



# Research on the Integration of “Professional Entrepreneurship” Education and Construction Engineering Surveying Curriculum Teaching

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**Abstract.** As the construction industry undergoes a profound transformation towards digitalisation and intelligence, problems such as the lack of fostering innovative skills in traditional construction surveying education and the structural imbalance between talent supply and industry demand are becoming increasingly apparent. This study explores the integration of ‘professional entrepreneurship’ education and construction engineering surveying course as a response to the contradiction between the shortage of surveying and engineering personnel in construction companies, which is as high as 63%, and the entrepreneurship rate of graduates, which is less than 2.1%. An interactive scenario with deep integration of technical verification and business simulation is built based on the construction of a three-level modular curriculum system of “technical foundation-entrepreneurship practice-comprehensive application”, the design of a project-based teaching model with parallel technical and entrepreneurial tracks, and the BIM collaborative platform and the “Surveying Metaverse” virtual training system. Practice has shown that this model effectively improves students’ technical application skills and business skills such as market demand insight and cost control, and achieves the dynamic transformation of professional knowledge into commercial value (Wang Qian, Liu Pan, 2023)<sup>[1]</sup>. The research also proposes a “Dual-Qualified Triple-Competency” teacher training mechanism and graduated quality control standards for school-enterprise cooperation, providing a theoretical paradigm and practical reference for solving the dilemma of the construction industry’s compound talent shortage and promoting integrated innovation between industry and education.

**Keywords:** Professional entrepreneurship education; Construction engineering surveying; Curriculum integration; Interdisciplinary integration

## 1 Introduction

In the context of the rapid development of the social economy, the construction industry is undergoing profound changes and transformations, moving from the traditional construction model towards a green, intelligent and sustainable direction. Consequently,

the construction engineering surveying course, as a basic core course for construction majors, is becoming increasingly important.

‘Professional entrepreneurship’ education, as an emerging educational concept, has received widespread attention and active exploration worldwide. In many developed countries, entrepreneurship education has been deeply integrated into professional curricula, yielding notable outcomes. Stanford University’s “Engineering Entrepreneurship Program” exemplifies this integration, with entrepreneurship education being embedded into the curriculum of engineering majors. In terms of course design, it offers a series of interdisciplinary courses such as ‘Engineering Innovation and Entrepreneurship Practice’ and ‘Technology-Driven Entrepreneurship Strategy’, which organically integrate engineering and technology knowledge with entrepreneurship theory, allowing students to systematically learn the skills and methods required for entrepreneurship while learning professional knowledge. The ‘Measuring Technology Incubator’ model, which is based on the dual education system of RWTH Aachen University in Germany, requires student teams to bid for infrastructure improvement projects in virtual cities during the course. Students need to complete the entire process from formulating a laser scanning technology plan to designing a service pricing model.

The education of “professional entrepreneurship”, as an emerging educational concept, has received widespread attention and active exploration worldwide. Abroad, many developed countries have deeply integrated it into the professional curriculum teaching system and achieved remarkable results. Take Stanford University’s “Engineering Entrepreneurship Program” as an example, which deeply integrates entrepreneurship education into the curriculum of engineering majors. In terms of course design, it offers a series of interdisciplinary courses, such as “Engineering Innovation and Entrepreneurship Practice” and “Technology-Driven Entrepreneurship Strategy”, which organically integrate engineering and technology knowledge with entrepreneurship theory, allowing students to systematically learn the skills and methods required for entrepreneurship while acquiring professional knowledge. The ‘Surveying Technology Incubator’ model, based on the dual education system of RWTH Aachen University in Germany, requires student teams to bid for infrastructure improvement projects in virtual cities during the course. Students need to complete the entire process, from formulating a laser scanning technology plan to designing a service pricing mode (Wang Qian, Liu Pan, 2023)<sup>[1]</sup>.

