

# Research on Innovation and Practice Path of Industry-Education Integration Model for Big Data Specialty under the Background of Hainan Free Trade Port

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**Abstract:** Within the strategic context of institutional openness and deep digital economy development in Hainan Free Trade Port, the big data industry has emerged as a core engine driving regional economic transformation, leading to a structural surge in demand for interdisciplinary and application-oriented technical professionals. Current industry-education integration practices face deep-seated bottlenecks, including fragmented collaboration mechanisms, outdated curriculum systems, and disconnected practical scenarios, making it difficult to effectively align with the precise requirements of a free trade port for data-driven talent. Grounded in industry-education integration theory and industrial ecosystem theory, this study systematically analyzes the demand characteristics and integration status of Hainan Free Trade Port's big data sector, identifies structural contradictions in school-enterprise collaboration, and innovatively proposes an industry-education integration model centered on "demand precision, collaborative depth, and dynamic pathways." By establishing a four-pillar collaborative mechanism featuring "government guidance, industry leadership, school participation, and enterprise engagement," reconstructing modular curriculum systems, designing tiered practical training pathways, and improving dynamic evaluation and policy incentive frameworks, the study establishes replicable and scalable operational paradigms. Focusing on logical coherence and practical applicability in model design while minimizing empirical data dependence, the research emphasizes value co-creation aligned with real industrial needs, providing systematic solutions for big data talent cultivation in free trade ports to effectively support high-quality coordinated development of the digital economy and industrial ecosystems.

**Keywords:** Hainan Free Trade Port; Big data specialty; Industry-education integration; Free trade port innovation; Big data pathway for free trade port development

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## 1. Introduction

As a pivotal national strategic initiative, Hainan Free Trade Port is accelerating the restructuring of its digital economy ecosystem through institutional reforms, with the big data industry emerging as the core engine driving regional economic transformation. According to the "General Plan for Hainan Free Trade Port Development," the port aims to establish

itself as a global hub for cross-border data flows, fostering emerging sectors like massive data processing and intelligent analytics. This growth has created multifaceted demands for big data professionals who must combine technical expertise, industry insights, and international perspectives. However, current higher education systems face significant gaps between talent cultivation and industrial needs: industry-academia integration remains superficial and fragmented, corporate partnerships lack sustainable mechanisms, curricula lag behind technological advancements, and practical training fails to align with real-world industrial scenarios. These issues not only compromise talent quality but also hinder the efficient development of the digital economy ecosystem. Grounded in Hainan Free Trade Port's strategic positioning, this study focuses on innovative industry-academia collaboration models and implementation pathways for big data disciplines. It seeks to address the "hot schools, cold enterprises" dilemma, promote organic integration of educational frameworks, talent pipelines, and industrial chains, and provide sustainable talent support for regional economic development.

## **2. Demand analysis of big data industry for Hainan Free Trade Port construction**

### **2.1. Policy-driven value release of data elements in free trade ports**

Free trade ports have implemented institutional open policies such as "zero tariffs, low tax rates, and simplified tax systems," accelerating the global aggregation and cross-border flow of data resources. The explosive growth of sectors like cross-border e-commerce and offshore financial services has created rigid demands for core capabilities, including real-time data analysis and user behavior modeling <sup>[1]</sup>. As a new production factor, data's value realization depends on professionals' systematic mastery of its entire lifecycle (collection, governance, analysis, and application). Guided by policy initiatives, the big data industry has evolved from a "supportive role" to a "core productive force," with talent requirements expanding from single technical positions to multidisciplinary roles such as cross-border data compliance engineers and industry solution architects.

### **2.2. Expanding talent competency boundaries in industrial scenarios**

The tourism industry, modern service sectors, and high-tech industries prioritized for development in free trade ports all require deep integration of big data capabilities. The tourism sector must optimize service experiences and consumer decision-making through multimodal tourist profiling, while modern service industries need data-driven approaches to enhance supply chain coordination efficiency and risk management capabilities. High-tech industries rely on data intelligence to accelerate R&D iterations and product innovation. This demands big data professionals with cross-domain knowledge transfer skills, capable of precisely integrating technical tools (such as machine learning and privacy-preserving computing) with industry pain points. Traditional education systems overemphasize algorithm theory and tool operation training while neglecting scenario-based application competency development, resulting in graduates experiencing prolonged adaptation cycles and significant skill gaps in real-world business environments.

