

Research on Innovative Vocational Undergraduate Talent Training Model for Modern Industrial Clusters in Hainan Free Trade Port Empowered by Industry-Education Integration

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Abstract: The accelerated development of modern industrial clusters in Hainan Free Trade Port has led to a sustained surge in demand for high-level technical professionals and interdisciplinary applied talents. Vocational undergraduate education, serving as a pivotal bridge between higher education and vocational training, plays a critical role in aligning talent supply with industrial needs and driving industrial upgrading. Current challenges in Hainan’s vocational education include mismatched program offerings with industrial demands, superficial industry-academia collaboration, inadequate practical training systems, and insufficient dual-qualified faculty resources. This study examines the intrinsic relationship between industrial cluster development and vocational education through the lens of industry-education integration. It identifies existing talent cultivation bottlenecks and proposes an innovative “government-industry-academia-enterprise-industry” collaborative model, along with a six-dimensional approach encompassing job placement, curriculum design, competition mechanisms, certification systems, innovation initiatives, and research development. The study provides actionable strategies to enhance vocational education quality and support the high-quality growth of Hainan’s industrial clusters, offering both theoretical insights and practical solutions for regional development.

Keywords: Industry-education integration; Hainan free trade port; Modern industrial clusters; Vocational undergraduate education; Talent cultivation model

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1. Introduction

As a pivotal national strategic initiative, Hainan Free Trade Port is accelerating the development of a modern industrial ecosystem. This system is anchored by tourism, modern services, high-tech industries, and tropical specialty agriculture, while being propelled by three emerging sectors: seed production, deep-sea exploration, and aerospace technology. The agglomeration effects of industrial parks are becoming increasingly pronounced, with modern industrial clusters rapidly evolving toward higher-end sophistication, intelligent integration, and global competitiveness. The high-quality growth of these industrial clusters urgently requires a substantial pool of high-caliber vocational professionals who possess solid

theoretical foundations, exceptional practical skills, and a global perspective coupled with innovative capabilities. This demand presents both unprecedented opportunities and challenges for the advancement of vocational undergraduate education ^[1].

Vocational undergraduate education is positioned to cultivate high-level technical professionals, serving as a crucial bridge between higher education and industrial development while addressing structural talent supply-demand imbalances. In recent years, Hainan's vocational undergraduate education has achieved breakthrough progress from scratch, with expanding enrollment scales and continuously refined academic programs. However, challenges persist in talent cultivation, including disconnection from industrial needs, insufficient industry-education integration, and homogeneous training models, which hinder precise alignment with the talent demands of modern industrial clusters in the Free Trade Port. As the core philosophy of vocational education, industry-education integration represents a key pathway to achieve comprehensive structural convergence between talent supply and industrial demand. Therefore, exploring innovative vocational undergraduate talent cultivation models empowered by industry-education collaboration, and realizing synchronized development between vocational education and modern industrial clusters in the Free Trade Port, holds significant practical implications and real-world value ^[2].

2. Core concepts and theoretical foundations

2.1. Definition of core concepts

Industry-Education Integration, as the core operational model of vocational education, refers to a demand-driven approach that fosters deep collaboration between education and industries through resource sharing. This initiative involves coordinated participation from multiple stakeholders, including governments, educational institutions, enterprises, and industrial parks. It ensures alignment between academic programs and industrial layouts, curriculum content and occupational standards, teaching processes and production workflows, as well as talent development and job requirements. Such integration creates a virtuous cycle where education empowers industries and industries, in turn, enrich educational practices ^[3].

The Modern Industrial Cluster of Hainan Free Trade Port is an industrial ecosystem developed through strategic clustering in key industrial parks, leveraging the free trade port's policy advantages, resource endowments, and geographical positioning. This cluster encompasses sectors including tourism consumption, modern logistics, digital economy, biomedicine, southern breeding seed industry, deep-sea technology, aerospace technology, and green construction. Characterized by high-end sophistication, internationalization, innovation-driven development, and agglomeration effects, it demonstrates an urgent demand for high-caliber, interdisciplinary, and globally competent technical professionals.

The Vocational Undergraduate Talent Cultivation Model is a systematic educational framework designed by vocational undergraduate institutions to cultivate high-level technical and skilled professionals. It integrates key elements, including talent development objectives, program design, curriculum systems, teaching processes, faculty development, practical instruction, and evaluation mechanisms. Distinct from conventional undergraduate education and vocational college programs, this model emphasizes dual cultivation of practical competencies and professional ethics, combining vocational orientation with applied learning approaches at an advanced level ^[4].

