Construction and Practice of a Long-Cycle Cultivation Model for Science and Technology Innovation and Entrepreneurship Competition Projects

Tao Jiang[1,*], Fei Xia[2], Jingqi Zhang[1], Youliang Tang[1]
[1]*School of Mechanical and Electrical Engineering, Suqian University, Suqian, Jiangsu, China*
[2]*School of Innovation and Entrepreneurship, Suqian University, Suqian, Jiangsu, China*
**Corresponding Author*

Abstract: The China International College Students' Innovation Competition serves as a vital platform for evaluating the effectiveness of innovation and entrepreneurship education in higher education institutions. Addressing the common challenges faced by local applied undergraduate universities in cultivating technology-oriented projects—such as short-term "sprint" approaches, ambiguous development models, and weak educational outcomes—this paper adopts an action research methodology from the perspective of faculty mentors. Using the four-year development journey of the "Zhangliang Sifang" (OmniMeasure) project at Suqian University as a case study, the paper constructs a long-cycle cultivation model for technology-oriented competition projects. The study defines the model's essence and characteristics, proposes a three-stage framework—"Initiation—Iterative Enhancement—Sprint and Consolidation"—and provides an in-depth analysis of the key tasks at each stage and the pivotal role played by faculty mentors. Furthermore, the paper outlines the model's implications for educational reform regarding innovation and entrepreneurship curricula, evaluation and incentive mechanisms for faculty and students, and industry-education integration. It offers both a theoretical reference and a practical paradigm for local applied universities seeking to deepen the reform of innovation and entrepreneurship education and cultivate successful technology-oriented competition projects.

Keywords: China International College Students' Innovation Competition; Long-Cycle Cultivation Model; Faculty Mentor Perspective; Action Research; Innovation and Entrepreneurship Education Reform

1. Introduction

With the deepening of the national innovation-driven development strategy, the demand for independent control of core technologies in the high-end manufacturing industry is becoming increasingly urgent. As the main battleground for cultivating innovative talents and transforming scientific research achievements, innovation and entrepreneurship education in universities has become one of the core contents of higher education reform [1-3]. The China International College Student Innovation Competition (hereinafter referred to as the "Innovation Competition"), with the concept of "I dare to venture, I can create", brings together high-quality innovation projects and young talents from universities across the country. Among them, the science and technology projects in the main track of higher education, which simultaneously contain the dual attributes of technological innovation and commercialization, have become an important carrier for testing the results of innovation and entrepreneurship education in universities and cultivating students' innovative spirit and practical ability [4-7].

Unlike the intensive preparation for short-term competition projects, the cultivation of science and technology projects often requires several years of technical refinement, product optimization and market verification [8]. This long-term characteristic puts forward higher requirements for the organizational and coordination ability, resource integration ability and educational philosophy of college instructors. At present, local applied colleges and universities generally have the following prominent problems in the cultivation of science and technology competition projects [9,10]: First,

Academic Education Publishing House

they are short-term utilitarian, focusing on competition results rather than process, and on demonstration rather than implementation. Most projects remain at the stage of laboratory prototypes and paper business plans; second, the model is vague, lacking a clear phased cultivation path and operation mechanism, and instructors often act based on experience; third, the cultivation is weak, the students' participation is not deep enough, the projects are disconnected from the courses, and it is difficult to achieve the educational goal of "promoting learning and innovation through competition".

Suqian University, a local applied undergraduate university, achieved a historic breakthrough in its "Measuring the Four Directions—A Leader in Optical Tracking Measurement of Large Components" project, which, under relatively limited resources, achieved a second-place finish in the Jiangsu Provincial Competition in 2023 and a silver medal in the National Competition in 2025. Simultaneously, the project yielded 11 national patents, 3 SCI papers, and numerous educational achievements, including student postgraduate entrance examinations and entrepreneurship. This practice provides a typical case study for exploring long-term cultivation models for science and technology competition projects.

Against this backdrop, this paper, from the practical perspective of supervising teachers, employs action research methods to systematically answer the following three questions: First, what are the core connotations and characteristics of the long-term cultivation model for science and technology competition projects? Second, how is the three-stage operation mechanism of this model and the pivotal role of the supervising teacher constructed? Third, what implications and promotional value does this model have for the reform of innovation and entrepreneurship education in local applied universities?