In summary, the demand for big data professionals in free trade ports exhibits three-dimensional characteristics: "high complexity (technology + industry + international regulations), strong contextual relevance (deep industrial integration), and internationalization (cross-border compliance capabilities)." This trend compels the industry-education integration model to transition from superficial resource alignment to profound ecosystem collaboration.

## **3. Current status and challenges of industry-education integration in big data specialization**

### **3.1. Limitations of existing integration models**

The mainstream talent integration model primarily relies on "order-based training programs" or "corporate campus visits," resulting in low enterprise engagement and lack of long-term planning <sup>[2]</sup>. Schools dominate curriculum design while companies provide only limited practical training positions, leading to a disconnect between academic content and

industrial technological advancements. For instance, courses still focus on traditional data processing techniques while neglecting cutting-edge fields like cloud computing and AI integration. Internship programs often adopt assembly-line-style operations, offering limited opportunities for immersive engagement in real business processes. This “one-way talent delivery” model creates a misalignment between workforce competencies and industry demands, resulting in generally low corporate satisfaction rates.

### **3.2. Lack of collaborative mechanisms and capability gaps**

The primary challenge lies in fragmented collaborative mechanisms. The four key stakeholders, government, industries, schools, and enterprises, lack effective communication platforms, resulting in policy benefits failing to translate into integrated actions. Rapid updates in industry standards contrast sharply with the lengthy curriculum renewal cycles in schools, creating a significant “technological generation gap.” Secondly, there is a pronounced talent competency gap: students lack industry awareness and practical thinking skills, while companies struggle to recruit immediately employable talent through campus recruitment<sup>[3]</sup>. Additionally, the evaluation system remains overly simplistic, over-relying on exam scores while neglecting project-based competencies and innovative thinking, further undermining the effectiveness of integration efforts.

The fundamental reason lies in the fact that the integration model does not start from the actual industrial demands but ends with the educational process. Without reconstructing the collaborative logic, industry-education integration will fall into a ‘formalization trap,’ making it difficult to meet the free trade port’s urgent need for interdisciplinary talents.

## **4. Theoretical basis for innovation in industry-education integration models**

### **4.1. Theoretical evolution and applicability of industry-education integration**

Traditional theories on industry-education integration focus on “school-enterprise collaboration,” emphasizing resource complementarity. Modern theories have evolved into “ecological synergy,” highlighting the symbiotic relationships among industrial chains, educational systems, and talent pipelines. Within the strategic framework of Hainan Free Trade Port, an “openness” dimension must be incorporated, where cross-border data flows require professionals with global perspectives, and integration models must transcend geographical boundaries to leverage worldwide industrial resources. Research indicates that successful integration should anchor itself in real industrial demands rather than relying solely on unilateral educational outputs. For instance, dynamic shifts in industry needs (such as the widespread adoption of RPA automation tools) necessitate educational systems with agile responsiveness capabilities.

### **4.2. Special characteristics and integration compatibility of big data majors**

Big data disciplines exhibit distinct characteristics compared to traditional engineering fields, featuring rapid technological iteration cycles, broad application scopes, and pronounced interdisciplinary features<sup>[4]</sup>. This necessitates an integration model with “dynamic adaptability”: course content must be updated in real-time with technological advancements, while teaching scenarios should closely mirror authentic industry data environments. Big data professionals require dual competencies in technical expertise and business acumen, with integration design incorporating soft modules such as business analytics and ethical compliance. The theoretical framework emphasizes a “dual-wheel drive” approach, balancing technical skill development with industry-specific knowledge cultivation, to avoid falling into the trap of purely technical training.

This theoretical foundation provides logical support for model innovation: integration is not merely additive, but a systematic project that reconstructs the educational ecosystem with industrial needs as its core.

## 5. Core elements and design concepts of innovative models

### 5.1. Core elements: Precise alignment with industry needs

Demand identification serves as the foundational logic for integration. Pattern innovation necessitates establishing a routine demand identification mechanism led by industry alliances, which regularly collects corporate technical pain points and talent gaps to generate dynamic demand inventories. For instance, addressing cross-border data compliance requirements in free trade ports, the inventory must precisely specify skill requirements for “Data Security Engineer” positions (such as GDPR compliance adaptation and encryption technology applications). These demand inventories directly drive curriculum restructuring, ensuring teaching content remains synchronized with cutting-edge industrial technologies.

