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Exploration on the Path of Innovative Talent Training Based on the Five-Dimensional Coaching Model under the Background of Emerging Engineering Education

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Abstract: In recent years, in response to the urgent demand for high-quality, interdisciplinary engineering talents under the emerging engineering education initiative, this paper presents the exploration and practice of Harbin Institute of Information Technology in advancing the "Five-Dimensional Coaching" model for Innovative Talent Training. It focuses on the five dimensions of the model: knowledge construction, practical application, engineering practice, Scientific and Technological Innovation, and job competency. Aiming to address the challenges in traditional engineering education—such as fragmented development stages, disconnection between education and industry, and insufficient job readiness—this study provides a practical, replicable, and scalable paradigm for innovative talent training in the context of Emerging Engineering Education.

Keywords: Emerging Engineering Education; Innovative Talent; Talent Cultivation

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1. Introduction

In the context of the accelerating advancement of a new wave of technological revolution and industrial transformation, the development of Emerging Engineering Education has become a strategic initiative to promote the connotative growth of higher education in China. Faced with the rapid rise of strategic emerging industries such as artificial intelligence, big data, intelligent manufacturing, and new energy, traditional models of engineering talent cultivation urgently need to be updated to meet the national innovation-driven development strategy's demand for high-quality, interdisciplinary engineering professionals.

The Third Plenary Session of the 20th Central Committee of the Communist Party of China clearly emphasized that higher education, as the "leading force" in building a strong education nation, bears the core mission of cultivating high-quality talents and advancing scientific and technological innovation. In this context, innovative talents—serving as a key driver of high-quality economic and social development—have become central to national competitiveness[1]. However, talent development in many current higher education institutions still suffers from fragmentation: it is often segmented across academic stages, characterized by disjointed curricula, and focused narrowly on outcomes rather than holistic development. Career education, innovation literacy, and employability skill building are frequently confined to isolated

phases of undergraduate study, lacking systematic design and longitudinal integration. This results in fragmented student competency development, slow career adaptation, and insufficient job readiness—ultimately hindering effective alignment between graduate capabilities and real-world industrial demands.

This paper proposes an integrated "five-dimensional" educational framework—encompassing knowledge construction, practical application, engineering practice, scientific and technological innovation, and job competency (hereinafter referred to as the "five dimensions")—to advance a holistic and longitudinal approach to innovative talent cultivation. By systematically embedding career development, innovation capacity building, and employment readiness across all stages of undergraduate education, this model ensures the seamless integration of these elements throughout the entire learning journey. Through the coordinated alignment of the five dimensions, the framework establishes a cohesive talent development paradigm characterized by clear objectives, well-defined pathways, and synergistic mechanisms. It aims to provide both actionable strategies and robust theoretical foundations for higher education reform in the new era, thereby supporting the sustained cultivation of high-quality engineering professionals who meet the evolving demands of industry and society.

2. Constructing a Coaching Model Based on Five Dimensions for Innovative Talent Development

The development of innovative talent is not an overnight achievement, but rather a systematic and progressive process that spans the entire undergraduate journey. From intellectual awakening to practical exploration, from goal setting to project-based training, and ultimately to value realization, each stage should be organically connected and sequentially advanced. An ideal talent cultivation model should take job competency and career development stability as its ultimate evaluation criteria, deeply integrating theoretical learning, practical training, project implementation, disciplinary competitions, and career development into a cohesive five-dimensional educational system (**Figure 1**). In terms of implementation, the early years should focus on interest stimulation and intellectual awakening, guiding students to develop professional awareness and clarify their career trajectories. The middle years should emphasize practical skill development and active project engagement, strengthening hands-on abilities and teamwork competencies. In the later years, the focus should shift to outcome incubation, innovation commercialization, and employment transition, enhancing job readiness and long-term career potential. Through a staged, progressive educational design, this approach fosters the synergistic development of students' innovative literacy and professional capabilities, enabling a meaningful transformation from "knowledge acquisition" to "competency enhancement," "quality formation," and ultimately, "holistic development.