2. The Connotation and Characteristics of the Long-cycle Cultivation Model

2.1 Definition of Concepts

Long-term cultivation of science and technology competition projects refers to a systematic cultivation model with the triple goals of winning competitions, transforming technological achievements, and cultivating talent. Led by instructors and primarily student-centered, it relies on resources from universities and enterprises and follows a complete process from "topic selection and project establishment—technical breakthrough—product development—commercial optimization—final sprint—results consolidation," spanning one or even multiple cohorts of students' university careers. Unlike short-term, intensive preparation, long-term cultivation emphasizes technology as the core, business as the wings, gradual progress, and sustained effort. Its core lies in achieving the gradual construction of students' innovative abilities and comprehensive qualities by fully covering the technological innovation lifecycle, rather than merely pursuing awards in a single competition.

2.2 Five Core Features

Based on theoretical analysis and practical induction, the long-cycle cultivation model has the following five core characteristics (see Table 1).

Table 1. Comparison of Core Characteristics between Long-term Training Models and Short-term Preparation Models.

Feature Dimension	Specific connotations	Comparison with short-term preparation
Time span	The training cycle covers 2 to 4 years, spans multiple grades of students, and forms a tiered system for knowledge transfer.	Single cohort of students, single competition
Technology and business in parallel	Technology research and development and commercialization are being promoted simultaneously and mutually supportive.	Overemphasis on technology over business, or a business plan that is merely a formality.
Deep collaboration between teachers and students	The supervising teacher acts as the core hub, integrating resources from both inside and outside the school.	The teacher-student dual subject structure and the limited resources
Outcomes - Dual Outputs of Education	Simultaneously pursuing competition results, the transformation of scientific research achievements, and the all-round development of students.	Award-only
incremental iteration	Through multiple cycles of "trial and error - feedback - optimization", it spirals upward.	One-time preparation, lack of iteration

The above characteristics together constitute the essential attributes that distinguish the long-term cultivation model from short-term intensive preparation. Among them, the time span is the external marker of long-term cultivation, the parallel development of technology and commerce is the content structure feature, the deep collaboration between teachers and students is the operational mechanism feature, the dual output of results and education is the goal feature, and the gradual iteration is the process feature.

2.3 Theoretical Logical Foundation

The theoretical foundation of the long-cycle cultivation model can be summarized as the integrated application of five major theories (see Table 2). These theories are not simply superimposed, but rather provide a systematic explanatory framework for long-cycle cultivation from five dimensions: learning process, innovation evolution, collaborative education, capital appreciation, and goal coupling.

It should be noted that the aforementioned theories are often fragmented or ignored in short-term intensive preparation for competitions. For example, short-term preparation focuses only on the presentation aspect of process learning, neglecting the complete life cycle of technological innovation; it relies solely on the teacher-student dual subject, lacking a collaborative education system; and it pursues only a single award, deviating from the coupled logic of the three bottom lines. The innovation of the long-term cultivation model lies in the organic integration of these theories, forming a systematic practical framework.

Table 2. Theoretical Support for Long-Cycle Cultivation Model

theory	Key points	Reflection in the pattern
Process-oriented learning theory	Knowledge and skills are gradually built through continuous practice, trial and error, and reflection.	Students spend 3 to 4 years fully involved in technology research and development and market validation.
Technology Innovation Life Cycle Theory	Technological innovation must go through a complete cycle from idea to commercialization.	The project covers the entire chain from topic selection, research and development, verification, and implementation.
Collaborative education theory	Multiple stakeholders collaborate to form a synergy in education	Collaborative system of universities + enterprises + industry experts + students
Human Capital Theory	Education investment enhances individual innovation capabilities and market value	Students produce SCI papers, patents, and achievements in postgraduate entrance examinations and entrepreneurship.
Triple Bottom Line Theory	Sustainable development must take into account multiple objectives	Competition awards, (technology transfer), and talent cultivation are mutually reinforcing.

