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Application of Project-Driven Teaching in the Fundamentals of Innovation and Entrepreneurship (Social Practice) Course under the Emerging Engineering Education Context

Yong Hu[1]
[1],Nanning University , China, Guangxi

Abstract: *The construction of Emerging Engineering Education (EEE) has imposed new requirements on innovation and entrepreneurship education in application-oriented universities, including interdisciplinary integration, practical competence cultivation, and alignment with industrial demands. However, the current Fundamentals of Innovation and Entrepreneurship (Social Practice) course commonly suffers from issues such as a disconnect between course content and professional practice, an overemphasis on theoretical instruction in teaching models, superficial practical components, and outcome-oriented evaluation methods. Grounded in constructivist learning theory and project-based learning (PBL) theory, and drawing on the institutional characteristics and prior educational reform foundations of Nanning University, this study constructs a "four-stage progressive" project-driven teaching model. This model comprises four spirally progressive teaching phases—needs identification, scheme design, achievement incubation, and roadshow presentation—and is systematically elaborated from four dimensions: diversified design of project sources, spirally progressive teaching implementation, school-enterprise collaborative resource integration, and a dual-dimensional "process + outcome" evaluation system. Practice has demonstrated that this model effectively stimulates students' learning motivation and innovative awareness. Within the course, students are able to independently complete business plans that conform to industry standards, acquire a systematic understanding of the fundamental processes and methods of innovation and entrepreneurship, and significantly improve their ability to solve practical problems, thereby achieving an organic integration of innovation and entrepreneurship education with professional education. This study provides replicable practical experience for the teaching reform of innovation and entrepreneurship courses in application-oriented universities under the context of emerging engineering disciplines.*

Keywords: *Emerging Engineering Education; project-driven teaching; innovation and entrepreneurship education; application-oriented university*

I. Introduction

The construction of Emerging Engineering Education (EEE) is a strategic initiative oriented toward the new round of technological revolution and industrial transformation. Its core essence lies in cultivating interdisciplinary engineering talents who possess both practical engineering capabilities and entrepreneurial and innovative competencies. Lin (2017) pointed out that EEE projects do not primarily aim at publishing academic papers, but rather emphasize research and actions in engineering education teaching reform that adapt to future changes in industrial development, with a focus on the tangible outcomes of such reforms. Yao et al. (2021), based on a grounded theory analysis of 37 EEE research and practice project documents, found that the construction of

EEE exhibits a notable characteristic of "shifting from employment-oriented engineering to entrepreneurial engineering," and that the comprehensive integration of innovation and entrepreneurship education has become a direction for connotative innovation in EEE. Against this backdrop, embedding innovation and entrepreneurship competence cultivation throughout the entire talent development process has become a key direction for teaching reform in application-oriented higher education institutions.

The Fundamentals of Innovation and Entrepreneurship (Social Practice) course is a compulsory public foundational course categorized under social practice. Its teaching effectiveness directly bears upon the quality of cultivating students' competencies in innovation and entrepreneurship. However, in current pedagogical practice, this course generally confronts the following challenges: First, the curriculum content tends to emphasize the instruction of theoretical knowledge and methodological tools, which remains disconnected from the concrete practices of engineering disciplines such as civil engineering, thereby failing to stimulate students' intrinsic learning motivation. Second, the instructional model is predominantly teacher-centered and oriented toward knowledge transmission, lacking systematic training in students' innovative thinking and practical abilities. Third, the design of practical components and disciplinary education operate in isolation from each other, preventing the deep integration of innovation-entrepreneurship education with professional education .

The project-driven teaching model is grounded in constructivist learning theory, emphasizing the active construction of knowledge and the systematic development of competencies through the process of completing authentic projects. Liu et al. (2023), in their study on project-based practical courses for postgraduate students integrating specialized and innovation-entrepreneurship education, point out that adopting open-ended innovation and entrepreneurship topic selection alongside project-driven instruction—guiding students to better understand social needs and market dynamics, stimulating their curiosity to tackle genuine problems, and igniting their exploratory enthusiasm for solving real-world challenges—constitutes an effective pathway to enhancing students' innovative and practical capabilities. Yuan et al. (2024) further elaborate on the value of project-based learning (PBL) for innovation and entrepreneurship education, asserting that PBL, driven by authentic and challenging problems, requires students to engage in teamwork, integrate multidisciplinary knowledge, and solve problems creatively—which inherently aligns with the core tenets of innovation and entrepreneurship education.

