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Research on the Coordinated Development of Vocational Education Professional Clusters and Regional Industrial Chains under the New Forms of Employment

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Abstract: The emergence of new employment models has introduced characteristics such as platformization, flexibility, and multifunctionality, creating a structural contradiction between the dynamic industrial demands of industry-education collaboration and the stable supply of education. This paper analyzes three layers of practical contradictions and deep integration barriers, establishes a four-dimensional collaborative framework encompassing technological integration, talent adaptation, functional coupling, and spatial agglomeration, proposes a systematic implementation pathway, and promotes deep alignment between the education chain, talent chain, industrial chain, and innovation chain.

Keywords: Professional clusters; Industrial chain collaboration; Talent training model; Integration of industry and education

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1. Introduction

Platform economy, sharing economy, and gig economy have spawned emerging posts such as cross-border e-commerce, digital marketing, and smart supply chain. Employment has evolved into a new landscape characterized by platformization, flexibility, and compound skill requirements, which poses prominent challenges to the organic integration of the education chain, talent chain, industrial chain, and innovation chain.

2. Practical challenges: Three structural contradictions under the new forms of employment

2.1. The contradiction between accelerated digital occupational iteration and lagging traditional professional structures

In the digital economy era, digital technologies evolve following an exponential growth trajectory. On one hand, the life cycles of various occupations experience drastic contraction. Emerging vocational roles covering AI trainers, blockchain engineers, and low-altitude economy operation specialists emerge every quarter or even every month, whose iterative velocity far surpasses the responsive capacity embedded within traditional educational institutional frameworks. On the other hand, the disciplinary architecture of vocational education suffers remarkable institutional hysteresis. The whole review and approval workflow for a new major setup is complicated and time-consuming, which normally takes two to three years from preliminary industrial research to official major filing. The updating rhythm of disciplinary and specialty catalogs fails to align with the fast iteration of digital technologies, thereby creating a conspicuous chronological gap between institutional talent cultivation and real industrial competency demands.

Fundamentally, such structural antagonism is embodied as a spatio-temporal disconnection between educational knowledge provision and industrial skill requirements. Educational resources carry inherent rigid attributes: teaching faculty's knowledge frameworks refresh sluggishly, practical training hardware falls behind technological upgrades, and curriculum contents cannot mirror state-of-the-art industrial practices. More importantly, conventional major construction paradigms rest upon relatively static occupational categorization frameworks, yet the high dynamism featured by the digital economy thoroughly overturns this core foundational hypothesis, imposing unparalleled adaptive pressures and challenges on vocational education systems.

2.2. The contradiction between employment model transformation and organizational adaptability of school-enterprise collaboration

The new forms of employment epitomized by platform-driven gig work fundamentally erode the stable institutional underpinning of industry-education integration. Within this emerging employment context, labor mobility surges substantially. Statistics released in the *2024 Flexible Employment Report* indicate that the average occupational tenure has shrunk to merely 2.3 years, while cross-platform concurrent work has evolved into a prevalent labor norm. Such profound shifts in workforce engagement patterns exert far-reaching repercussions on conventional school-enterprise collaborative frameworks: enterprises face mounting uncertainty regarding the return on their cooperative investments, and long-term outlays dedicated to talent development carry substantial risks of unrecovered costs.

This incompatibility-driven structural conflict manifests three distinct adverse repercussions for school-enterprise partnerships. To begin with, diversified post-graduation career options among students render tailored order-based training regimes obsolete. Secondly, corporate willingness to allocate resources for hands-on training diminishes, stemming from pervasive concerns that internally nurtured skilled personnel will eventually transfer to rival market entities. Thirdly, the established equilibrium mechanism governing benefit distribution within joint school-enterprise talent cultivation collapses, eliminating persistent incentives that drive corporate engagement. Delving into the root cause, the widespread adoption of flexible labor arrangements has restructured the organizational architecture of the labor market, rendering legacy industry-education cooperation models premised on permanent, stable employment contracts incapable of

adapting to today's highly mobile workforce landscape.

2.3. The regional structural contradiction between industrial upgrading and talent supply

Regional industrial restructuring and upgrading generate escalating demand for high-level, interdisciplinary talents, as emerging sectors see drastically rising requirements for digital literacy, innovative capacity and cross-disciplinary expertise. Nevertheless, a prominent structural incongruity exists between the supply of vocational education and industrial labor demands, which can be categorized into three dimensions. To start with, there lies a spatio-temporal mismatch: the 3–4-year cycle of talent training is drastically misaligned with the 1–2-year cycle of industrial technological renewal, leaving educational institutions unable to forecast and accommodate fast-evolving technical requirements. Next comes quality mismatch: graduates' skill portfolios deviate markedly from practical corporate expectations, as conventional skill training schemes fail to satisfy competency criteria for emerging domains including intelligent manufacturing and digital twin technology. The third dimension refers to disjointed standards: talent development benchmarks lag behind industrial technical specifications and occupational competency frameworks, and credential accreditation systems lack coherent linkage with vocational qualification frameworks.