In China, the government’s proactive promotion of innovation and entrepreneurship education policies has led to the gradual implementation of ‘professional entrepreneurship’ education in universities. However, the integration and application of this education in construction engineering surveying course remains in the exploratory stage. According to the statistics in the “China Blue Book on Innovation and Entrepreneurship Education in Higher Education”, the implementation rate of entrepreneurship education in construction majors is less than 5%, indicating a significant impediment to the integration of ‘professional entrepreneurship’ education in construction majors. The crux of the issue lies in the organic integration of professional education with entrepreneurship education, the dissolution of boundaries between the two in conventional education, and the provision of a more comprehensive and forward-looking development path for students. According to the “2023 China Construction Industry Talent Development

White Paper”, the majority of construction companies are grappling with the challenge of a dearth of technical-management compound talents in their digital transformation initiatives. Notably, the scarcity of innovative talents in surveying and mapping technology stands at an alarming 63%, significantly higher than the 37% observed in traditional roles (as reported by the Development Research Center of the Ministry of Housing and Urban-Rural Development). The entrepreneurial rate of architectural graduates in 2022 was only 2.1%, as reported by the Department of Student Affairs, Higher Education Division of the Ministry of Education, indicating a discrepancy between the professional education offered by universities and the needs of enterprises. The integration of ‘professional entrepreneurship’ education into construction engineering surveying course is not only an inevitable choice to adapt to the times, but also has far-reaching significance for improving students’ comprehensive quality and employment competitiveness. It enables students to cultivate surveying expertise, an innovative mindset, and entrepreneurial skills, thereby preparing them to enter the construction industry in the future.

## **2 The Significance of Integrating “Professional Entrepreneurship” Education into the Construction Engineering Surveying Curriculum**

The integration of ‘professional entrepreneurship’ education into the construction engineering surveying curriculum serves to bridge the gap between theoretical knowledge and practical application. Upon acquiring a foundation of basic surveying theories and skills, students can attain an in-depth comprehension of contemporary industry trends and market demands through engagement with entrepreneurial projects. A case in point is digital surveying and mapping technology. The integration of advanced surveying and mapping technologies, such as unmanned aerial vehicle surveying and 3D laser scanning, into engineering projects has become increasingly prevalent. Through entrepreneurial practice, students can not only learn and apply these technologies, but also utilise their knowledge to solve practical problems in all aspects of project planning, implementation, and delivery. This enhances their ability to solve problems and deepens their understanding and mastery of professional knowledge.

The incorporation of entrepreneurial education components into the construction engineering surveying course is a strategy that has been proven to foster innovative thinking, entrepreneurial spirit and entrepreneurial ability in students. The integration of entrepreneurial practice activities, such as conducting market research to understand the needs of potential customers, utilising surveying technology for entrepreneurial projects, and formulating project planning and feasible business plans, serves to hone students’ market analysis abilities. Furthermore, the execution of projects through teamwork fosters the development of their team management, communication, and coordination skills. These entrepreneurial qualities will provide students with more possibilities for future career development, whether they choose to work in a company or start their own business, and will become their valuable assets.

The fierce competition in the construction industry has forced companies to innovate, and interdisciplinary talents who not only have professional skills but also entrepreneurial abilities have become a scarce resource in the industry (.Qu Yi, Sun Ling, Jiang Jiashun, 2025)<sup>[2]</sup>.

The integration of professional entrepreneurship education with the teaching of construction engineering surveying courses is a strategic initiative that aims to address this shortage by equipping students with the skills to adapt to market demands. These students will possess the ability to complete engineering projects using surveying techniques, as well as the capacity to generate new development opportunities for enterprises and promote their innovative development through entrepreneurial thinking and action. This, in turn, will contribute to the overall advancement of the construction industry.

To illustrate the relationship between surveying expertise and entrepreneurial literacy, a ‘correspondence framework between professional and entrepreneurial abilities’ has been developed (see Table 1).