As one of the first national pilot institutions for applied technology universities, Nanning University has long been committed to the exploration of applied curriculum reform. The university has accumulated substantial experience in industry-education integration and practical teaching. It has vigorously implemented the "Four Gold Projects"—Golden Land, Golden Gardener, Golden Seed, and Golden Climate—concentrating institutional resources to establish an ecosystem for specialization-innovation integration, promoting interdisciplinary synergy, serving the "Four New" constructions (New Engineering, New Medical Science, New Agriculture, and New Liberal Arts), and enhancing educational quality. Grounded in the practical exploration of Nanning University, this paper focuses on the Fundamentals of Innovation and Entrepreneurship (Social Practice) course, and systematically constructs the design framework, implementation pathways, and evaluation mechanisms of a project-driven teaching model. The aim is to provide a reference for the teaching reform of innovation and entrepreneurship courses in application-oriented universities within the context of Emerging Engineering Education.

II. Theoretical Foundations

Constructivist Learning Theory

Constructivist learning theory posits that learning is not a process of passively receiving one-way indoctrination of pre-existing knowledge, but rather a process in which learners form cognitive structures through interaction with the environment, active exploration, and meaning construction within specific contexts. Within this theoretical framework, knowledge is gradually constructed by learners based on their prior experiences and through their interaction with the external world. Yuan et al. (2024) provide an in-depth exposition of the

constructivist underpinnings of project-based learning, noting that project-based learning emphasizes the acquisition and application of knowledge in authentic contexts, and generates practical wisdom as well as innovative and creative capabilities through "doing." Bian (2023), in his teaching practice of the E-commerce Principles course, also confirmed that task-driven teaching models designed on constructivist theory can achieve a trinity of "learning – thinking – practicing" by creating teaching scenarios centered on project planning. Constructivist learning theory offers the core pedagogical conceptual support for this study: the essence of project-driven teaching lies in creating authentic problem contexts, enabling students to construct knowledge and develop competencies through active exploration and collaborative practice.

Project-Based Learning Theory

Project-based learning organizes instruction around complex tasks or driving questions, requiring students to work autonomously over a relatively extended period and to complete projects through collaborative teamwork, producing explicit deliverables. Yuan et al. (2024) distilled the core elements of project-based learning into six dimensions: "problem-oriented orientation, inquiry-based process, authentic contexts, practical activities, participatory teams, and explicit outcomes." Liu et al. (2023) applied a four-in-one project-based teaching model — integrating "innovation-entrepreneurship orientation, knowledge provision, project practice, and competition presentation"—to specialization-innovation integrated courses, using real-world topics to better guide students in understanding industry needs and market dynamics. Yao et al. (2021) noted that the innovation and entrepreneurship training program for college students is highly aligned with the goals and philosophy of Emerging Engineering Education talent cultivation, as both take real-world problems or practical topics as their direct objects of study and emphasize a student-centered, practice-oriented engineering education philosophy. These studies provide important theoretical and practical references for the systematic implementation of project-driven teaching in innovation and entrepreneurship courses.

III. Analysis of the Current State of Teaching and Its Problems

The Disconnect between Curriculum Content and Professional Practice

Currently, the teaching content of the Fundamentals of Innovation and Entrepreneurship (Social Practice) course fails to adequately reflect the disciplinary characteristics under the context of Emerging Engineering Education. The course tends to overemphasize generic innovative methods and entrepreneurial theories, while seldom introducing engineering project cases and technological frontiers that are closely related to engineering disciplines such as civil engineering. In their textual analysis of Emerging Engineering Education projects, Yao et al. (2021) identified a salient feature of China's Emerging Engineering Education development—namely, a shift from "adapting to industry" to "leading industry"—which demands that engineering education proactively align with emerging industry needs. However, due to factors such as the prolonged update cycles of textbooks, instructors' insufficient understanding of the Emerging Engineering Education paradigm, and underdeveloped interdisciplinary collaboration mechanisms, the teaching content lacks an organic integration of emerging technologies—including BIM, green construction, and smart construction—with innovation and entrepreneurship knowledge.

Teaching Mode Inclined to Theoretical Delivery

In terms of instructional methods, the course remains predominantly lecture-based, with a relatively monotonous pedagogical approach. Despite being titled "Social Practice," the actual teaching is still largely confined to in-class theoretical explanations and case analyses, lacking systematic training in the complete lifecycle of real projects—from idea generation to tangible outcome delivery. Qin et al. (2023), in their study on the Innovation and Entrepreneurship Training Program for College Students, pointed out that some universities face issues such as insufficient student motivation, lack of initiative, and over-reliance on supervisors, all of which are closely related to the absence of project-driven practical training in teaching. Consequently, student-centered,

practice-oriented inquiry-based and project-based pedagogical methods require further promotion and wider adoption.

