

# Theoretical Logic and Practical Dilemmas of Cluster Cultivation of High-Skilled Talents from the Perspective of Industrial Chain

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**Abstract:** *Industrial chain modernization and upgrading is core to China's modern industrial system and high-quality economic development, raising new systematic demands for talent supply quality and structural allocation. High-skilled talents are the key force driving industrial chain upgrading, and vocational education, as the main front for fostering such talents, determines talent supply quality through its adaptation to industrial needs. However, China's traditional vocational education, structured around single specialties and disciplinary logic, features narrow cultivation scope and weak synergy. It fails to meet the cross-linking and compound talent demands of industrial chains, widening talent gaps in high-end equipment manufacturing and restricting industrial chain transformation. To address this structural contradiction and respond to industrial upgrading needs, this paper clarifies the theoretical connotations of three core categories, analyzes the internal logic of three foundational theories, and examines practical cultivation dilemmas, providing theoretical support and practical orientation for building a systematic cluster cultivation model.*

**Keywords:** Industrial chain, High-skilled talents, Cluster cultivation, Theoretical logic, Industry-education integration.

## 1. Introduction

Industrial chain modernization is the core task of building China's modern industrial system. With the in-depth transformation of industries toward high-end, intelligent and integrated development, the industrial division system has been continuously refined and industrial convergence has deepened, putting forward whole-chain and systematic new requirements for the structural hierarchy and competence quality of talent supply. As a core component of the technical and skilled talent workforce, high-skilled talents act as the key link connecting technological innovation achievements and industrial application. Their quantity and quality directly determine the upgrading speed and independent control level of the industrial chain. Vocational education undertakes the core mission of cultivating high-quality technical and skilled talents and is the main channel for high-skilled talent supply. The adaptability of its talent cultivation system to industrial development needs is directly related to the strength of talent support for industrial upgrading.

From the perspective of vocational education practice in China, the structural contradiction between the traditional talent cultivation model and the needs of industrial chain modernization has become increasingly prominent. Traditional vocational education generally takes a single specialty as the basic schooling unit, sets up specialties, constructs curriculum systems and allocates teaching resources according to disciplinary classification logic. As a result, talent cultivation features a narrow scope, fragmentation and weak synergy, making it difficult to adapt to the cross-link and compound talent demands of the industrial chain. On the one hand, specialty adjustment lags behind industrial iteration, with insufficient coverage of emerging links and high value-added fields in the industrial chain, resulting in structural gaps in talent supply. On the other hand, the cultivation boundary of a single specialty limits the development of students' cross-post competence, making it hard to meet the demand for compound talents in

integrated positions. This structural contradiction between supply and demand is particularly prominent in industries with a high degree of integration and long industrial chains, such as high-end equipment manufacturing and modern shipping services, and has become an important bottleneck restricting the upgrading of the industrial chain.

To address this contradiction, the state has continuously introduced policies to promote the reform of vocational education talent cultivation models, clearly proposing deepening industry-education integration as the core direction and specialty cluster construction as an important starting point to advance the cluster cultivation of high-skilled talents. Relevant policies explicitly require vocational colleges to optimize their specialty layout around key industrial chains, build high-level specialty clusters, promote the integration of teaching resources and collaborative education, and comprehensively improve the adaptability of talent supply to industrial needs. This series of policy arrangements has provided a solid institutional guarantee for the industrial chain-oriented cluster cultivation of high-skilled talents, and also marks the official transformation of vocational education talent cultivation from "single specialty-based schooling" to "cluster-based education". Against this background, clarifying the core connotation and logical mechanism of cluster cultivation at the theoretical level and confronting the practical dilemmas in current schooling practice have become the primary premise for advancing the cluster cultivation of high-skilled talents.

## 2. Theoretical Connotation of Cluster Cultivation of High-Skilled Talents from the Industrial Chain Perspective

The cluster cultivation of high-skilled talents from the industrial chain perspective is a compound concept with multiple layers of connotations. Its core categories cover three dimensions: industrial chain orientation, high-skilled talents and cluster cultivation. The three are interrelated and

organically unified, jointly forming the conceptual foundation of this study.