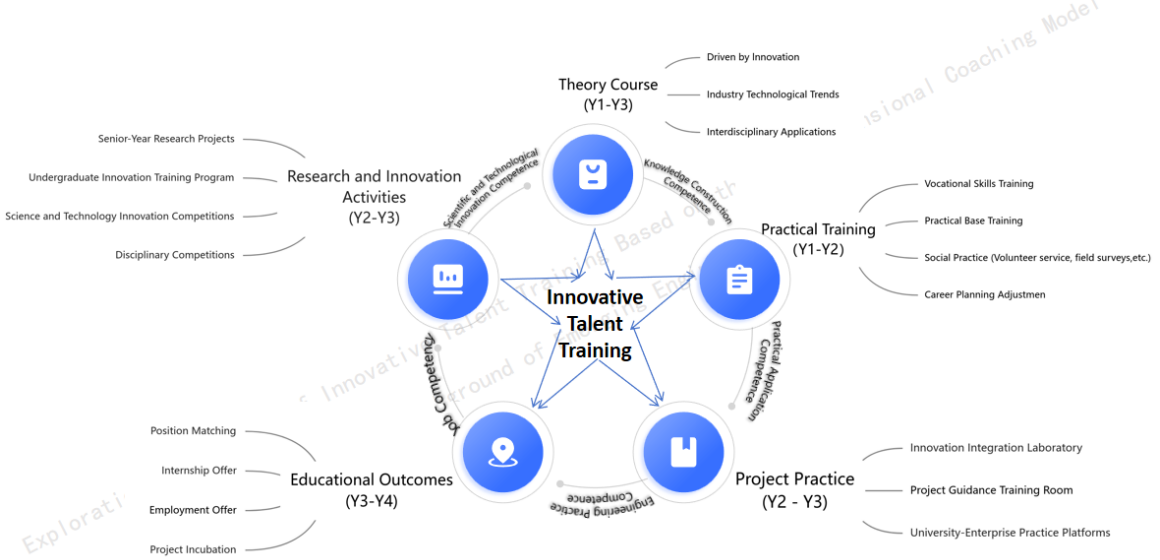

Figure 1. An Innovative Talent Development Model under the "Five-Dimensional" Coaching Framework

2.1. Industry-Driven Talent Development: Co-Designing Educational Programs through University-Enterprise Collaboration

Knowledge construction is the foundation of the five-dimensional framework; only with a scientific, forward-looking, and industry-relevant knowledge system can subsequent competencies—practical application, engineering practice, technological innovation, and job readiness—be effectively developed. Ensuring high-quality knowledge input is therefore critical to enabling university-enterprise collaboration to support students' integrated and longitudinal growth.

Talent cultivation programs must align with real workforce demands. Through close collaboration, universities and enterprises should jointly design and continuously refine curricula based on industrial trends and specific competency requirements. This partnership allows institutions to promptly respond to technological advancements and evolving skill needs, guiding the optimization of academic structures, course offerings, and content to ensure graduates meet both current and future industry expectations.

By integrating real-world enterprise requirements with emerging technologies and new product development needs, universities and enterprises jointly establish collaborative projects that actively involve students in research and practical work. Together, they co-design and develop applied undergraduate curricula that emphasize the integration of theory and practice, aiming to cultivate students' abilities to solve practical problems and foster innovation.

The co-developed curriculum strengthens the integration of theoretical instruction with hands-on training, adopting a competence-oriented approach that focuses on developing students'capacity to address complex engineering challenges and nurture an innovative mindset.

Furthermore, through diverse formats such as joint courses, practice-oriented teaching, industry-university-research projects, and innovation and entrepreneurship training programs, this collaborative model systematically enhances students' practical skills, professional adaptability, and employability competitiveness.

2.2. Building a Full-Chain Approach to Practical Competence Development through Collaborative Education

In the "five-dimensional" framework for cultivating innovative talent, practical training serves as a critical starting point for transforming knowledge into competence. This framework is oriented toward enhancing practical capabilities, breaking down the traditional disconnect between theoretical instruction and real-world application, and effectively extending educational contexts from the classroom to frontline enterprise settings and authentic social environments.

By leveraging both on-campus and off-campus practice Platforms, institutions provide access to real-world projects and work environments, thereby strengthening hands-on operation and engineering practice abilities. Students are also encouraged to participate in social service initiatives and field research, which fosters a sense of social responsibility and enhances their capacity to address complex, interdisciplinary problems. Integrated with career planning guidance and a dynamic feedback mechanism, this approach supports students in clarifying their developmental trajectories and improving professional adaptability and employability[2].

Through collaborative efforts among universities, enterprises, and society, a full-chain system for practice-based education has been established, forming a closed-loop pathway of "learning → practice → improvement → application". This cycle enables the effective transformation of knowledge construction competence into practical application competence, providing robust support for the cultivation of high-quality, application-oriented innovative talent in the context of emerging engineering education[3].