**Table 1.** Example of Correlation between Professional Competencies and Entrepreneurial Competencies

Surveying Technical Competencies	Corresponding Entrepreneurial Competencies	Market Demand	In-Class Competency Development
Unmanned Aerial Vehicle (UAV) Surveying Technology	Technological Innovation and Resource Integration Capability	UAV surveying service market size: 42 billion CNY (2024). 30% of surveying enterprises face a shortage of certified UAV operators.	Integrated into curriculum via “3D Modeling for Urban Renewal Sites” project.
Surveying Error Analysis	Risk Management and Decision-Making Competency	Acceptance error tolerance for plateau railway projects $\leq 0.5\text{mm}$ . Post-error correction costs exceed 7% of total project costs.	Digital sandbox simulation: error analysis overlay on BIM models.
Geospatial Data Analytics	Market Demand Insight Competency	71% of real estate firms require integration of geospatial data with macroeconomic indicators.	GIS development potential assessment model with 40 parameters.
Topographic Surveying	Project Planning and Execution Competency	On-time completion rate of urban-rural surveying projects is less than 65%.	Panoramic project simulation: full-process training from tender drafting to final delivery.

Surveying Instru- ments Operation and Maintenance	Equipment Manage- ment and Cost Control Competency	SOEs' equipment utili- zation KPI raised to 75%. Each 10% increase in utilization reduces pro- ject costs by 3-5%.	Cost simulation sand- box: economic com- parison of in-house vs. outsource maintenance models.
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### 3 Analysis of the Current Pedagogical Status

#### 3.1 Prominent Weakening of Students Motivation System

A survey of construction engineering students (data source: ‘2022 China Vocational Education Quality Report’, which shows that 63.5% of higher vocational college students have cognitive biases towards innovation) identified three main levels of learning dilemmas. Firstly, the utilitarian nature of learning goals is evident, with 46.8% of students content with short-term goals such as obtaining certifications and credits. Secondly, misconceptions about innovation are prevalent, with innovation being equated with ‘high-precision, advanced, and cutting-edge’ activities such as scientific research and patents. Thirdly, there is a low level of participation in practice, with only 21.3% of students having actively participated in innovative practical activities, according to the survey. This psychological set-up of passive learning severely restricts the formation and development of innovative thinking.

#### 3.2 Insufficient Development of Teachers’ Innovative Pedagogical Competence

1. **Relatively Outdated Educational Philosophies:** The role of teachers as ‘transmitters of traditional skills’ remains in place, with 91.2% of classrooms continuing to adhere to the conventional teaching paradigm of ‘teacher-centered instruction with passive student reception’.
2. **Deficiencies in Instructional Competency:** A survey of professional teachers revealed that 67.4% of them lacked practical engineering experience, and the application rate of modern teaching methods, such as project-based teaching and contextual teaching, was less than 30%.

Specifically, the traditional lecture-based teaching model has shown significant negative effects. In a 90-minute traditional classroom, the median time students can concentrate effectively is only 17.3 minutes, a decrease of 21.8% compared to a parallel class using BIM virtual simulation teaching. The learning engagement index was found to be 33.6% in the innovative teaching class, in comparison to 46.7% in the standardised test for the ‘passive knowledge group’ and 72.3% for the ‘active inquiry learning group’ in the transfer application question type. The absence of innovative thinking elements, such as diversity of solutions and analysis of technical and economic indicators, in the homework assignments was as high as 82.4%, while the experimental class that employed the case teaching method exhibited a rate of only

34.1%. A comparative experiment in architectural CAD course demonstrated that students in traditional teaching class exhibited a convergence rate of 89.3% in problem-solving paths for the ‘optimised construction drawing design’ task, while the class that incorporated the engineering case library. The latter exhibited a solution difference of 57.8%. Moreover, Revit modelling competition data demonstrated that the application rate of parametric design in traditional teaching group was less than 12%, which was significantly lower than the 43% observed in project-driven teaching group.

3. **Lack of Incentivization Mechanisms:** A mere 8.7% of institutions have incorporated innovative educational achievements into the teacher performance appraisal system, resulting in insufficient motivation to improve teaching quality. A survey by a provincial vocational education alliance in the construction industry showed that 46.5% of innovative experimental projects were stalled due to a lack of effective teacher guidance.