Such structural misalignment manifests most acutely on a regional scale. Advanced manufacturing agglomerations suffer acute deficits of high-end technical practitioners, whereas graduates from conventional majors face labor market surplus. When coping with regional industrial upgrading, existing industry-education collaborative frameworks display systematic inertia and insufficient adaptive capacity [1].

3. Deep-seated dilemmas: Systemic barriers hindering the integrated development of industrial chains and talent chains

3.1. The structural contradiction between high-end industrial chains and low-end talent supply

The advancement of high-end industrial chains generates growing demands for talents equipped with advanced and interdisciplinary competencies, whereas the talent provision system is plagued by grave structural disequilibrium. For one thing, emerging industries are confronted with a high-skilled labor shortage totaling 20 million, especially in pivotal sectors including semiconductors, industrial software, and artificial intelligence, which imposes prominent constraints on industrial progression. For another, the automated transformation of traditional manufacturing has eliminated massive low-skill vacancies, thereby giving rise to the contradictory coexistence of vacant posts lacking competent employees and unemployed workers without matching occupational openings [2].

3.2. The spatial-temporal mismatch between technological innovation demand and lagging talent cultivation

The exponential advancement of digital technologies has drastically compressed the life cycles of various occupations and continuously spawned novel digital vocational categories. Nevertheless, the vocational education system is trapped in conspicuous institutional hysteresis, featured by cumbersome, time-consuming specialty approval procedures and catalog update rhythms that fail to keep pace with rapid technological iteration. Such spatio-temporal disconnection creates a stark temporal dislocation between talent training

cycles and industrial technological renewal cycles, disabling educational institutions from proactively forecasting and dynamically accommodating fast-evolving technical competency requirements from industries [3].

3.3. Resource integration challenges caused by imperfect industry-education collaboration mechanisms

The implementation of industry-education integration is permeated by the ubiquitous predicament of "superficial amalgamation without substantive convergence and nominal collaboration devoid of practical execution," wherein school-enterprise alliances merely adopt disjointed discrete cooperation rather than establishing holistic industrial-chain ecological frameworks. When designing disciplinary architectures, vocational institutions overlook comprehensive systematic investigation of clustered occupational roles, leaving them unable to accurately pinpoint core nodal segments of industrial chains for overarching integrated planning. A host of restrictive impediments endure within institutional and operational frameworks: disparate participation motivation between vocational academies and industrial corporations, perfunctory short-term collaborative programs, incomplete standardized governance systems, alongside the deficiency of sophisticated operational mechanisms for equitable revenue distribution and shared risk aversion [4].

3.4. Institutional barriers to deep integration caused by inadequate policy systems

Though central and local administrative authorities have issued a portfolio of policy instruments to advance industry-education integration, the majority of such documents retain broad, abstract wording without concrete, enforceable regulatory clauses and detailed implementing provisions. The long-standing evaluative bias that prioritizes academic publications and professional rank credentials continues to dominate talent assessment mechanisms, intellectual property safeguarding measures remain inadequate, and cross-departmental policy synergy stays insufficient. Pronounced structural skewness prevails in talent allocation: while the overall employment landscape presents grim prospects, industrial sectors suffer acute shortages of specialized technical personnel. As stated in *China Digital Economy Talent Development Report (2025)*, the digital economy faces a talent deficit of approximately 30 million, with the scarcity of high-end interdisciplinary composite talents standing as an especially acute bottleneck [5].

3.5. The disconnect between the education and training system and industrial demand

The vocational education ecosystem is encumbered by an array of endogenous structural defects. To begin with, these institutions maintain a comparatively modest strategic positioning in their operational governance and are constrained by limited capabilities to consolidate heterogeneous educational and industrial resources. Secondly, antiquated instructional frameworks dominate daily teaching practices, paired with an overemphasis on theoretical coursework that marginalizes hands-on skill cultivation. Thirdly, the contingent of "dual-qualified" teaching staff commonly lacks robust competencies to provide industrial technical services and carry out independent technological research and innovation. Fourthly, practical training hardware fails to satisfy industrial benchmarks, manifested by inadequate equipment reserves and functionally outdated physical installations. Taken together, these interwoven defects engender marked dissonance between the talent cultivation frameworks deployed by vocational colleges and the authentic competency prerequisites of corporate occupational posts [6].