Industrial chain orientation is the extension and transformation of industrial development logic into the field of vocational education, and serves as the fundamental principle of cluster cultivation. Its core connotation is that the whole process of talent cultivation is fundamentally based on the division system, post demands, technical standards and development trends of the industrial chain. Educational resources are allocated and cultivation programs are designed around the complete industrial chain from R&D and design, manufacturing to operation and service, so as to achieve full-dimensional and dynamic matching between talent supply and industrial demand. Different from the traditional single post orientation, industrial chain orientation emphasizes a systematic and whole-chain perspective, and focuses on the structural adaptability of talent cultivation and industrial support. It is no longer limited to delivering talents for a specific post, but aims to provide echeloned talent support for the independent control and upgrading of the entire industrial chain. It requires that all educational links, including specialty layout, curriculum system and practical training conditions, be deeply aligned with the operation logic of the industrial chain.

From the industrial chain perspective, the connotation of high-skilled talents has been further expanded, and is no longer limited to traditional operation-skilled talents. As the core of the technical and skilled talent workforce, high-skilled talents not only need to have exquisite professional skills, be able to solve key technical problems in production and operation, and have strong innovative practical ability, but also need to adapt to the requirements of industrial chain technological iteration and business format upgrading, realizing the shift from single operation skills to comprehensive professional competence. Specifically, industrial chain-oriented high-skilled talents need to master both special operation skills and scenario-based problem-solving ability, cross-post collaboration ability and comprehensive professional literacy. They can cover core posts in all links of the industrial chain including manufacturing, technology and service, such as technical backbones, field engineers and operation managers, presenting compound and echeloned characteristics.

Cluster cultivation is a talent cultivation organization model corresponding to industrial clusters and industrial chain division. It is a systematic reconstruction of the traditional single specialty schooling model, and also the organizational carrier for cultivating industrial chain-oriented high-skilled talents. Its core is to break the traditional schooling boundary of single specialties around a specific industrial chain field, integrate several specialties with high relevance and strong resource sharing into a specialty cluster, and systematically cultivate compound high-skilled talents that meet the multi-post demands of the industrial chain through teacher sharing, common courses, joint practical training and school-enterprise collaboration. Cluster cultivation is not a simple combination of several specialties. Instead, it relies on the synergy effect among specialties to realize the intensive allocation of educational resources and the systematic design of talent cultivation. It can not only improve the utilization

efficiency of schooling resources, but also broaden the scope of talent cultivation and enhance the industrial adaptability of talent cultivation. It is the core organizational form for vocational education to align with the industrial chain.

### 3. Logical Mechanism of Cluster Cultivation of High-Skilled Talents

The cluster cultivation of high-skilled talents from the industrial chain perspective is not an arbitrarily constructed education model, but a systematic design following the law of vocational education development and industrial operation logic. Its underlying logic is rooted in three theoretical foundations: industry-education integration theory, Outcome-Based Education (OBE) theory and specialty cluster theory. The three are coupled with each other to form a complete operation logic, which jointly supports the construction of the cluster cultivation model.

Industry-education integration is the underlying development logic of cluster cultivation and constitutes the theoretical foundation of the model. Industry-education integration is the essential attribute and core development path of vocational education. Its theoretical core lies in the deep interaction and two-way empowerment between the industrial system and the education system. Through resource integration, element integration and value co-creation between education and industry, it realizes the synchronous resonance between talent cultivation and industrial development. From the perspective of the industrial chain, industry-education integration breaks through the limitations of traditional point-to-point school-enterprise cooperation, expands the scope of collaboration to the entire industrial chain, and emphasizes the systematic matching between education supply and industrial demand. The cluster cultivation model takes the industrial chain as the link to upgrade scattered point-to-point school-enterprise cooperation into whole-chain systematic collaboration. Through the precise alignment of the specialty chain and the industrial chain, the deep connection between curriculum content and professional standards, and the high integration of teaching process and production process, it finally realizes the organic connection of the education chain, talent chain, industrial chain and innovation chain. This logic determines that cluster cultivation must take industrial demand as the starting point, take industry-education collaboration as the core path, and ultimately serve the high-quality development of the industrial chain.