### 3.3 Underdeveloped Institutional Support System

1. **Fragmentation in Curriculum Architecture:** A recent study revealed that 89.6% of institutions have not yet established a step-by-step curriculum system that includes ‘innovation fundamentals, professional innovation, and comprehensive innovation’. Furthermore, the rate of offering new courses, such as ‘innovative application of building information modelling’, is less than 40%.
2. **Scarcity of Experiential Learning Infrastructures:** The financial value of innovative practical equipment allocated to each student is 800 CNY, significantly below the Ministry of Education’s stipulated benchmark of 1500 CNY per student for pivotal academic disciplines. Moreover, a substantial proportion, amounting to 75% of the equipment, is reportedly afflicted with technical deficiencies.
3. **Absence of Triple Helix Collaboration (Industry-Academia-Research):** The extant literature indicates that the coverage rate of innovation studios established by schools and enterprises is less than 15%. The mid-term evaluation report of the Action Plan for Vocational Education Quality Improvement and Excellence Cultivation shows that the teaching transformation rate of real engineering projects is only 28.3%. A survey also shows that only 6.8% of institutions have established a sound mechanism for transforming innovative achievements.

## 4 Integration Strategies of “Professional Entrepreneurship” Education and Construction Engineering Surveying Curriculum Teaching

### 4.1 Optimize Teaching Content: Construct a Modular Curriculum System

The Construction Engineering Surveying course is divided into three modules: technical foundation, entrepreneurship practice and comprehensive application. The ‘technical foundation’ module has been augmented with a cost sensitivity analysis session,

in which students are required to calculate the input-output ratio of equipment with different accuracies by introducing data from the equipment rental market (Wu Zhihong, 2024)<sup>[3]</sup>. In the ‘entrepreneurial practice’ module, with the urban renewal project providing the context, students are tasked with developing a business plan for an ‘asset-light surveying and mapping service company’ while conducting topographic surveys. The ‘comprehensive application’ module is linked to the smart construction scenario, with a task set for the development of a SaaS service for foundation pit monitoring, integrating the learning of Internet of Things technology with business model design.

In the context of the development of entrepreneurial-oriented teaching resources, a digital teaching case library has been established, encompassing six major fields, including housing construction, municipal administration, and transportation. Each case is accompanied by a ‘technical file’ and an ‘entrepreneurial file’. To illustrate this, the UAV surveying and mapping module is considered. At the technical level, the completion of oblique photogrammetric modelling is required. In contrast, the entrepreneurial level entails the calculation of service pricing and the design of value-added services, with these being based on the modelled area and data accuracy (Wang Rong, Guo Wei, 2024)<sup>[4]</sup>.

#### **4.2 Enhance Teaching Methods: Establish Immersive Interactive Learning Scenarios**

The entire process of project-based teaching is subject to re-engineering, with each teaching project delineating a primary technological focus and, by extension, a complementary entrepreneurship strand. To illustrate this approach, consider the ‘Intelligent Park Topographic Mapping’ project (Wang Ning, Yang Qian, 2024)<sup>[5]</sup>, which the technology line involves the deployment of control networks, followed by UAV aerial surveys, the construction of 3D models, and the verification of data accuracy. The entrepreneurship line encompasses the analysis of customer demand, the comparison of service plans, the management of risk, and the preparation of business plans. The dynamic team management mechanism involves the implementation of a ‘job competition + rotating CEO’ system, the allocation of roles such as demand analyst, technical director, and cost controller for each project cycle, and the conduct of process assessments through role task lists. A BIM collaborative platform is used for team log management, with early warning set for key nodes.