3. Research Design

3.1 Research Methods

This study employs an action research paradigm. Action research emphasizes researchers identifying problems, taking action, reflecting on improvements, and refining theories within real-world educational contexts. It is particularly suitable for educational practitioners conducting research based on their own work. The first author, as the mentor throughout the " Measuring the Four Directions " project, continuously engaged in a cycle of "planning-action-observation-reflection" over four years, systematically recording key decisions, stage reviews, and student growth data. This methodological approach aligns closely with the mentor's perspective, effectively avoiding the subjectivity of purely empirical summaries and enhancing the traceability of the research process and the credibility of the conclusions.

3.2 Case Selection

"Measuring the Four Directions—A Leader in Optical Tracking Measurement of Large Components" project was selected as a typical case study primarily for the following four reasons. First, its typicality: this project, a technology-related project in the main track of an innovation competition, combines technological research and development with commercial application, representing the general characteristics of technology competition projects. Second, its long duration: the project spanned four years and covered three cohorts of students, fully demonstrating the cross-generational nature of long-term cultivation. Third, its significant achievements: the project won a silver medal in the national competition, achieving a historic breakthrough for Suqian University in this event, and producing abundant research and educational results, providing ample evidence for model refinement. Fourth, its traceability: the supervising teachers participated throughout the process, accumulating complete documentation, including business plans at each stage, debriefing reports, student interview records, and supervising teacher logs, ensuring the richness and authenticity of the research data.

3.3 Data Sources

The data sources for this study include four aspects. First, project documents, including business plans, presentation slides, debriefing reports, and project summary reports for each stage. Second, interview records, including one in-depth interview per semester with core student members, totaling eight interviews and approximately 12 hours, covering topics such as technological breakthroughs, teamwork, and personal growth. Third, instructor logs, such as the first author's approximately 20,000-word reflection log written over four years of practice, recording key decisions, problem-solving, and insights gained at each stage. Fourth, supporting materials for the achievements, including award certificates, patent certificates, software copyrights, paper acceptance notices, corporate cooperation agreements, and third-party testing reports. In addition, written feedback from provincial and national competition judges was also considered. The cross-verification of data from multiple sources enhances the reliability of the research conclusions.

4. Case Studies: Long-Term Cultivation Practices of the "Measure the Four Directions" Project

4.1 Project Background

The "Measuring All Directions" project focuses on the measurement needs of large-scale components exceeding the meter level. Addressing three major industry pain points of large-field-of-view measurement equipment—small measurement range, low relay accuracy, and difficulty in processing multimodal data—the project develops an optical tracking and measurement device for large components with independent intellectual property rights. The first author holds master's and doctoral degrees from Nanjing University of Aeronautics and Astronautics and has over 10 years of R&D experience in the field of large-scale measurement. He has led or participated in multiple national-level research projects and provided the project with preliminary technical reserves and an industry resource network.

The project relies on platforms such as the Jiangsu Provincial Engineering Technology Research Center for Intelligent Manufacturing Equipment and the Jiangsu Provincial Key Discipline of Mechanical Engineering, possessing ample equipment and instruments for large-scale measurement scenario construction and precision instrument testing. The student team comprises students from interdisciplinary majors such as mechanical design and manufacturing automation, intelligent manufacturing, automation, financial management, and journalism and media, forming a talent structure that complements technology and business.

Since joining the research group in his sophomore year, the project leader has continuously designed and developed a relay positioning target for the optical tracking and measurement system. He innovatively proposed an isotropic positioning target design and obtained a utility model patent. Under the in-depth guidance of his supervisor, the project leader led the team in continuous research and development, achieving breakthroughs in core technologies while consistently producing results. Over four years, they have accumulated 11 national patents, 2 software copyrights, and published 3 SCI papers. The business model adopts a "equipment sales + technical services + customized solutions" approach, and plans to raise 2 million yuan to expand production and market promotion.

4.2 Three-Stage Cultivation Process

4.2.1 Phase 1: Cultivation and Launch Period

The core objectives of this stage are to complete the project selection and approval, assemble a high-quality team, and establish a basic framework integrating technology and business. As the starting point for long-term development, this stage directly determines the project's direction and the scope for subsequent iterations. In terms of topic selection, the supervising teachers adhered to the principle of combining national needs, the university's strengths, and market pain points. Recognizing the urgent need for independent control of core measurement technologies in the nation's high-end manufacturing industry, and leveraging the disciplinary advantages of the university's mechanical engineering and its partner institutions' aerospace science and technology programs, the teachers led students to visit companies such as AVIC Xi'an Aircraft Industry Group and the Nanjing University of Aeronautics and Astronautics Industrial Research Institute. This identified three major industry pain points: small measurement range, low relay accuracy, and difficulty in processing multimodal data. Ultimately, the topic of optical tracking measurement for large components was chosen. This topic not only aligns with national strategic needs and possesses clear market value but is also highly relevant to the students' professional studies.