Practical Sessions as Mere Formalities

Although the course allocates practical credit hours, the practice component tends to remain at a superficial level—confined to activities such as site visits, surveys, and report writing—due to the lack of project vehicles closely integrated with the discipline and the absence of collaborative implementation mechanisms involving industry partners. Yao et al. (2021) pointed out that the current level of university-industry collaboration in higher education institutions is insufficient, and that enterprises have not been fully engaged in the cultivation of emerging engineering talents. The reform experience of the Robotics Industry College at Changzhou University demonstrates that only through a model of "enterprises posing problems, teachers and students solving them, and the market evaluating the outcomes"—allowing students to practice under real industrial constraints—can a genuine transformation from "knowledge infusion" to "value creation" be achieved (MOE, 2026). This situation stands in marked contrast to the demands of engineering disciplines such as civil engineering, which require students to develop practical competencies through solving real-world engineering problems.

Outcome-Oriented Evaluation Approach

Course assessment still relies mainly on traditional assignments and final reports. A process-based evaluation system and a quantitative assessment of innovation-entrepreneurship ability have not yet been established. Qin et al. (2023) observed that "Dachuang" project evaluations often show patterns of "emphasizing application but neglecting completion" and "emphasizing theory but neglecting process." Evaluations usually check only the final deliverables, ignoring process follow-up and feedback. In terms of evaluators, teachers dominate. Student self-evaluation, peer evaluation, and corporate tutor evaluation are missing. In terms of evaluation dimensions, core qualities such as innovative thinking, teamwork, and problem-solving ability displayed during project execution are not measured effectively.

IV.Design and Implementation of a Project-Driven Teaching Model

Building upon the above theoretical underpinnings and diagnostic problem analysis, and incorporating the practical experience gained from the national-level first-class undergraduate course Fundamentals of Innovation and Entrepreneurship (Social Practice) at Nanning University, this study proposes a four-stage progressive project-driven instructional model that encompasses needs exploration, solution design, outcome incubation, and roadshow demonstration. Figure 1 presents the complete cyclical framework, which highlights the dynamic interaction between teacher roles, student activities, and the iterative nature of the learning process.

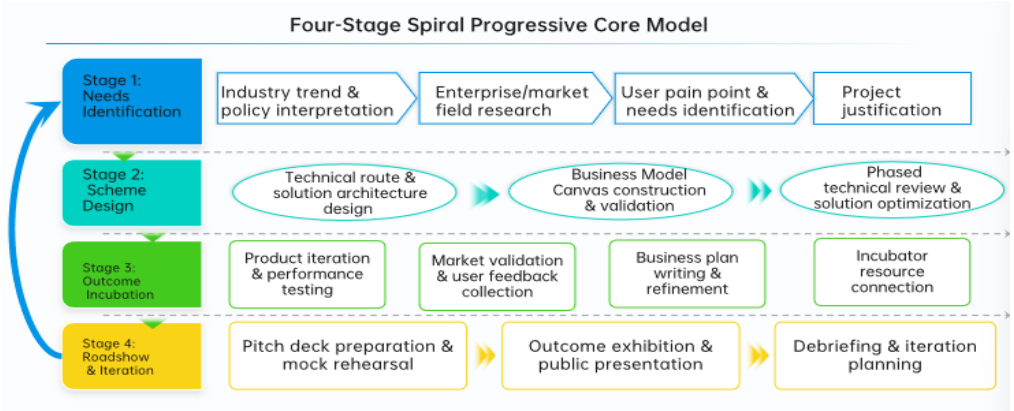

Figure 1. Four-Stage Spiral Progressive Project-Driven Teaching Model

Design of Diversified Project Sources

The quality and authenticity of projects constitute the lifeline of the project-driven teaching model. Hu and Du (2025), in their research on the deep integration of specialization and innovation within emerging engineering education, pointed out that industry-education integration is a key element of specialization-innovation integration, enabling students to acquire professional knowledge while simultaneously gaining an in-depth understanding of industrial contexts and demands. The course practice draws upon four primary channels:

First, enterprise-demand projects. Through practical investigations, students are guided to formulate project topics derived from genuine industrial needs, thereby establishing a teaching mechanism of "addressing real problems with real solutions." This approach echoes the logic of "enterprises posing problems, teachers and students solving them, and the market evaluating" as practiced at Changzhou University (MOE, 2026).