Innovative teaching methods are used to inform technology, and a ‘surveying metaverse’ virtual training platform has been constructed, integrating the following functional modules. Automatically push entrepreneurial cases through the knowledge map, and when completing the project testing experiment, simultaneously simulate the economic consequences of different processing plans and propose bidding information for the project. The dynamic competitive environment is designed to simulate the matching of supply and demand in the rental market for surveying instruments, with students tasked with formulating the optimal rental plan based on the project cycle and accuracy requirements. The system automatically generates a service quotation range upon input of project parameters, conducting a competitive analysis with the average

price in the regional market. Finally, based on the historical litigation case database, the system intelligently prompts the legal risk points in the surveying plan.

### 4.3 Refine Support Mechanisms: Build a Collaborative Education-Talent Ecosystem

The teacher capacity improvement plan implements the ‘dual-qualified triple-competency’ training project, which requires professional teachers to have the qualifications of ‘engineering survey + innovation and entrepreneurship’ double mentors (Zhang Zhuo, Zhao Fengxiang, 2024)<sup>[6]</sup>. This is achieved by entering surveying and mapping service enterprises for a cumulative total of 8 weeks each academic year, and participating in-depth in the entire process from bidding to final accounts; regularly carrying out case development seminars on ‘commercialisation of surveying and mapping technology’ to form reusable teaching templates; and creating a ‘building surveying and mapping maker space’ to form a closed-loop mechanism of ‘real projects entering the school - undertaken by teacher-student teams - guided by enterprise mentors - results tested in the market’.

Project-Based Learning (PBL) is a student-centered instructional model that integrates theory with practice, attracting widespread attention. To ensure its effective implementation and teaching quality, it is essential to formalize its implementation process and critical quality control metrics. The framework titled ‘Implementation Process and Key Quality Control Points of Project-Based Learning’ has been developed (see Table 2).

**Table 2.** Implementation Process and Quality Control Benchmarks for Project-Based Teaching

Phase	Technical Tasks	Entrepreneurial Tasks	Quality Control Benchmarks
Project Initiation	Technical Requirement Analysis	Customer Profiling	Requirement Misinterpretation Rate $\leq$ 15%
Scheme Design	Surveying Scheme Comparison	Service Pricing Model Development	Cost Calculation Completeness Index $\geq$ 0.8
Project Execution	Field Data Acquisition	Equipment Utilization Monitoring	Instrument Idle Time Ratio $\leq$ 10%
Deliverables Submission	Surveying Report Compilation	Post-Service Plan Design	Simulated Customer Satisfaction Score $\geq$ 4.2/5
Review and Improvement	Accuracy Compliance Analysis	Return on Investment Calculation	Lessons Learned Coverage $\geq$ 80%

## 5 Conclusion

This study systematically analyses the necessity and practical path of integrating ‘professional entrepreneurship’ education with the teaching of construction engineering

surveying courses, and the integrated education model has significant two-way empowerment value. The deep integration of the construction engineering surveying course and ‘professional entrepreneurship’ education can build a dynamic transformation mechanism between technical capabilities and business literacy. The innovation of the modular curriculum system enables students to master hard core technologies such as UAV surveying and mapping and 3D modelling, while also cultivating soft skills such as market demand insight, cost control and risk analysis in practical scenarios. This demonstrates a strong coupling relationship between the demand for talent in the iterative process of industry technology and the core elements of innovation and entrepreneurship education.

In the process of cultivating measurement professionals with entrepreneurial and innovative abilities to identify, research, and solve problems, it is essential to comprehensively integrate the school's educational positioning and goals, relevant policy backgrounds, industry professional requirements and development needs, as well as teaching evaluation feedback from teachers and students. A scientific approach should be taken to formulate and implement talent cultivation plans. First, it is crucial to clearly define the talent cultivation goals, precisely align them with regional talent demands, and ensure they adapt to industry development trends. Second, the curriculum system should be optimized by organically integrating entrepreneurial and innovative education throughout the course construction process, particularly reflecting innovative concepts in the development and construction of specialized courses. Third, by improving teaching evaluation and feedback mechanisms, dynamic adjustments can be made to the curriculum system, ensuring teaching quality and the effectiveness of talent cultivation.

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