2.2. Theoretical basis

The collaborative governance theory emphasizes that multiple stakeholders can achieve common goals through communication, resource integration, and clear division of responsibilities. In vocational undergraduate education, governments, industrial parks, enterprises, educational institutions, and industry associations must break down institutional barriers and collaborate throughout the talent development process. This approach fosters a co-constructed, co-governed, and shared educational ecosystem, providing theoretical foundations for establishing diversified collaborative talent

cultivation models.

Industrial cluster theory posits that industrial agglomeration drives demand for specialized talent and creates large-scale job opportunities, thereby imposing specific requirements on professionals' skill sets and competencies. Vocational undergraduate education must align with industrial cluster trends by dynamically adjusting talent development strategies, program structures, and curricula to ensure precise alignment between educational outcomes and industry needs^[5].

The competency-based education theory centers on the skill requirements of occupational positions, designing talent development systems around professional expertise, comprehensive competencies, and innovative capabilities needed for specific roles. This framework guides vocational undergraduate education to move beyond traditional theory-centered teaching models, focusing instead on cultivating students' practical professional skills and job-fit competencies, thereby aligning with the core objectives of vocational undergraduate education.

3. Current status and challenges in vocational undergraduate talent cultivation under modern industrial clusters in Hainan Free Trade Port

3.1. Preliminary achievements in talent cultivation

In recent years, Hainan's vocational undergraduate education has seized opportunities presented by the Free Trade Port development, aligning with modern industrial cluster demands and achieving phased educational outcomes. Vocational institutions such as Hainan Science and Technology Vocational University have established specialized programs focusing on key Free Trade Port industries. This includes digital economy, biotechnology, green intelligent construction, shipping management, and tropical agriculture and forestry, forming an industry-aligned curriculum system. School-enterprise collaboration has deepened through joint training bases and modern industrial colleges with leading Free Trade Port enterprises and industrial parks, implementing dual-mentorship education models. The policy framework for industry-education integration continues to improve, with Hainan Province introducing measures to enhance vocational education integration, increasing support for industry-academia projects, training facilities, and faculty development to provide policy guarantees for talent cultivation^[6].

3.2. Existing core challenges

The professional structure lacks alignment with industrial clusters, with vocational undergraduate programs lagging behind the rapid evolution of modern industrial clusters in the free trade port. There is insufficient coverage of emerging and future industry-related disciplines, while specialized programs in characteristic sectors such as the seed industry, deep-sea technology, aerospace technology, and cross-border services exhibit limited scope and weak academic capacity. Traditional majors dominate the curriculum, suffering from severe homogenization that fails to meet the high-end and international development demands of industrial clusters, ultimately falling short of addressing talent needs in specialized industrial fields^[7].

Industry-academia collaboration in talent cultivation has become superficial, with school-enterprise partnerships remaining at a basic level of cooperation. While enterprises primarily provide internship opportunities and host lectures, they have yet to establish comprehensive mechanisms for deep involvement in professional planning, curriculum development, teaching implementation, and evaluation processes. Some enterprises exhibit a "employment-first, education-second" mindset, showing insufficient enthusiasm for talent development and lacking long-term incentive mechanisms for school-enterprise collaboration. Additionally, there is inadequate coordination among multiple stakeholders, including government agencies, industrial parks, schools, enterprises, and industry associations, resulting in inefficient resource integration due to the absence of unified coordination mechanisms.

The curriculum and teaching system are disconnected from real-world job requirements. The course structure prioritizes theoretical instruction over practical components, with content lagging behind emerging industry technologies, processes, and standards while failing to align with the core competency demands of professional roles. Traditional

teaching methods lack immersive, project-based, and hands-on approaches, hindering the development of students' practical skills and problem-solving abilities. Furthermore, the integration of vocational certifications, skill certifications, and industry competitions remains superficial, resulting in low alignment between professional certifications, competition content, and academic instruction. This disconnect ultimately compromises students' job readiness and professional adaptation capabilities^[8].