4. Theoretical mechanisms: A four-dimensional logical framework underpinning coordination between vocational education and regional industries

Serving as an indispensable prop underpinning the advancement of modern industrial systems, the coordinated interplay between vocational education and regional industrial sectors can be systematically unpacked across four analytical dimensions: technological integration, talent matching, functional coupling, and spatial agglomeration.

4.1. Technological integration dimension: Collaborative innovation of industrial clusters–technology clusters–professional clusters

Following the intrinsic logic of "industrial clusters–technology clusters–professional clusters," this dimension constructs an industry-education integration ecosystem centered on technological innovation. By bridging basic research and applied transformation, it achieves a positive interaction between knowledge production and knowledge application, forming an industrial cluster development model based on technological interconnectedness. Vocational education professional cluster development precisely matches the technological nodes of industrial chains, establishing a mapping model of "industrial chain nodes–core competencies of professional clusters" [7].

As a critical vehicle for technological skill accumulation, vocational education achieves systematic transmission and innovative development of technological knowledge through professional cluster development, promoting the co-evolution of technology clusters and industrial clusters. At the practical level, the establishment of industrial technology research institutes drives technology R&D and transformation; the introduction of authentic enterprise technical standards in the construction of industry-education integration training bases; the integration of technological projects into teaching processes to form project-based curriculum systems; and the joint establishment of teaching teams by schools and enterprises to serve industrial digital transformation. These measures effectively address the spatial-temporal mismatch between technological innovation and talent cultivation, achieving organic integration of education chains and innovation chains.

4.2. Talent alignment dimension: Supply-demand balance of industrial chains–talent chains–education chains

Following the logical framework of "industrial chains–talent chains–education chains," this dimension establishes an industry-upgrading-oriented talent cultivation ecosystem. It connects the supply end of talent training with the demand end of industrial development to realize the structural equilibrium of talent supply and industrial needs. Through precise mapping of industrial talent demand characteristics, it proactively constructs interdisciplinary and cross-domain composite professional cluster systems.

Talent alignment is not merely a passive adaptation to market occupational demands. Instead, by instituting systematic talent demand forecasting mechanisms, it facilitates the dynamic optimization of specialty structures and the real-time iteration of curriculum content, thereby embodying the forward-looking and leading attributes of modern vocational education. Its core implementation pathways encompass the following: building industrial big data-enabled precision demand forecasting systems; developing specialty adjustment mechanisms anchored in employment quality, order-based cultivation and other empirical indicators; refining the docking and transformation mechanisms between occupational competency standards and curriculum systems; and constructing a five-in-one practical teaching module integrating "job demand,

project training and competitive innovation." These targeted governance and instructional measures effectively mitigate the structural mismatch between the upgrading of high-end industrial chains and the low-end quality of existing talent supply.

4.3. Functional coupling dimension: Multi-stakeholder collaboration of workflow–innovation flow–task flow

Following the logical pathway of "workflow–innovation flow–task flow," this dimension constructs a multi-stakeholder collaborative service ecosystem. By optimizing the bilateral correspondence between supply and demand entities, it enhances the coupling degree between industrial and educational chains, and realizes the precise matching of vocational service functions and industrial task requirements.

Functional coupling transcends conventional linear collaboration paradigms and establishes networked, modular coordination mechanisms. Centering on functional activities including project development, joint research and industrial technical services, it facilitates multi-level and multi-form collaborative innovation. Specific implementation paths encompass: constructing a governance-driven mechanism featuring "government guidance, school-enterprise interaction and industrial coordination"; developing school-enterprise cooperation platforms and industrial vocational education alliances; fostering a long-term operational mechanism characterized by resource sharing, complementary advantages and mutual benefit; and exploring interest distribution models such as equity-based cooperation and technical service revenue sharing. These institutional arrangements effectively resolve the systemic resource integration dilemmas inherent in industry-education collaboration.

4.4. Spatial agglomeration dimension: Factor allocation of industrial parks–living circles–vocational education parks

Following the logical structure of "industrial parks–living circles–vocational education parks," this dimension constructs a regionally integrated factor allocation ecosystem. Grounded in regional collaborative development strategies, it facilitates the market-oriented allocation of core factors including talents, technology, and capital, and realizes the optimal matching between industrial agglomeration layout and regional spatial structure.