### 5.2. Deep integration of university-enterprise collaboration

To transcend the limitations of traditional ‘superficial collaboration’, we propose a ‘four-dimensional synergy’ mechanism as follows:

- (1) Government guidance: Formulate integrated incentive policies, such as tax reductions and special project funding support, to strengthen the endogenous motivation for enterprises’ deep involvement;
- (2) Industry-led initiative: Establish a Big Data Industry-Education Integration Committee, with leading enterprises taking the lead in formulating capability standards and technical specifications;
- (3) School focus: Restructuring the teaching system by translating real-world business scenarios from enterprises into course modules;
- (4) Corporate deep involvement: Dispatching technical experts as industry mentors to participate throughout the course design and practical training case development.

The design emphasizes a “two-way empowerment” mechanism, where schools provide talent resources, and enterprises input technological scenarios and business requirements, forming a value co-creation closed loop. This design avoids the trap of “formal integration,” ensuring that all stages serve the precise enhancement of talent capabilities and deep alignment with industrial demands.

## 6. Construction and implementation strategies of practical pathways

Innovative models require systematic implementation pathways to achieve practical transformation. This study proposes a tripartite implementation strategy of “platform-course-practical training” to establish a closed-loop system integrating conceptual frameworks with tangible outcomes<sup>[5]</sup>.

### 6.1. Platform construction requires identification and innovation of collaborative mechanisms

The provincial big data industry-education integration hub platform integrates resources from government agencies, industries, educational institutions, and enterprises, featuring three core functional modules: Demand Matching Center (regularly publishing dynamic reports on industrial technology needs and talent gaps), Project Incubation Pool (systematically collecting real business challenges from enterprises and transforming them into teaching project databases), and Resource Sharing Repository (continuously aggregating industry case studies, technical documentation, and practical training tools). The platform innovatively adopts a “leading enterprise rotation system”, where different industry leaders conduct demand research and compile requirement lists quarterly, establishing a review process for requirement lists to effectively avoid bureaucratic inertia caused by unilateral government initiatives (e.g., when tourism companies submit “visitor flow forecasting” projects, school teams undertake development with full technical guidance from corporate experts), significantly enhancing the precision and timeliness of demand response<sup>[6]</sup>. Serving as an integration hub, the platform eliminates information asymmetry, transforming school-enterprise collaboration from sporadic partnerships to institutionalized coordination, thereby providing infrastructure support for precise alignment between industrial demands

and educational offerings.

## 6.2. Modular design of curriculum restructuring and project-based teaching

The implementation of a “three-dimensional modular” curriculum restructuring: The foundational technology module retains core knowledge systems such as data structures and machine learning to ensure solid technical foundations; the industry application module deeply integrates with key industries of the free trade port (e.g., offshore finance, smart logistics), developing scenario-based teaching cases (e.g., anti-fraud model construction for offshore financial transactions, route optimization analysis for smart logistics); the innovation practice module focuses on real enterprise challenges (e.g., compliance process design for cross-border data flows), driving student teams to develop solutions. The teaching methodology innovates with a “dual-mentor project-driven approach,” where students work in groups on corporate projects under joint guidance from university faculty and industry technical experts, achieving classroom value transformation through “teaching as production.” For instance, addressing cross-border data flow requirements, students must design data processing workflows compliant with GDPR regulations rather than merely learning theoretical algorithms, ensuring simultaneous knowledge internalization and skill development. This design breaks through traditional course fragmentation, forming a “foundational-application-innovation” competency progression chain that keeps teaching content synchronized with cutting-edge industrial technologies.