In team building, we adhere to the principles of complementary strengths, clear division of labor, and efficient collaboration. Students are selected from various majors such as mechanical engineering, intelligent manufacturing engineering, financial management, and accounting, and divided into four functional groups: technology research and development, market development, finance, and production, ensuring that each link is supported by professional capabilities. Regular team meetings, technical seminars, and collaborative activities rapidly enhance team cohesion.

In terms of framework development, the technical and business frameworks were built simultaneously. Technically, students were guided to outline the core technology roadmap, clarify the R&D ideas for the three core technologies, conduct preliminary experiments using the school's experimental equipment, and develop a product prototype. Commercially, based on the initial market research results, a project report and a draft business plan were completed, identifying the target customer group and preliminary profit paths. At the end of this phase, the project won second prize in the 2023 Jiangsu Provincial Competition, laying the foundation for subsequent iterations.

4.2.2 Phase Two: Iterative Improvement Perio

This stage is the core of the long-term development process. Its core objective is to address the shortcomings exposed in the initial stage and achieve simultaneous improvement in both technology and business. After the provincial competition in 2023, the instructors led the team in a systematic review, identifying three major shortcomings at the technical level: insufficient precision in core technologies, lack of product practicality, and insufficient experimental data.

In terms of technological iteration, the supervising teachers developed targeted optimization plans. On the one hand, they invited industry leaders such as professors from Nanjing University of Aeronautics and Astronautics and experts from the Chinese Society of Mechanical Engineering to provide technical guidance, and utilized their own research resources to provide students with experimental sites and equipment support. On the other hand, they guided students to conduct in-depth scientific research experiments. Through repeated iterations, they successfully developed an isotropic tracking target ball with independent intellectual property rights, developed a collaborative control algorithm for the span measurement system, effectively solving the pain point of low transfer accuracy; improved the multimodal point cloud cross-scale data fusion technology, improving data processing efficiency and accuracy; optimized the product's hardware structure and software functions, simplified the operation process, and adapted it to the actual production needs of enterprises. At the same time, they guided students to solidify their technological achievements, applying for 11 national patents and 2 software copyrights, publishing 3 SCI papers and 1 Chinese core journal paper, and constructing a relatively complete intellectual property system.

In terms of business optimization, instructors guided students to refine their business plans by combining technological advancements with market research findings. The market positioning was clearly defined as manufacturing large and complex aerospace components, with a gradual expansion into high-end manufacturing sectors such as automobiles, high-speed rail, and shipbuilding. The core competitive advantages of independent and controllable core technologies and high product precision were emphasized. The optimized profit model was "equipment sales + technical services + customized solutions," with projected sales revenue increasing from 6.7

million yuan to 73.5 million yuan and net profit climbing from 1.4 million yuan to 18 million yuan over the next three years. Simultaneously, efforts were made to connect with various resources, coordinate with the university for dedicated funding, and lead students on company visits to learn about company registration procedures, preparing them for subsequent commercial implementation.

After this phase of iterative improvements, the project quality significantly increased, winning first prize in the Jiangsu Provincial Competition in 2024. However, due to insufficient emphasis on commercial implementation and a lack of clarity in explaining the business logic, it ultimately failed to advance beyond the ranking rounds. This setback clarified the direction for optimization in the next phase of the competition.

4.2.3 Phase Three: Sprint to Consolidate

This stage marks the culmination and breakthrough phase of the long-term cultivation program. The core objective is to focus on the national competition, while simultaneously consolidating project achievements, promoting the transformation of these achievements, and supporting student growth, thereby achieving a triple breakthrough in competition results, achievement transformation, and talent cultivation.

