, applications, achievements and real cases from enterprises into the school and integrate them into teaching. Integrate the digital engineers of enterprises and the teachers of schools on the basis of student-centeredness to form a joint community of teaching resources, build the core competitiveness of the intelligent construction major of the School of Architectural Engineering of Dianchi University, and cultivate compound high-quality engineering application-oriented talents with new concepts, strong creativity, the ability to continue learning, innovative consciousness, organizational management ability and international vision.

4.2. Dynamic Evaluation Model

4.2.1. Evaluate the Theoretical Basis of the Model

Build a hierarchical structure: Goal layer (quality of innovative talents) → Criterion layer (knowledge, skills, attitudes) →Indicator layer (12 detailed indicators, see Table 1).

Weight calculation: The judgment matrix is constructed through expert scoring (using the 1-9 scale method), and the feature vectors and consistency checks are calculated (CR<0.1).

Example: The process of calculating the weights of the criterion layer.

Table 1. Judgment matrix

	Knowledge	Skills	Attitude
Knowledge	1	2	3
Skills	1/2	1	2
Attitude	1/3	1/2	1

Feature vector calculation

Weight = [0.539, 0.297, 0.164]

The maximum eigenvalue $\lambda max=3.009$, $CI=0.0045$, $CR=0.008<0.1$ (passed the test)

Steps of the Fuzzy Comprehensive evaluation method:

Evaluation set definition: V= {Excellent (90-100), Good (80-89), Qualified (60-79), Unqualified (<60)}.

Construction of membership degree matrix

For example, for the indicator of "BIM software operation proficiency", 30% are rated as "excellent" by experts, 50% as "good", and 20% as "qualified", then the membership degree is [0.3, 0.5, 0.2, 0].

Comprehensive operation: The weight vector W is combined with the membership degree matrix R, and the $M(\cdot,\oplus)$ operator (weighted average type) is adopted.

Example: A student's evaluation result

Criterion layer weight: W=[0.3, 0.4, 0.3]

Membership degree matrix

Knowledge: [0.2, 0.6, 0.2, 0]

Skill: [0.4, 0.4, 0.2, 0]

Attitude: [0.5, 0.3, 0.2, 0]

Synthesis operation: $B=W\cdot R = [0.3\times0.2+ 0.4\times 0.4+ 0.3\times 0.5, ...,...] = [0.35, 0.42, 0.23, 0]$

Final score: $0.35\times95 + 0.42\times85 + 0.23\times70 = 84.3$ (Good)

4.2.2. Model Implementation and Verification

Design of Data Acquisition System

Multi-source data integration

Learning behavior data: Login duration on MOOC platforms, submission rate of experimental reports (captured in real time through API interfaces).

Practical ability data: Enterprise mentor scoring, AI analysis of project defense videos (using OpenCV to identify the fluency and logic of expression).

Innovation achievement data: Number of patents/papers, competition award levels (weighted scoring based on national/provincial levels).

Empirical Analysis

Sample selection: Students majoring in intelligent construction of grades 2021-2023 in a private college (N=300), and the control group was evaluated by traditional examinations.

Result comparison:

Dynamic evaluation group: The compliance rate of innovation ability is 78%, and the satisfaction rate of enterprises is 92%.

Traditional evaluation group: The compliance rate of innovation ability was 43%, and the satisfaction rate of enterprises was 65%.

The t-test showed that $P<0.01$, and the difference was significant.

Model optimization path:

Dynamic adjustment of weights: Update the index weights annually based on changes in industry demand (for example, the weight of "green Building knowledge" has been increased from 10% in 2021 to 15% in 2023).

Ai-assisted decision-making: Train the LSTM neural network based on historical data to predict students' weak points and push intervention plans (for example: Predict that a student's "engineering cost control" ability may not meet the standard, and arrange one-on-one guidance from an enterprise mentor in advance).

5. Summary

Private colleges and universities need to take the integration of industry and education as the link, practical innovation as the handle, and through school-enterprise collaboration, cross-disciplinary integration, competition-driven and faculty optimization, build an innovative talent cultivation ecosystem in the field of civil engineering that suits the era of smart construction, ultimately achieving a high degree of alignment between the quality of talent cultivation and industry demands. Establish a dual-track practical system of "on-campus virtual simulation training + off-campus real project practice", for instance, use VR/AR technology to simulate the construction process, and at the same time connect with real enterprise projects (such as community renovation, commercial building design) to enable students to participate throughout the process.

Implement "project-based" practical teaching, taking real engineering projects (such as BIM modeling and digital management of construction progress) as the carrier, allowing students to learn by doing and cultivate their ability to solve complex problems.

Application of metaverse technology: Building a "virtual construction metaverse", where students can participate in cross-border engineering collaborations in an immersive environment. It is suggested that the Ministry of Education add a "Special Fund for Industry-Education Integration in Private Colleges and Universities" to break the financial shackles.

Acknowledgments

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] Zhou Xiaohan, Chen Minyun, Yu Dan. Research on the Reform of the Training Mode for Applied Engineering Management Talents under the Background of Digital Transformation in the Construction Industry [J] Journal of Engineering Management, 2024, 38(3):153-158.

[2] Hao Juan, Zhong Wenqi. Research on the New Teaching Mode of Architecture Major in Applied Undergraduate Colleges in the "Internet +" Era [J] China New Communications, 2024,26(01):149-151.

[3] Sun Yali, Fang Jianping, Zhang Lusha. Exploration and Application of BIM Application-oriented Talent Cultivation in Civil Engineering under the Background of Industry-Education Integration [J] Architecture and Culture,2022(4):28-30.

[4] Xie Guangrong. Optimizing the Talent Cultivation Mode of Architecture Major by Integrating with the Industry [J]. Modern Marketing (Information Edition), 2019,(09):206.

[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] Chen Wen. Research on the Alignment between the Development of "Digital Architecture" and the Cultivation of "New Engineering" Talents in Civil Engineering [J]. Heilongjiang Science,2019,10(05):1-5+9.