The development of dual-qualified faculty remains underdeveloped in vocational undergraduate institutions. Most instructors are recruited from regular universities, lacking frontline industry experience and technical expertise, resulting in insufficient practical teaching capabilities. The two-way talent exchange mechanism between schools and enterprises is inefficient, making it difficult for corporate technical experts and industry professionals to teach full-time. Additionally, the management and evaluation systems for part-time faculty are inadequate. The recognition, training, and incentive mechanisms for dual-qualified teachers are incomplete, and a regularized system for faculty internships in enterprises has yet to be established.

The practical teaching system remains underdeveloped, with the delayed construction of practical training bases. On-campus training facilities are outdated and disconnected from frontline industrial production equipment, failing to simulate real-world work scenarios. Off-campus training bases are insufficient in number and lack robust operational mechanisms, resulting in student internships that primarily involve basic observation and simple operations rather than hands-on experience in core technical positions. The practical teaching evaluation system is overly simplistic, focusing excessively on outcomes while neglecting the learning process, leading to inadequate assessment of students' practical skills and professional competencies^[9].

4. Innovation in the vocational undergraduate talent cultivation model empowered by industry-education integration

Based on the development needs of modern industrial clusters in Hainan Free Trade Port, and with deep integration of industry and education as the core, an innovative vocational undergraduate talent cultivation model has been established. This model features multi-party collaboration among "government, park, schools, enterprises, and industries" and integrates six dimensions: "positions, courses, competitions, certifications, innovation, and research." It achieves coordinated efforts among multiple stakeholders, comprehensive educational integration throughout the entire process, and holistic capability development.

4.1. Multi-dimensional collaboration: Building an educational community of "government-park-school-enterprise-industry" partnership

Guided by the principles of government-led coordination, industrial park infrastructure support, enterprise-driven participation, academic institution-led implementation, and industry-standard orientation, we establish a "five-in-one" talent cultivation ecosystem. The government introduces incentive policies for industry-education integration, coordinates industrial talent demands, and builds school-enterprise collaboration platforms. Industrial parks consolidate enterprise resources within their zones to establish training bases and implement customized talent development programs through partnerships with educational institutions. Enterprises provide authentic job positions, technical standards, and practical training resources while participating throughout the talent development process. Vocational undergraduate colleges fulfill their primary educational responsibilities by optimizing academic programs and delivering instruction. Industry associations formulate professional competency standards and conduct talent quality assessments, creating a collaborative talent development mechanism characterized by clear accountability, coordinated efforts, shared benefits, and risk-sharing mechanisms^[10].

4.2. Target positioning: High-level technical and skilled personnel for industry integration

Closely aligned with the job market demands of modern industrial clusters in the Free Trade Port, we have established a training objective centered on “integrating moral education with technical skills, combining work and study, anchoring in free trade practices, and serving industrial development.” Our program cultivates high-level interdisciplinary technical professionals equipped with solid theoretical foundations, exceptional vocational competencies, strong professional ethics, global perspectives, and innovative capabilities. Graduates will be qualified for advanced technical, managerial, and service roles while adapting to industrial transformation and upgrading needs, ensuring comprehensive alignment between talent development, industrial positions, sectoral growth, and Free Trade Port construction initiatives.

4.3. Core system: Establishing an integrated framework of “position-course-competition-certification-innovation-research” with six dimensions

- (1) Curriculum-Position Alignment: The curriculum system is restructured based on industrial job requirements. Through in-depth research on competency standards for core positions in free trade port industrial clusters, we break down essential skills, knowledge, and literacy requirements to design courses in reverse engineering. Outdated courses are phased out while integrating cutting-edge technologies, processes, and industry standards. School-enterprise collaborative materials and project-based textbooks are developed. Modular teaching approaches are implemented to deeply integrate theoretical and practical courses, increasing practical component ratios to ensure seamless alignment between curriculum content and job market demands.
- (2) Integration of Competency Certification: Enhance skill development through vocational competitions and certification programs by incorporating vocational skill level certificates and industry qualification assessments into specialized curricula. Implement a certificate-integrated teaching model to synchronize academic education with vocational certification evaluations. Align with national and provincial vocational skills competitions related to free trade port industries, integrating competition content into daily instruction to leverage competitions as learning and teaching catalysts, thereby elevating students’ skill proficiency.
- (3) Innovation-Research Synergy: By integrating innovative practices and scientific research to enhance capabilities, we align with the industrial innovation needs of the free trade port. This includes offering entrepreneurship courses and establishing innovation incubation platforms to cultivate students’ innovative thinking and entrepreneurial skills. We also promote collaboration between academic institutions and enterprises in technology R&D and project breakthroughs, guiding students to participate in real-world corporate projects and research initiatives. This approach seamlessly integrates teaching processes with R&D workflows, significantly boosting students’ technological innovation and practical application competencies.