In the final push for the national competition, the instructors led the team in a thorough study of the national competition's judging rules, recognizing that the national competition places greater emphasis on the project's innovation, practicality, market value, and social significance compared to the provincial competition. Learning from the lessons of the preliminary round's setback, they focused on strengthening the presentation and explanation of the commercialization aspect. Project optimization further emphasized technological barriers and independent intellectual property advantages, supplementing supporting materials such as enterprise cooperation agreements, third-party testing reports, and experimental data. The layout of the project report and business plan was also optimized, highlighting core strengths. For the presentation, intensive mock training was organized, and university innovation and entrepreneurship experts, industry entrepreneurs, and previous award-winning instructors provided on-site feedback, addressing issues such as presentation skills, PPT presentations, and adaptability. Simultaneously, attention was paid to the students' mental state, with regular psychological counseling sessions to help them approach the competition in optimal condition. Ultimately, the project successfully passed the Jiangsu provincial preliminary round, the national online review, and the on-site competition, winning a silver medal at the national competition, achieving a historic breakthrough for Suqian University in this event.

Regarding the consolidation and transformation of results, a comprehensive review of the project's development outcomes was conducted. Students were guided to summarize the lessons learned throughout the process and form a complete project summary report; the intellectual property system was further improved, and new relevant patents and software copyrights were added; simultaneously, product production and market promotion were promoted, enterprise cooperation orders were secured, and investment institutions were contacted to obtain more funding support, integrating the project development experience into the school's innovation and entrepreneurship education case library.

Regarding student development, we provide targeted guidance based on students' individual development plans. We guide students to integrate the core technologies of projects into their undergraduate graduation projects, with the graduation projects of core members winning the first prize for outstanding graduation projects at the university level. We provide exam preparation guidance for students planning to take the postgraduate entrance examination, and many students have successfully been admitted to postgraduate programs in related fields. We provide entrepreneurial guidance for students planning to start their own businesses, helping them improve company operation and management, connect with entrepreneurial resources, and assist them in achieving their entrepreneurial goals.

5. Model Construction and Operation Mechanism

5.1 Structured Model of the Three-Stage Pattern

Based on the above practical experience, this paper constructs a three-stage model for the long-term cultivation of science and technology competition projects. The core elements and operational logic of this model are as follows.

The first phase is the incubation and development period, where instructors primarily act as facilitators and platform builders. Key mechanisms include a demand-driven topic selection mechanism and an interdisciplinary team formation mechanism. The outputs of this phase are a clear project direction, a stable team structure, and preliminary technical prototypes and business plans.

The second phase is an iterative improvement period, where mentors transform into resource connectors and problem solvers. Key mechanisms include expert guidance, results consolidation, and university-industry collaboration. The outputs of this phase are breakthroughs in core technologies, a robust intellectual property system, and market-tested business plans.

The third stage is the final sprint and consolidation period, where instructors act as coordinators and psychological supporters. Key mechanisms include mock defense training, a mechanism to promote the transformation of research results, and a personalized growth guidance mechanism. The outputs of this stage include national competition awards, industrialization projects, and students' achievements in postgraduate entrance examinations/entrepreneurship.

The progressive logic of the three stages can be summarized as "foundation building, iterative optimization, and breakthrough solidification." The output of each stage becomes the input of the next stage, forming a spiraling, upward-moving closed loop of cultivation. This structured division of stages provides a clear operational framework for other mentors.

5.2 The Pivotal Role of the Mentor

In the long-term training model, mentors are not knowledge transmitters in the traditional sense, but rather the core hub of a multi-stakeholder collaborative education system. Specifically, mentors assume the following four roles.

First, guidance is crucial. If the topics of science and technology projects deviate from real industry needs or the school's disciplinary strengths, subsequent iterations will lack a foundation. Supervising teachers, leveraging their own research experience and industry knowledge, guide students to avoid the pitfalls of choosing topics that are based on false needs or are too far ahead of their time, ensuring the project's direction is correct.

Secondly, there's the issue of resource connections. Local applied universities typically have limited resources, requiring instructors to proactively connect with various resources, including on-campus laboratories, off-campus companies, industry experts, and government platforms. In this case, the instructor leveraged their academic network to secure technical support from a professor's team at Nanjing University of Aeronautics and Astronautics, and utilized industry connections to facilitate company visits and collaborations, effectively compensating for the lack of university resources.