Outcome-Based Education is the teaching implementation logic of cluster cultivation and provides methodological guidance for the reconstruction of the teaching system. Outcome-Based Education takes students' final learning outcomes as the core, and reversely designs teaching content, teaching links and evaluation methods. It emphasizes the goal achievement degree and post adaptability of talent cultivation, with the core idea of "starting from the end" and deducing the cultivation process from expected outcomes. In the cluster cultivation of high-skilled talents, the outcome-based concept requires taking the comprehensive competence requirements of core posts in the industrial chain as the final output goal, and reversely constructing the curriculum system and teaching model within the cluster. Different from the competence goal of a single specialty, the output goal of

cluster cultivation is structured and multi-level, covering both special skills of each link of the industrial chain and cross-post compound competence. It can ensure that students' competence growth trajectory is highly matched with the post demands of the industrial chain, and provide a clear path for the systematic reconstruction of the teaching system.

Specialty cluster theory is the organizational logic of cluster cultivation and provides organizational support for the education model. Specialty cluster theory originates from industrial cluster theory and is the mapping and application of industrial cluster development in the field of vocational education. Its core is to give play to the synergy effect and scale effect through the agglomeration and integration of related specialties, so as to improve schooling efficiency and talent cultivation quality. Building related specialty clusters around the core links of the industrial chain can break the administrative barriers between specialties, integrate schooling resources such as teachers, courses and practical training, and form a corresponding relationship of "clusters aligning with industries, specialties aligning with posts". It not only solves the problems of narrow coverage and scattered resources of a single specialty, but also provides an organizational carrier for the cultivation of compound high-skilled talents. The organizational form of cluster cultivation is the specific implementation of specialty cluster theory at the education level. It realizes the precise correspondence with the industrial chain division system through the cluster layout of specialties, and provides organizational guarantee for systematic education.

#### **4. Practical Dilemmas Faced by Current Cluster Cultivation of High-Skilled Talents**

With the continuous upgrading of China's industrial chain toward high-end and integrated development, the demand structure and competence standards for high-skilled talents have undergone profound changes. The inadaptability of the traditional talent cultivation model has become increasingly prominent, and the structural contradiction between supply and demand has become more acute. This contradiction is concentrated in three aspects of vocational education: specialty layout, teaching system and industry-education collaboration, which form a sharp contrast with the logical mechanism of talent cultivation under the background of industrial chain modernization.

The structural mismatch between specialty layout and industrial chain demand is the primary dilemma. At present, the specialty setting of vocational colleges is mostly based on disciplinary classification logic, with a long adjustment cycle and slow dynamic response, which forms a sharp contrast with the rapid iteration of the industrial chain. From the perspective of supply structure, traditional specialties mostly focus on the manufacturing link of the industrial chain, with insufficient coverage of emerging high value-added links such as technical services and operation management, leading to talent supply gaps in core areas of the industrial chain. Taking the cruise industry as an example, most original specialties in domestic colleges and universities focus on a single field of shipbuilding or tourism services. Key links of the industrial chain such as cruise interior design and operation management have long lacked corresponding specialty

support, resulting in a significant talent gap. From the perspective of organizational form, there are strict barriers between specialties, lack of synergy and linkage mechanisms, and a narrow scope of talent cultivation, making it difficult to meet the demand for compound high-skilled talents in the industrial chain. The construction of specialty clusters in most colleges and universities still stays at the level of name integration, without forming a real mechanism of resource sharing and collaborative education. The organizational advantages of cluster-based schooling have not been fully exerted, and it is impossible to provide structured and echeloned talent support for the whole industrial chain. On the whole, the construction of specialty clusters in most colleges and universities still has problems of incomplete industrial chain coverage and insufficient synergy, which lags behind the benchmark of whole-chain post demands.