## 6.3. Hierarchical progression of the practical training system and closed loop of value transformation

A practical training system featuring “three-tier progression, deep integration, and value closed-loop” should be established using the design as follows:

- (1) Hierarchical progressive design: The beginner level focuses on fundamental data tool operations (e.g., Python data cleaning, SQL queries); the intermediate level simulates typical industry scenarios (e.g., clustering analysis of e-commerce user behavior); and the advanced level involves deep engagement in real enterprise operations (e.g., real-time scheduling optimization project for cross-border logistics in free trade ports);
- (2) Industry scenario integration: Enterprises provide open and anonymized production data environments, enabling students to train on real business datasets to enhance practical data processing skills and industry-specific understanding;
- (3) Value transformation mechanism: Establish evaluation and application channels for outstanding practical training outcomes. For instance, student-developed tourist behavior analysis models for tourism enterprises can be directly applied to enterprise service optimization systems, forming a closed-loop cycle of “practical training–application–feedback”.

The system adopts a competency progression pathway of “tool operation → scenario simulation → business practice,” enabling students to hone their skills in real industrial environments. This ensures that training outcomes are translated into actual corporate productivity, effectively addressing the inefficiency dilemma of traditional training methods that prioritize mechanical execution over substantive learning.

In summary, the “Three-in-One” implementation strategy integrates resources through platform hubs, aligns curriculum systems with industrial scenarios, and enhances competency training via practical training systems. This approach establishes a closed-loop process encompassing “demand identification–teaching transformation–competency output,” achieving seamless alignment between student skill development and industry needs. It provides actionable practical models for transitioning industry-education integration from conceptual frameworks to tangible outcomes.

## 7. Safeguard mechanisms and sustainable development

### 7.1. Policy and incentive mechanism construction for integrated ecosystem

The government should establish specialized policies to clarify the boundaries of responsibilities among stakeholders

in industry-education integration. For instance, a dedicated fund could be created for “Industry-Education Integration Demonstration Projects” to provide tax incentives for deeply involved enterprises, while an “Integration Contribution Assessment System” should be implemented to incorporate corporate participation into industry qualification evaluation criteria. Concurrently, school performance evaluation mechanisms should be enhanced by incorporating industry-education integration outcomes into faculty promotion metrics. The core of incentive mechanisms lies in “positive reinforcement,” driving enterprises to transition from passive participation to proactive engagement.

## **7.2. Quality assessment and dynamic optimization to ensure model iteration**

Building a “Dual Circulation” Evaluation System: Process evaluation integrates corporate feedback, student competency assessments, and real-time project completion monitoring to assess integration effectiveness<sup>[7]</sup>. Dynamic optimization is implemented by quarterly updates to requirement lists and course content based on evaluation results (e.g., promptly adding practical training modules addressing corporate feedback on “insufficient AI model deployment capabilities”). The evaluation system moves beyond single-data reliance by synthesizing multidimensional indicators, including corporate satisfaction, student employment outcomes, and project implementation rates, creating a continuous improvement cycle. Sustainable development hinges on endogenous mechanism development, when integration forms a “community of shared interests” among stakeholders, the model achieves self-sustaining operation without external coercion.

## **8. Conclusion**

The institutional innovations of Hainan Free Trade Port have created strategic opportunities and institutional frameworks for industry-education integration in big data disciplines. Through systematic analysis of industrial demands, identification of integration bottlenecks, theoretical framework development, and design of innovative models with practical implementation pathways, this study proposes a new industry-education integration paradigm centered on “precision demand alignment, deepened collaboration, and dynamic pathways.” Rooted in real-world industrial needs, this paradigm achieves ecological synergy among education systems, talent development, and industrial chains through platform-based collaborative mechanisms, project-based teaching frameworks, and scenario-driven training approaches. Its core value lies in overcoming the fragmentation challenges of traditional integration models, establishing replicable operational logic characterized by government guidance, industry leadership, institutional accountability, and enterprise-driven participation. In the future, as the data factor market in free trade ports deepens and technological iterations accelerate, the demand for big data professionals will exhibit diversified and advanced trends. Innovative models require continuous iteration by integrating cutting-edge technologies such as generative AI and privacy-preserving computing, while strengthening international compliance capabilities. However, the core principle remains consistent: the essence of industry-education integration lies in “value co-creation.” Only by anchoring efforts to industrial needs can we unleash talent supply efficiency and support high-quality development of the digital economy in free trade ports. This study provides theoretical references and operational frameworks for regional industry-education integration practices, paving the way for exploring cross-regional collaboration mechanisms to facilitate broader implementation of these models.

## **Disclosure statement**

The author declares no conflict of interest.

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