2.3. Enhancing Engineering Practice Competence in Innovative Talent through Project-Based Learning

In the "five-dimensional" framework for cultivating innovative talent, project-based practice serves as a critical component for strengthening engineering practice competence and achieving the integration of knowledge and action (knowing and doing). Students can enhance their engineering practice capabilities through multiple pathways:

(1) Specialized Innovation-Integrated Laboratories:

Based on their academic specialization and project focus, students—guided by faculty advisors—select appropriate specialized innovation-integrated laboratories. These open-access laboratories integrate entrepreneurship and innovation with disciplinary practice, enabling students to engage with interdisciplinary knowledge and technologies. This fosters cross-disciplinary collaboration and stimulates innovative thinking. The laboratories provide a platform for students to conduct technical problem-solving and innovation-driven projects, helping them apply theoretical knowledge to real-world challenges and cultivate innovation capacity.

(2) Project Guidance Training Rooms:

These rooms function as comprehensive, multi-functional platforms for talent development. Beyond project simulation and outcome refinement, they offer: Support for project planning and design; A dual-mentor system; A cross-disciplinary collaboration platform; Instruction in business plan development; Training in pitch presentations and mock defenses; A long-term follow-up service mechanism. Through comprehensive, end-to-end guidance and support, the project guidance studio effectively facilitates students' transition from knowledge application to transformative competence development.

(3) University-Enterprise Practice Platforms:

By engaging in university-enterprise Practical Platforms, students directly participate in real-world industrial projects and production processes. Within authentic work environments, they apply technical knowledge, solve practical problems, and implement engineering solutions, thereby deepening their professional competence and industry readiness[4].

2.4. Enhancing Scientific Research and Innovation Capacity through Research Leadership and Competition-Driven Learning

Within the "five-dimensional" framework for cultivating innovative talent, scientific research and academic competitions serve as a vital component. Through multi-level practice pathways—such as senior-level research projects, innovation training programs, technological innovation contests, and discipline-specific competitions—students' research proficiency, innovative capacity, and overall competence are systematically enhanced. This integrated approach lays a solid foundation for cultivating outstanding engineers and innovative talents in the new era.

2.5. Establishing a Closed-Loop Educational Mechanism Based on Backward Validation and Continuous Improvement

Job competency serves as the ultimate goal and a key metric for evaluating the effectiveness of talent cultivation. It represents not only the "last mile" of the five-dimensional framework, but also a litmus test for assessing the development outcomes across knowledge construction, practical application, engineering practice, and innovation competitiveness. Validating educational effectiveness through job competency involves multiple pathways: Job-person fit assessment; Internship offer acquisition rate; Quality of employment offers; Project incubation and technology transfer outcomes.

Only by aligning talent development with industry-specific competency demands as the guiding driver, and by using authentic employment outcomes as a key validation metric, can higher education achieve genuine synergy with industrial development. This alignment is essential for enabling the high-quality cultivation and effective output of application-oriented innovative talents.

3. Implementation Effectiveness of Innovative Talent Cultivation under the "Five-Dimensional" Coaching Model

Harbin Institute of Information Technology has achieved remarkable results in cultivating innovative talents through the implementation of the "Five-Dimensional" coaching model.

(1) In recent years, the institution has been committed to developing well-rounded, high-quality innovators with strong comprehensive competencies. In 2024, the university launched a large-scale scientific and technological innovation training program for students, resulting in the submission of 385 senior-level research projects and the participation of 4,770 students. Building on this foundation, students earned a total of 496 awards in provincial and national-level disciplinary competitions, representing a 25% year-on-year increase. The number of National College Students' Innovation and Entrepreneurship Training Program (NCIETP) projects increased by 12.3%, while student participation rose by 35.9% compared to the previous year. In 2025, the university achieved significant success in the Heilongjiang Provincial Division of the China International College Students Innovation Competition (CISCIC), securing 14 Silver Awards and 9 Bronze Awards—a 21% increase in award count from the previous year.

For a detailed overview of student participation in the CISCIC in recent years, see **Figure 2**. The data demonstrate a growing trend in student engagement in innovation activities, indicating not only increased willingness to participate but also tangible benefits in terms of skill development, practical application, and innovation capacity.