Spatial agglomeration emphasizes not merely the centralized physical spatial layout, but also the organic integration of diverse functional spaces. By constructing industry-education integrated urban carriers, it realizes the in-depth convergence of productive functions of industrial parks, service functions of urban living circles, and educational functions of vocational education parks. Practical implementation measures cover: strengthening multi-dimensional collaborative cooperation with science and technology parks and industrial parks; building dual innovative shared bases featuring "on-campus virtual simulation training plus off-campus industrial park practice"; forming a "one-core and multi-pole" platform network for industry-education integration; and advancing the synchronous upgrading of talent cultivation and regional social services. These systematic initiatives effectively ameliorate the structural talent distribution imbalance stemming from unbalanced regional economic development.

5. Practical pathways: Collaborative development strategies based on the four-dimensional logic

Based on the inherent collaborative logic linking professional clusters and regional industrial chains, the construction of systematic industry-education integration pathways under the new employment context necessitates coordinated advancement across four core dimensions, namely technological integration, talent alignment, functional coupling, and spatial agglomeration. This framework establishes a synergistic development mechanism that realizes the in-depth fusion of the education chain, talent chain, industrial chain, and innovation chain.

5.1. Building digital industry-education integration innovation platforms

Establish industry-education collaborative innovation mechanisms anchored by industrial internet platforms. Construct an industrial technology cloud platform that realizes logical mapping among industrial clusters, technology clusters, and professional clusters. By leveraging functional modules including technology demand release, precise resource matching, and collaborative R&D organization, the platform integrates technical resources from regional leading enterprises. It enables real-time sharing of industrial technical standards, procedural specifications and research outputs, thereby underpinning joint industry-university technological development and the translational application of innovative achievements.

Develop virtual simulation training systems adapted to the new forms of employment. Guided by digital twin technology, this approach reconstructs authentic job scenarios tailored to emerging employment demands, with a particular focus on building virtual training environments for burgeoning digital occupations, including artificial intelligence training, blockchain application, and low-altitude economy operation. Immersive scenario experiences and interactive operational training effectively strengthen students' adaptive competency against technological iterations. Meanwhile, a dynamic updating mechanism for training content is formulated to sustain the consistency between virtual training environments and real-world industrial job scenarios.

Establish a quarterly technical standard iteration mechanism. A dedicated technical standard committee consisting of industry specialists, enterprise technical backbones, and professional teachers is constituted to timely incorporate emerging industrial technologies, innovative processes, and updated specifications into teaching standards and curriculum systems. The dynamic governance of industrial technical standards ensures that talent cultivation evolves synchronously with technological advancement. Furthermore, it encourages teachers and students to participate in enterprise technological innovation projects, fostering a virtuous cyclic ecosystem of "technological R&D, achievement transformation, and instructional application."

5.2. Establishing demand-oriented dynamic program adjustment mechanisms

Construct a dynamic talent cultivation adjustment system empowered by big data analytics. By integrating employment data from human and social security authorities, corporate recruitment information, and job release data from mainstream recruitment platforms, a regional industrial talent demand monitoring platform can be established. Adopting machine learning algorithms to predict industrial skill demand trends over the next 3–5 years, the platform is endowed with versatile functions including demand early warning, structural analysis, and quality assessment, thereby providing scientific decision-making support for specialty setup optimization and enrollment scale planning.

Implement quality evaluation and dynamic optimization mechanisms for professional cluster development. An evaluation indicator system centered on employment quality, post competency matching degree, and enterprise satisfaction is formulated to support annual systematic assessment of existing

vocational specialties. For emerging industries with robust market demand, a green channel for specialty approval is set up to streamline the approval procedure within six months. For traditional majors facing shrinking market demand, targeted adjustments such as enrollment restriction and directional specialty transformation are implemented.

Advance the modular reform of curriculum systems adaptive to the evolving employment context. In accordance with the occupational task characteristics of emerging employment scenarios, occupational competency requirements are disassembled into standardized independent skill modules to develop systematic micro-credential curriculum systems. Credit bank mechanisms and learning outcome certification systems are established to enable students to flexibly integrate curriculum modules based on personal career planning and corporate developmental needs.

5.3. Innovating multi-stakeholder collaborative governance models

Construct a collaborative governance model featuring "government guidance, industrial coordination, school-enterprise dominance, and platform support." A regional industry-education integration council, consisting of governmental administrative departments, industrial associations, leading enterprises and vocational college representatives, is established to coordinate regional resource allocation, institutional formulation and project examination. A regular quarterly joint meeting mechanism is also implemented to identify and resolve major bottlenecks in industry-education collaborative development.