Second, science and innovation competition projects. The requirements of competitions such as the China International College Students' Innovation Competition are integrated into course practice. Yao et al. (2021) noted that promoting learning and teaching through competitions, and infusing project topics with new industrial concepts that emphasize emerging technologies in communications, electronics, and control, can help students grasp the development trends of industrial transformation both domestically and internationally, while cultivating their innovation and entrepreneurship capabilities through an integrated "course-competition-creation" model. Nanning University's achievement of one national gold award in the 2025 China International College Students' Innovation Competition fully validates the educational effectiveness of the competition-teaching integration model (Nanning University, 2025a).

Third, research translation projects. Based on authentic engineering projects accumulated within the university's practice teaching system, students are guided to transform their exploration of new technologies into actionable innovation and entrepreneurship proposals.

Fourth, social practice topics. Students are encouraged to self-select projects centered on social hotspots such as rural revitalization, urban renewal, and community services, thereby combining their professional competencies with societal needs.

The Spiral Progressive Process of Teaching Implementation

At the implementation level, the course follows a spiral progressive process of "project initiation—project execution—project presentation—project iteration."

Project Initiation Phase: Instructors guide teams to conduct market research, needs analysis, and feasibility validation. In this phase, instructors act as "facilitators," encouraging students to independently identify authentic problems. This approach is highly consistent with the view proposed by Qin et al. (2023) that "mentors should play a guiding and directing role, helping students select topics based on their individual characteristics and interests."

Project Execution Phase: Students engage in project development in teams. Instructors provide interdisciplinary knowledge support to help students establish a comprehensive "technology – business – needs" mindset. The experience of the Shenghua Innovation Class at Central South University demonstrates that through project-based courses that compress theoretical instruction and integrate teaching content, time is genuinely allocated to "hands-on work" and "doing projects," enabling a leap from "learning knowledge" to "applying knowledge" (Central South University, 2026). The course leverages the university's innovation and entrepreneurship exhibition center and adopts the ICS (Integration of Theory and Practice) teaching method, guiding students through problem-based inquiry to actively construct knowledge within immersive exploration.

Project Presentation Phase: Project roadshows and outcome exhibitions are organized, with evaluation panels consisting of on-campus experts, industry mentors, and investors. The panels provide multidimensional assessments covering technical merit, application value, and commercial potential.

Project Iteration Phase: Based on evaluation feedback and pedagogical reflection, the course facilitates continuous optimization and upgrading of the projects, feeding back into the next cycle.

Resource Integration Mechanism through University-Industry Collaboration

The course leverages the foundation of industry-education integration to build a school-enterprise collaborative education mechanism. Sun et al. (2024), in their study on industry-education integration in packaging engineering, pointed out that it is necessary to build a diversified educational team and a talent chain for cultivating outstanding engineers, so as to achieve deep and organic integration of the industrial chain, teaching chain, talent chain, and innovation chain. Yao et al. (2021) also emphasized that through comprehensive and multi-form university-industry collaboration, students should be introduced to authentic engineering environments, thereby constructing a three-dimensional integrated engineering practice system that progresses from cognition to practice, from fundamentals to frontiers, and from imitation to innovation.

A Two-Dimensional Evaluation System of Process and Outcomes

The course breaks away from the traditional final-examination assessment approach and establishes a "process + outcome" two-dimensional evaluation system. Zhou et al. (2023), in their study on the innovation and entrepreneurship education system for Energy and Power Engineering, pointed out that an evaluation system oriented toward student competencies should be constructed, adhering to the principles of diversification, developmental orientation, and comprehensiveness. Qin et al. (2023) also proposed the need to establish a diversified assessment mechanism, with supervision based on students' performance in research team discussions, research activities, and phased deliverables.

Process Dimension: Phased outcomes such as project topic justification, scheme design, teamwork, and project presentations are incorporated into the scoring system, with a focus on assessing students' level of engagement, cognitive activeness, and competency development at each stage of project execution.

Outcome Dimension: The completeness, innovativeness, and translational value of project deliverables are comprehensively evaluated, encompassing diversified indicators including the quality of the business plan, functionality of the product prototype, patent application status, and competition award levels.

Evaluation Subjects: Multiple stakeholders are involved, including student self-assessment, intra-group peer evaluation, teacher evaluation, and enterprise expert evaluation, so as to render the assessment perspective more comprehensive and objective.