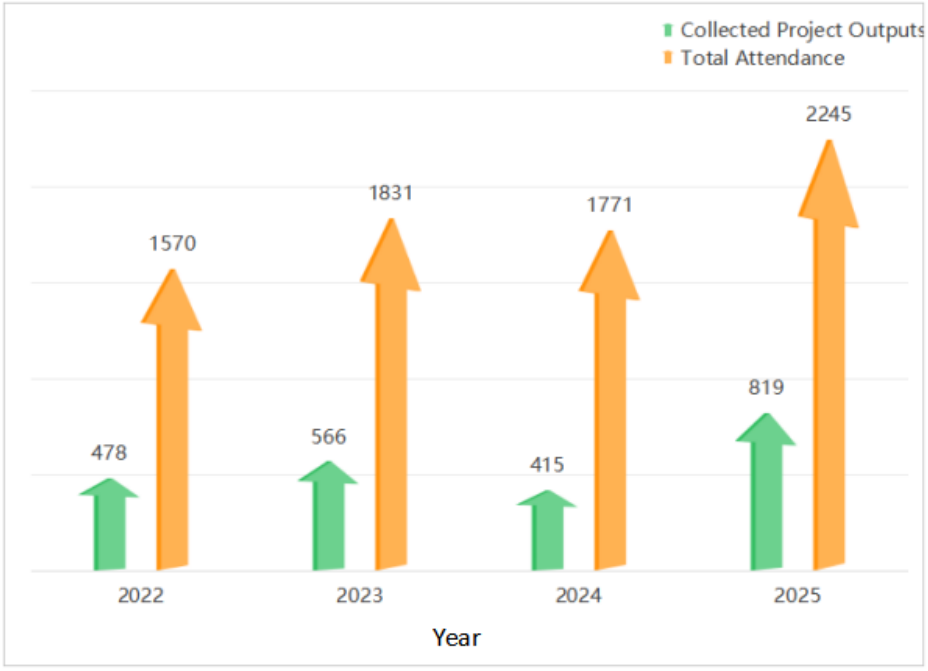

Figure 2. Trends in Student Participation in the China International College Students Innovation Competition (CISCIC) at Harbin Institute of Information Technology (2022–2025)

(2) In terms of employment outcomes, as one of China's first national model institutes of software technology, our university has consistently demonstrated strong undergraduate employment performance. The initial employment rate for the Class of 2024 reached 92.15%. As of June 2025, the verified employment rate for the Class of 2025 stood at 88.90%. These figures not only reflect the institution's significant effectiveness in adapting to an evolving job market, but also underscore the critical role of innovation-driven educational reforms in enhancing the quality of talent cultivation.

(3) In building a faculty with strong industry-relevant expertise, our university has adopted an integrated approach of "introducing" and "developing" talent to cultivate a "dual-competence" teaching team.—equipped with both academic excellence and practical engineering capabilities. On one hand, senior engineers from industry are hired as part-time instructors who actively participate in core curriculum delivery, practical training supervision, and project-based mentoring. On the other hand, the university has intensified the recruitment of full-time faculty members with substantial industrial experience, thereby enhancing the teaching team's practical engineering

skills.

(4) Currently, faculty members with "dual-qualified" or "dual-competence" attributes account for nearly 30% of the total full-time teaching staff. This initiative has gradually established a high-caliber academic team characterized by solid theoretical foundations, systematic disciplinary knowledge, rich industry experience, and strong practical capabilities. This evolving faculty profile effectively supports the in-depth implementation of practice-oriented instruction and industry-university collaboration within the "Five-Dimensional" innovative talent development framework.

(5) In promoting the integration of specialized education with innovation and entrepreneurship education, our university adheres to the principle of "disciplinary competence as the foundation and innovation capability as the orientation," systematically advancing their deep convergence. First, interdisciplinary innovation laboratories have been established, equipped with discipline-specific tools and integrated with real industrial projects and R&D tasks. Second, we have developed 23 specialized-innovation (Zhuan-Chuang Integrated) courses, designed around project-based and problem-oriented learning, incorporating industry cases, technological innovation, and business models into disciplinary teaching to enhance students' abilities in problem analysis, resource integration, and innovative design in authentic contexts. Third, these courses are closely linked with practical programs—including the National College Students' Innovation and Entrepreneurship Training Program, subject competitions, and industry-university collaboration projects—encouraging students to "learn methods in class, implement projects outside, and achieve outcomes through competitions."

4. Conclusion

By establishing an integrated "five-dimensional" framework for innovative talent development—encompassing theory, practice, projects, competitions, and job readiness—the university has effectively embedded career education, innovation capacity building, and employment preparation into the entire undergraduate education process[5]. This holistic approach has driven a transformative shift from knowledge transmission to competence development, quality formation, and well-rounded growth. Moving forward, the institution will continue to refine this model to cultivate a greater number of high-quality, application-oriented innovators capable of leading technological revolutions and industrial transformation, thereby providing robust human capital support for China's national strategy of innovation-driven development.

Disclosure statement

The authors declare no conflict of interest.

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