Develop a dedicated information service platform for industry-education integration. By optimizing core functions covering demand release, resource exhibition, cooperative signing and performance evaluation, the platform delivers one-stop services including project matching, resource integration and policy consultation, thereby substantially reducing the institutional transaction costs of school-enterprise cooperation. Furthermore, it establishes a standardized cooperative project database and expert resource reservoir to provide sustained intellectual support and technical assurance for cross-stakeholder collaborative innovation.

Innovate benefit distribution and risk-sharing mechanisms for collaborative governance. This study explores diversified cooperation paradigms including equity participation, contractual collaboration and industrial alliances to clarify the rights, obligations and interest boundaries of all participating subjects. It conducts a quantitative assessment of multi-dimensional input resources such as equipment, technology, and capital, and constructs a contribution-based benefit distribution mechanism. Meanwhile, an industry-education integration risk compensation fund is set up to underwrite innovative cooperative practices. Additionally, joint intellectual property application and profit-sharing systems are formulated to fully mobilize the initiative and creativity of all collaborative participants.

5.4. Optimizing regional industry-education integration spatial layout

Optimize the spatial layout and factor resource allocation of industry-education integration. Guided by the tripartite fusion logic of "industrial parks–living circles–vocational education parks," this study develops integrated industry-education cities (parks) through holistic spatial planning that coordinates productive, residential, and educational functions. In core industrial agglomeration zones, supporting vocational education parks and talent residential facilities are constructed to shorten spatial and operational distances and improve the overall efficiency of factor allocation.

Establish a "one-core, multi-pole" platform system for industry-education integration. Taking the regional industry-education integration practice center as the core hub, the system interconnects specialized

industrial colleges and professional cluster training bases to form a comprehensive service network covering key industrial sectors. The core hub undertakes fundamental functions including resource integration, information sharing and standard formulation, while each functional pole targets segmented industries to deliver specialized, precise and scenario-oriented services.

Foster the development of regional industry–education integration communities. Unified regional systems for technical standard specification, talent evaluation and vocational qualification certification are formulated to facilitate cross-regional factor flow and optimal allocation. Regional integrated information platforms are built to realize the interconnection of talent demand data, technological innovation achievements and educational resource information. Meanwhile, regional skilled talent databases are established to provide systematic data support for talent mobility and precise resource deployment.

5.5. Improving the institutional environment and support measures

Improve the legal and regulatory system for industry-education integration. This framework clarifies the rights, obligations, and benefit boundaries of all participating entities and standardizes their cooperative behaviors. Refined implementation rules for school-enterprise cooperation are formulated to provide operational guidelines for cooperation agreement formulation, resource investment, and benefit distribution. Meanwhile, a quality certification system for industry-education integration is established to support third-party assessment and accreditation of cooperative projects.

Scale up fiscal and financial policy support. Special funds for industry-education integration are set up to fund key technological R&D and institutional model innovation through project-based funding mechanisms. Preferential policy incentives including tax exemptions and subsidized loans are offered to enterprises engaged in industry-education collaborative initiatives. Furthermore, the tripartite co-construction model among governments, enterprises, and vocational institutions is promoted to encourage social capital participation in the development of industry-education integration projects.

Optimize the talent policy support system. Targeted introduction programs for high-skilled leading talents are implemented alongside flexible talent recruitment mechanisms. Regular release of regional talent demand catalogs guides the directional optimization of talent cultivation. The talent evaluation system is reformed to establish assessment criteria oriented toward innovative capacity, practical performance, and industrial contribution. In addition, remuneration packages for technical and skilled talents are improved to enhance the social attractiveness of vocational careers.

Construct systematic monitoring, evaluation, and incentive-constraint mechanisms. A comprehensive evaluation index system centered on student, enterprise, and social satisfaction is formulated to enable regular performance appraisal of industry-education integration practices. A corresponding whitelist mechanism is established to commend and reward regions and institutions with exemplary performance, thereby forming a standardized institutional orientation that incentivizes excellence and regulates ineffective practice.

6. Conclusion

Through the above systematic practical pathways, this study constructs a four-dimensional collaborative development model encompassing technological integration, talent alignment, functional coupling, and spatial agglomeration. It further fosters a virtuous ecological system characterized by the integrated fusion

of the education chain, talent chain, industrial chain, and innovation chain. The research findings deliver feasible, replicable, and generalized implementation strategies for advancing the coordinated development of vocational professional clusters and regional industrial chains amid the evolving new forms of employment.

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Disclosure statement

The authors declare no conflict of interest.

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