4.4. Teaching model: Implementation of work-study integration and practical education

The study implements a four-phase practical teaching model integrating “corporate awareness cultivation + on-campus training + industrial park internships + corporate job placements” to strengthen holistic practical education. Through project-based, case-based, and scenario-based teaching methods, we incorporate authentic corporate projects to enhance students’ skills through real-world application. The dual-mentor system (in-house faculty + corporate technical mentors) ensures comprehensive guidance throughout teaching, training, and internships. Drawing inspiration from Hainan’s “peak employment during peak seasons, off-season learning” model, we flexibly adjust teaching schedules and internship arrangements according to seasonal variations in tourism and service industries, achieving seamless work-study integration with precise alignment.

5. Implementation pathways for empowering vocational undergraduate talent cultivation through industry-education integration

5.1. Optimize the dynamic adjustment mechanism for specialties to achieve precise alignment with industrial clusters

Establish a monitoring and early warning mechanism for industrial talent demand, collaborating with industry associations, industrial parks, and leading enterprises to regularly publish free trade port industry talent demand reports and dynamically adjust academic program offerings. Prioritize developing specialized programs aligned with key free trade port industries such as digital economy, biomedicine, deep-sea technology, shipping logistics, and green construction, creating distinctive program clusters that integrate with industrial clusters. Phases out programs that are disconnected from industrial development and have low employment rates, ensuring program offerings keep pace with industrial cluster upgrades and achieve precise alignment.

5.2. Improve the multi-stakeholder collaboration mechanism and deepen the integration of industry and education

Strengthen the government's coordinating role by implementing certification programs for industry-education integration enterprises, tax incentives, and financial support policies to boost corporate engagement in talent development. Establish provincial-level information-sharing platforms for industry-education collaboration to streamline supply-demand matching channels between schools and enterprises. Promote joint initiatives between vocational undergraduate institutions and industrial parks/leading enterprises to establish modern industrial colleges and municipal industry-education alliances, jointly managing training bases, teaching teams, and curriculum development. Implement a shared-interest mechanism that clearly defines rights, responsibilities, and profit distribution between schools and enterprises, fostering deep integration and collaborative talent cultivation.

5.3. Deepening curriculum teaching reform and implementing the integration of job-course-competition-certification-innovation-research

With job competencies as the core, we will reconstruct a modular and project-based curriculum system, increase investment in practical teaching to ensure it accounts for no less than 50% of total instructional hours. Schools and enterprises will jointly develop industry-aligned textbooks and teaching resources, integrating free trade port industrial policies and international industry standards into curricula. We will fully implement the integration of academic credentials and vocational certifications, as well as competition-based education, incorporating skill certification assessments and competition training into talent development plans. Innovative teaching methods will be adopted, utilizing information technologies such as virtual simulation and digital twins to create immersive and intelligent training classrooms, thereby enhancing teaching effectiveness.

5.4. Establishing a robust mechanism for building a dual-qualified faculty team

Refine the certification, training, and incentive systems for dual-qualified teachers while establishing clear evaluation criteria. Develop a two-way talent exchange mechanism between schools and enterprises, implementing a fast-track program for corporate technical experts to join faculty positions with relaxed academic qualifications and professional title requirements. Engage industry experts and skilled craftsmen as adjunct instructors. Regularly organize professional teachers to undertake on-the-job training in enterprises and industrial parks while participating in technological R&D to enhance practical teaching capabilities. Form cross-disciplinary teaching teams integrating academic and industry expertise to achieve complementary strengths in theoretical instruction and hands-on education.

5.5. Improve practical teaching platforms and enhance practical education capabilities

Increase investment in practical training base development by establishing collaborative on-campus production-oriented training facilities with enterprises, incorporating cutting-edge industrial equipment and technologies to create authentic work environments. Leveraging key industrial parks in the free trade port, develop stable, high-quality off-campus internship bases while implementing the “school within factory, factory within school” educational model. Construct virtual simulation training centers to address challenges in teaching high-risk and high-cost practical training programs. Refine the practical teaching evaluation system by establishing a multi-stakeholder assessment mechanism involving faculty, industry mentors, and professional associations to comprehensively evaluate students’ practical competencies and professional qualities.