V. Implementation Support and Practice-Based Outcomes

Foundational Safeguards: A Mature Curriculum System and Accumulated Reform Experience

The Fundamentals of Innovation and Entrepreneurship (Social Practice) course at Nanning University, as a national-level first-class undergraduate course, has established a well-developed instructional organizational system. The course is offered to students across all majors and is delivered in a phased, module-based format. Its implementation is centrally coordinated by the Office of Innovation and Entrepreneurship Education, drawing upon the "Golden Gardener" entrepreneurial mentor team and collaborative platforms both on and off campus (Nanning University, 2025b). The teaching team regularly holds collective lesson presentation and preparation meetings each semester to continuously refine course content and pedagogical methods. These prior accumulations provide a solid foundation for the implementation of the project-driven teaching model.

Distinctive Support: Synergistic Advancement of Industry-Education and Competition-Education Integration

The course implementation is deeply grounded in two core strategies of Nanning University: integration of industry and education and integration of competition and teaching. At the level of industry-education integration, the university has established long-term cooperative relationships with leading enterprises in relevant industries, providing students with abundant access to real-world project resources. At the level of competition-teaching integration, the course actively organizes and guides students to participate in high-level innovation and entrepreneurship competitions. As Yao et al. (2021) pointed out, participation in such competitions can enhance students' understanding of innovation and entrepreneurship, while also serving as a means to assess their innovative outcomes, entrepreneurial awareness, and personal capabilities.

Practical Outcomes: Multidimensional Enhancement of Student Competencies

After two rounds of teaching practice, the project-driven teaching model has achieved significant outcomes in the course delivered to the 2023 civil engineering and 2024 architecture cohorts at Nanning University. The results are manifested in the following three aspects:

(1) Notable improvement in the quality of business plan outputs. Driven by the course projects, students worked in teams to select project topics grounded in real-world issues within the civil engineering domain (e.g., resource utilization of construction waste, intelligent safety monitoring on construction sites, promotion of green building materials, etc.), and strictly adhered to the standard framework of business plan writing. By the end of the course, students were able to independently produce business plans that are structurally complete, data-rich, and logically coherent, encompassing core modules such as market pain-point analysis, product and service design, Business Model Canvas, financial forecasting, and risk assessment. Liu et al. (2024) pointed out that using the Business Model Canvas tool for project design offers advantages of completeness, consistency, and standardization—a view that is corroborated by the practical experience of this course. Over the past two semesters, the course has generated more than 30 student project business plans.

(2) Significant enhancement in students' systematic understanding of innovation and entrepreneurship. Through the course, students progressed from an initial vague conception of "innovation and entrepreneurship" to a systematic grasp of the entire entrepreneurial process. Students were able to accurately articulate common models of entrepreneurship (e.g., product-based and platform-based ventures), types of entrepreneurial risks, principles of team formation, and financing channels, among other core knowledge points.

(3) Systematic development of problem-solving competencies in real-world contexts. During project execution, students were required to independently undertake the entire process from problem identification, needs definition, solution design, to implementation and validation. This process demanded the integrated application of disciplinary knowledge (e.g., civil engineering materials, construction organization design), investigative methods (questionnaire design, interview techniques), data analysis, and presentation skills. Analysis of student project process records and end-of-course reflective reports revealed that the vast majority of students were able to proactively identify technical challenges and team collaboration conflicts encountered during project advancement, and to seek solutions through literature review, mentor consultation, and intra-group negotiations.

Anticipated Dissemination: Model Replication and Continuous Optimization

Based on the aforementioned practical outcomes, the project-driven teaching model has preliminarily taken shape as a replicable and scalable instructional scheme. Looking ahead, we will further expand the depth of interdisciplinary collaboration in project design, incorporate more authentic enterprise demand scenarios, continuously refine the evaluation mechanisms, and explore more precise quantitative assessment methods for

innovation and entrepreneurship competencies, thereby advancing the curriculum teaching reform to a more profound level.

VI. Conclusion

Within the EEE landscape, the core objective of integrating innovation and entrepreneurship competence development into the teaching reform of the Fundamentals of Innovation and Entrepreneurship (Social Practice) course lies in constructing a curriculum teaching model that is project-driven, competency-oriented, and underpinned by industry-education integration. Grounded in constructivist learning theory and PBL theory, and taking into account the institutional characteristics and teaching practice of Nanning University, this study has developed a "four-stage progressive" project-driven teaching model. Practical implementation demonstrates that this model effectively yields high-quality business plans, significantly enhances students' systematic understanding of innovation and entrepreneurship, and systematically cultivates their ability to solve real-world problems, thereby achieving a deep integration of innovation-entrepreneurship education with professional education. In the future, the pilot scope should be further expanded, the formative assessment indicator system should be refined, and a personalized learning support mechanism based on learning analytics should be explored and established, so as to continuously improve the educational effectiveness of the course.

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