Thirdly, there is the process organization. Long-term training involves multiple stages, multiple groups, and multiple task lines. Without systematic process management, chaos or negligence can easily occur. Supervising teachers ensure the project progresses according to plan through regular debriefings, milestone checks, and mock defenses.

Fourthly, psychological support is crucial. Long-term training can easily lead to burnout, anxiety, and even self-doubt in middle school students, especially when they suffer setbacks in competitions or encounter obstacles in overcoming technical challenges. Instructors need to continuously monitor students' mental state and maintain team morale through individual counseling, team encouragement, and stress management.

These four roles support each other and together constitute the complete meaning of the mentor's pivotal role. The lack of any one dimension may lead to the interruption or failure of long-term training.

5.3 Dual Mechanism for Student Growth and Achievement Transformation

The long-term cultivation model achieves dual outputs of competition results and educational outcomes, and its internal mechanism can be analyzed from two dimensions: student growth and outcome transformation.

Regarding the student development mechanism, students have achieved significant improvements in four dimensions through full participation in technology research and development, market research, business planning, and presentations. First, students participated in experimental design, data analysis, thesis writing, and patent applications, with many members publishing SCI papers or obtaining authorized patents. Second, students immersed themselves in frontline enterprises, gaining a deeper understanding of real production scenarios and customer needs, thus substantially honing their product development and debugging abilities. Third, students participated in business plan writing, financing planning, and cost accounting, establishing a preliminary framework for technology commercialization. Finally, project experience became a core competitive advantage for students in postgraduate entrance examinations and job interviews, with many successfully gaining admission to postgraduate programs or launching their own businesses.

In terms of technology transfer mechanisms, the project's results have been transformed into various physical forms. Eleven patents, two software copyrights, and three SCI papers constitute intellectual property barriers. Enterprise cooperation agreements, third-party testing reports, and product prototypes validated the technology's market value. The registration and operation of startups propelled the technological achievements to market. The project's incubation experience was compiled into teaching cases, enriching the school's innovation and entrepreneurship courses.

The key to the formation of the aforementioned dual mechanism lies in the fact that the long-term cultivation provides ample time and space, enabling the process-oriented learning of "learning by doing" to truly take root, rather than merely remaining at the level of superficial preparation of competition materials.

6. Implications and Pathways for Educational Reform

6.1 Feedback to the Innovation and Entrepreneurship Curriculum System

Long-term training experience shows that traditional general entrepreneurship courses are insufficient to support the in-depth needs of technology-related projects. Taking this case as an example, the shortcomings students exhibited in areas such as business plan writing, intellectual property strategy, and financing planning precisely reflect the deficiencies of the existing curriculum system. Therefore, it is recommended to promote the following three curriculum reforms: First, embedding project-based courses. Transform competition project topics into course design questions to achieve integration of coursework and competition. For example, the " Mechatronics System Design " course for mechanical engineering majors can set design tasks based on project technical requirements, and the " Corporate Finance " course for financial management can use projects as case studies for financial analysis. Second, interdisciplinary elective modules. Offer micro-courses on technology commercialization, intellectual property management, business plan writing, and technology entrepreneurship financing to address the shortcomings in business skills among engineering students. These courses can be offered in the form of short-term workshops or online MOOCs to reduce the cost of offering them. Third, long-term practical credits. Allow students to convert 2 to 3 years of project participation into innovation practice credits to incentivize continued investment. Specifically, credits can be awarded based on "annual assessment + output," avoiding the phenomenon of students merely registering projects to gain credits.

6.2 Optimization of the Student Evaluation Mechanism

Current student evaluations still primarily rely on exam scores, failing to reflect the implicit skill development within long-term projects. In this case, core members dedicated over 1000 hours to the project, producing patents, papers, competition awards, and other achievements, but the traditional GPA system cannot reflect these contributions. Optimization is recommended in two aspects: First, allow achievements to replace academic credits. Allow achievements such as patent grants, paper publications, competition awards, and company registrations to replace some elective course credits. Clear standards for converting achievements into academic credits need to be established to avoid arbitrariness in implementation. Second, incorporate practical experience into postgraduate admission and scholarship evaluations**.** Use contributions from long-term projects, such as technological breakthroughs, team succession, and output, as important indicators for postgraduate admission and scholarship evaluations. Contributions can be detailed by the supervising professor and verified by the college's review committee.