5.6. Highlighting Free Trade Port characteristics and promoting international talent development

Building on the free trade port’s open-door positioning, we will introduce international vocational education standards, high-quality curriculum resources, and certification systems to offer international programs in foreign service, global commerce, and cross-border cultural tourism. Through strengthened collaboration with overseas vocational institutions and multinational corporations, we will implement joint training initiatives and faculty-student exchanges. By enhancing foreign language proficiency and cross-cultural communication skills, we aim to cultivate high-level technical professionals tailored to the international industrial development needs of the free trade port.

6. Conclusion

The high-quality development of modern industrial clusters in Hainan Free Trade Port relies heavily on vocational undergraduate education supported by industry-education integration. While Hainan has made progress in cultivating vocational undergraduates, challenges persist, including mismatched program offerings, superficial industry-academia collaboration, outdated curricula, insufficient faculty resources, and underdeveloped practical training systems. Building on theories of collaborative governance and industrial clustering, we propose an innovative talent development model featuring “government-industry-academia-enterprise-community” multi-stakeholder synergy and a “position-course-competition-certification-innovation-research” integrated framework. By optimizing program structures, enhancing collaborative education, reforming teaching methodologies, strengthening faculty teams, upgrading practical platforms, and advancing internationalization efforts, this approach can effectively address talent cultivation challenges, elevate educational quality, and achieve precise alignment between vocational education and the Free Trade Port’s modern industrial ecosystem.

Going forward, as Hainan Free Trade Port enters the full operational phase and modern industrial clusters continue to evolve, vocational undergraduate education must align closely with the trends of industrial digitalization, intelligent transformation, and globalization. This requires deepening integration among industry-education collaboration, scientific research, and industrial innovation while continuously optimizing talent cultivation models. We should further explore sustainable mechanisms for industry-education partnerships, diversified funding channels, and personalized learning approaches to establish a distinctive vocational education brand reflecting Hainan Free Trade Port’s unique characteristics. By enhancing the relevance and adaptability of talent development programs, we can provide high-quality technical professionals to support the growth of modern industrial clusters, thereby contributing to Hainan Free Trade Port’s role as a model for reform and opening-up in the new era.

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References

- [1] Xia SW, Luan C, 2025, Mechanisms, Challenges, and Approaches of Industry-Education Integration in Vocational Education under Digital Transformation. *Research on Ethnic Education*, 36(06): 119–127.
- [2] Hainan Free Trade Port Initiates Full Island Customs Closure, Marking a New Chapter in China’s Opening-up, 2025, *China Chief Accountant*, (12): 9.
- [3] Dong Y, 2025, “A Critical Leap” Pushes Hainan Free Trade Port into a New Stage of Comprehensive Institutional Openness. *Modern Financial Guide*, (12): 4–9.
- [4] Xia SW, Luan C, 2025, Mechanisms, Challenges, and Approaches of Industry-Education Integration in Vocational Education under Digital Transformation. *Research on Ethnic Education*, 36(06): 119–127.
- [5] Yi LY, 2025, Research on the Construction Path of Industry-Education Integration in Vocational Undergraduate Education from the Perspective of New Quality Productivity. *High Technology and Industrialization*, 31(12): 59–61.
- [6] Gong L, Zheng Y, 2025, Research on the Construction of Industry-Education Integration Community Driven by Digital Intelligence from the Perspective of New Quality Productivity. *High Technology and Industrialization*, 31(12): 40–43.
- [7] Liu B, Li SH, Gao X, et al., 2025, Analysis of High-Quality Development in the Food Industry and Talent Cultivation Pathways in Higher Education from the Perspective of Innovation-Driven Development. *Food Engineering*, (04): 104–108.
- [8] Jiao JH, Liang YX, 2025, Policy-awareness-driven Sports Industry-Education Integration Entrepreneurial Chain: An Empirical Study on Regional Differentiation Based on 12 Schools in Guangdong. *Anhui Sports Science and Technology*, 46(06): 1–5.
- [9] Jia YY, 2025, Research on Innovation of Higher Vocational Education Management Mechanism Driven by Industry-Education Integration and Digital Transformation. *Taste·Classics*, (24): 84–87.
- [10] Yang JQ, 2025, Research on the Construction Practice of Modern Industrial Colleges from the Perspective of Industry-Education Integration. *Science and Technology Wind*, (36): 160–162.

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