The adaptation deviation between the teaching system and post competence requirements is the core contradiction. High-end industrial chain posts are generally characterized by high precision, scenario-based nature and compound requirements, putting forward high demands on practitioners' practical ability, problem-solving ability and comprehensive literacy. However, the traditional teaching system still has the problems of separation between theory and practice and fragmentation of knowledge and skills, making it difficult to support the systematic cultivation of high-skilled talents. On the one hand, teaching content focuses on theoretical knowledge systems and is disconnected from real production and operation scenarios of enterprises. Students lack training in solving practical problems, resulting in a long post adaptation period and difficulty in quickly qualifying for core posts in the industrial chain. On the other hand, the supply of practical training resources can hardly meet the requirements of high-skilled cultivation. Practical training projects in high-end industries are often characterized by high cost, high risk and scarce scenarios. It is difficult for colleges and universities to independently build a complete real practical training system, resulting in insufficient depth and breadth of students' skill training, which cannot reach the competence standard of high-skilled talents. In addition, teaching organization forms are scattered and lack systematic project carriers. The imparting of knowledge and skills presents fragmented characteristics, making it difficult for students to form complete post work ability and adapt to the comprehensive requirements of complex posts in the industrial chain.

The institutional obstacle to industry-education collaborative education is an important restricting factor. The cluster cultivation of high-skilled talents requires the deep participation of multiple subjects along the industrial chain. However, most current school-enterprise cooperation still stays at the shallow agreement level, and a stable and long-term collaborative education mechanism has not yet been formed. First, there is a lack of governance structure. School-enterprise cooperation is mostly spontaneous and loose, lacking institutionalized decision-making and interest distribution mechanisms. Enterprises lack endogenous motivation to participate in talent cultivation, and it is difficult for them to deeply participate in core links such as specialty cluster construction and teaching standard formulation. Cooperation often becomes a mere formality. Second,

collaborative education lacks a full-cycle closed-loop design. Cooperation mostly focuses on terminal links such as practical training and employment, and fails to establish a complete chain of demand exchange, standard co-development, whole-process co-education and evaluation feedback. It is difficult for talent cultivation and industrial demand to form dynamic adaptation. Third, industrial demand transmission is unsmooth. There is a lack of a regular demand monitoring and research mechanism. The adjustment of talent cultivation programs lags behind industrial technological iteration, making it impossible to respond in a timely manner to post changes and competence upgrading requirements of the industrial chain. The continuous adaptability of high-skilled talent cultivation is difficult to guarantee.

## 5. Conclusion

Against the background of industrial chain modernization, the cluster cultivation of high-skilled talents is an inevitable choice for vocational education to deepen industry-education integration and serve industrial upgrading. Its essence is to systematically embed the operation logic of the industrial chain into the whole process of talent cultivation, and realize the systematic matching between talent cultivation and industrial demand through a clustered organizational form. From the theoretical level, the three core categories of industrial chain orientation, high-skilled talents and cluster cultivation constitute the conceptual foundation of the study, while the three theories of industry-education integration, outcome-based education and specialty cluster provide solid logical support for model construction. From a practical perspective, three dilemmas—structural mismatch in specialty layout, competence disconnection in the teaching system and institutional obstacles in industry-education collaboration—restrict the effectiveness of advancing the cluster cultivation of high-skilled talents.

Therefore, to truly realize the industrial chain-oriented cluster cultivation of high-skilled talents, it is necessary to clarify the theoretical logic, confront the practical dilemmas, construct a systematic cultivation model and operation mechanism, and carry out systematic reconstruction from the aspects of specialty layout, teaching implementation and support system. This is also the core issue that follow-up research needs to focus on.

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