6.3 Improvement of the Incentive Mechanism for Mentors

Local universities commonly suffer from problems such as not including competition guidance workload in performance evaluations and not recognizing competition results in professional title assessments, which seriously affects teachers' enthusiasm for long-term training. In this case, the supervising teacher has continuously invested for four years, but it is difficult to obtain equivalent recognition under the current evaluation system. It is recommended to improve the system in the following three aspects: First, workload recognition. Long-term project guidance should be calculated as teaching workload on an annual basis, with each cohort of students counted as 0.5 to 1 course. Specific standards can be differentiated based on whether the project is at the school, provincial, or national level, and the award level. Second, professional title assessment channel**.** Innovation and entrepreneurship guidance achievements should be included in professional title assessments, alongside research papers and teaching reform projects. For example, guiding a project that wins a silver medal or higher in a national competition can be considered a core journal teaching reform paper, and guiding a national gold medal can be considered a provincial-level teaching reform project. Third, performance rewards. Special performance rewards should be given to teams that win national competition awards, and supervising teachers should be supported to participate in innovation and entrepreneurship education training or academic exchanges to improve their guidance capabilities.

6.4 Deepening the Industry-Education Integration Mechanism

Long-term cultivation cannot be achieved without the deep involvement of enterprises. In this case, the enterprise's input of needs, technology verification, and scenario support were key factors in the project's success. To further deepen the integration of industry and education, the following three measures are recommended: First, jointly build university-enterprise joint laboratories. Universities provide technology R&D services to enterprises, while enterprises provide universities with real-world industry scenarios and equipment support, with both parties sharing intellectual property benefits. Second, implement an enterprise mentorship system. Appoint senior technical executives and market experts from enterprises as joint mentors to participate in stage reviews, defense training, and guidance on (technology transfer). Enterprise mentors can be appointed as industry professors or part-time researchers. Third, implement order-based training. Align the technical direction of the competition project with the talent needs of enterprises to achieve a seamless "project-internship-employment" process. The process of students participating in the competition project is also a pre-training process for enterprises, allowing them to directly enter the cooperating enterprises for employment after graduation.

6.5 Adaptability Conditions for Model Promotion

This model is highly transferable to local applied universities, but it requires certain adaptability conditions. First, supervising teachers need to possess certain research experience and industry resources, or compensate for these shortcomings through inter-university cooperation (such as joint supervision with high-level universities). Second, university-level policy support is needed, including dedicated funding, credit recognition, facilities and equipment, and preferential treatment in professional title evaluation. Third, a tiered mechanism of "sophomore year entry—junior year core members—senior year mentorship" needs to be established to prevent personnel gaps through mentorship programs. Finally, it is recommended to start the project in the first semester of the sophomore year to ensure at least two years of nurturing; starting in the junior year makes it difficult to complete the full three-stage iteration. For universities with relatively scarce resources, it is recommended to leverage the research resources of high-level universities or the industry resources of leading enterprises to initiate long-term nurturing through joint supervision, gradually operating independently after accumulating experience and achievements.

7. Conclusions and Outlook

This paper takes the four-year cultivation practice of the "Measuring the Four Directions" project as a case study and uses action research methods to systematically construct a long-term cultivation model for science and technology competition projects. The main conclusions and contributions of the study are reflected in the following three aspects.

First, the connotation and characteristics were defined. The core connotation of the long-cycle cultivation model was clarified: a systematic cultivation model with competition awards, technological achievement transformation, and talent cultivation as its three objectives, led by instructors and with students as the main participants, spanning a complete innovation cycle. Five core characteristics were extracted: cross-generational timeframe, parallel development of technology and business, deep collaboration between instructors and students, dual output of achievements and education, and gradual iteration. These characteristics effectively distinguish the essential difference between long-cycle cultivation and short-term intensive preparation for competitions.

Second, model construction and mechanism analysis. A three-stage structured model of "initiative development – iterative improvement – final consolidation" was extracted, analyzing the key tasks and operational mechanisms of each stage, and revealing the pivotal role of the mentor as a directional guide, resource linker, process organizer, and psychological supporter. This model provides a clear operational framework for other mentors.

Third, the implications and pathways for educational reform. From four dimensions—curriculum system, student evaluation, teacher incentives, and industry-education integration—actionable reform suggestions are proposed, and the adaptability conditions for promoting the model are analyzed, providing theoretical reference and practical paradigm for local applied universities to deepen the reform of innovation and entrepreneurship education.

This study has the following limitations, which require further exploration in the future. First, the generalization validity of a single case needs to be tested in practice by more universities and projects. Future research could involve comparative studies of multiple cases to identify differentiated cultivation strategies across different disciplines and levels of universities. Second, long-term cultivation involves high time and resource investment; how to reduce costs and increase efficiency under resource constraints requires in-depth research. Future research could explore lightweight long-term cultivation models, such as cross-institutional resource sharing and digital tools to assist management. Third, student attrition and talent gaps are common challenges in long-term cultivation, which this paper has not discussed in sufficient depth. Future research could specifically investigate the mechanisms for maintaining students' continued motivation and effective strategies for talent succession. Fourth, this study primarily uses qualitative analysis; future research could design quasi-experimental studies, employing pre- and post-test comparisons or follow-up surveys to quantitatively measure the net effect of long-term cultivation on students' ability enhancement.

Acknowledgments

Excellent Teaching Team of Jiangsu Qing Lan Project (Su Teacher Letter [2024] No.14); Special Research Project on Digital Transformation of Higher Education and Educational Modernization Practice in Jiangsu Province (2024CXJG035); Jiangsu Provincial Higher Education Reform Research Project (2025JGYB677); Comprehensive Research Project on Teaching Reform at Suqian University; Jiangsu Province Young Scientific and Technological Talent Support Project (JSTJ-2024-663).

References

[1] Zhao Xuan, Yang Liu, Dai Xi, et al. Cultivation of students' innovation and entrepreneurship ability based on the China International College Student Innovation Competition. Research and Practice of Innovation and Entrepreneurship Theory, 2024, 7(14): 194-198.

[2] Liu Huabin, Zhang Qinying, Zhou Cheng. Exploration of Cultivation of Innovation and Entrepreneurship Ability of Application-Oriented College Students Based on the China International College Student Innovation Competition. Journal of Hubei Open Vocational College, 2025, 38(17):1-3.

[3] Bin Shiyu, Sun Tao, Bin Quan, et al. Research on the transformation mechanism of college students' scientific and technological innovation achievements driven by the integration of science and

technology projects and innovation competitions. Science and Technology Entrepreneurship Monthly, 1-10 [2026-03-16].

[4] Windsor, Yang Lichao, Su Fang, et al. Research on the path to improve college students' innovation and entrepreneurship ability from the perspective of "learning through competition". Journal of Youjiang Medical College for Nationalities, 2026, 48(01):128-131.

[5] Jiang Siwei. A Study on the Cultivation and Practice of Students' Business Thinking Ability in the China International College Student Innovation Competition. China Science and Technology Investment, 2025, (21): 136-138.

[6] Zhou Xiaowei, Li Xinjie, Sun Wenying, et al. Current Status and Optimization of Innovation and Entrepreneurship Education under the Background of International Innovation and Entrepreneurship Competitions. Journal of Shaoguan University, 2025, 46(05): 87-94.

[7] Cheng Jinsheng, Chen Weiji, Wang Siju, et al. A Study on Participation and Influencing Factors of the China International College Student Innovation Competition from the Perspective of Students. Journal of Shaoguan University, 2025, 46(05):81-86.

[8] Sun Weili, Chen Kairong, Zhou Linlin, et al. Research on scientific and technological innovation of higher vocational students—taking the project “Research on China’s first hyperbranched waterborne polyurethane new material” as an example. Research and Practice of Innovation and Entrepreneurship Theory, 2024, 7(03): 171-176.

[9] Chen Libin, Guan Yuno, Liu Huan. “Promoting Innovation through Competition” or “Formal Participation”: An Empirical Study on the Impact of Innovation and Entrepreneurship Competition Management Mechanism on College Students’ Innovation and Entrepreneurship Ability. Educational Development Research, 2026, 46(01):65-74.

[10] Wang Han, Shi Quan, Gao Ruifeng. Exploration of high-quality college student innovation project cultivation model under the perspective of industry-education integration. Research and Practice of Innovation and Entrepreneurship Theory, 2025, 8(09):180-182.