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The role and practices of German educational enterprises and their enlightments for the development of industry-education integrated enterprises in China

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Abstract. Industry–education integrated enterprises are among the key organizational forms and practical carriers through which China implements its industry–education integration strategy at the micro level. Their development outcomes directly reflect the degree to which policy objectives are being achieved and the effectiveness of their implementation. From an international perspective, German educational enterprises represent a paradigmatic model of deep engagement in vocational education. The historical and cultural legacy that shaped the evolution of these enterprises, together with the legal confirmation of their principal behaviors, firmly grounds the role positioning of core actors. By directly investing in comprehensive, unified, and high-quality industry–education resource elements, these enterprises effectively fulfill their principal responsibilities. At the same time, they form collaborative mechanisms with multiple stakeholders—including governments at various levels and industry associations—thereby enhancing the capacity and effectiveness of educational enterprise actors. Drawing on the practical experience of German educational enterprises, China's development of industry–education integrated enterprises should focus on the following: establishing a sound institutional framework to clarify enterprises' principal responsibilities; promoting unified allocation and increased direct investment of enterprise industry–education resources; strengthening the supervisory and guiding roles of vocational education program committees to safeguard the quality of talent cultivation; building precise incentive mechanisms that encourage enterprise participation; and enhancing value guidance related to social responsibility to deepen enterprises' internalized recognition of their roles.

Keywords: Germany, educational enterprises, principal-role practice, multi-actor collaboration, industry–education integrated enterprises

1. Introduction

From an international perspective on vocational education, it is well recognized that the success of Germany's dual vocational education system lies in the deep involvement of German enterprises—one of the two pillars of the "dual system"—in the cultivation of high-tech skilled talents. Enterprises that possess formal training qualifications in Germany are referred to as "educational enterprises" (Ausbildungsbetrieb), and together with vocational schools, they share responsibility for cultivating high-tech skilled talents needed by their own

enterprises, the industry at large, and the future labor market. Statistics show that within Germany's dual vocational education system, only about 25% of enterprises obtain qualification certification to become educational enterprises, yet these enterprises are responsible for roughly 70% of the overall vocational education workload [1], thereby becoming the legally recognized principal actors in talent cultivation under the Federal Vocational Education and Training Act. These enterprises form highly efficient, well-coordinated operational mechanisms with vocational schools, governments, industry associations, and trade unions, each performing their respective functions, which has gradually shaped Germany's model of high-quality technical and skilled talent development.

Since the 19th National Congress of the Communist Party of China, industry–education integration has been established as a strategic initiative crucial for national development and has become the core and soul of current vocational education reform. In recent years, the Chinese government has continuously promoted and strengthened the implementation of industry–education integration policies through top-level design. Among these, establishing diverse organizational forms of industry–education integration and building highly effective practical carriers has become a key policy goal. The construction of industry–education integrated enterprises has been launched fully within this context. In 2019, six ministries—including the National Development and Reform Commission (NDRC) and the Ministry of Education—issued the Implementation Plan for National Industry–Education Integration Pilot Construction [2], which explicitly proposed: "establish a certification system for industry–education integrated enterprises" and "cultivate over 10,000 industry–education integrated enterprises nationwide, while developing a system and combination of incentive policies for such enterprises." In the same year, the NDRC, together with the Ministry of Education, issued the Implementation Measures for Building Industry–Education Integrated Enterprises (Trial), requiring enterprises to "deeply participate in the 'enterprise–school integration' initiative… exert their role as key actors in running educational programs, and establish enterprise-led collaborative innovation and achievement transformation mechanisms." The construction of industry–education integrated enterprises represents the industry's proactive crossing into the educational domain, with the establishment of a "strong-identity" certification system designed to enhance enterprises' recognition of and accountability for their role as principal actors in vocational education.

This study adopts the perspective of the principal role of German educational enterprises to systematically deconstruct the operational mechanisms of multi-stakeholder collaboration in vocational education. It focuses on analyzing the historical development, training practices, and collaborative operations of German educational enterprises, offering a reference for understanding and promoting the deep engagement of China's industry–education integrated enterprises in vocational education, thereby contributing jointly to the cultivation of technical and skilled talents.

2. Historical development of the principal role of German educational enterprises

2.1. Basic structure of Germany's dual vocational education system

The formation of Germany's dual vocational education system is the result of a complex interplay among economic, social, educational, and training factors. In its modern form, the dual system is structured as follows: First, dual actors of vocational education: Enterprises and vocational schools constitute the two pillars of vocational education. Enterprises serve as the primary actors responsible for cultivating practical knowledge, skills, and competencies, while vocational schools are responsible for imparting professional theoretical knowledge, general knowledge, and related skills and competencies. Second, societal framework of

"small government, large society": Germany's social structure fosters the participation of federal and state governments alongside multiple social organizations in regulating, supervising, coordinating, and supporting the effective operation of the dual system. The federal and state governments, through legislation and top-level policy design, perform functions including investment, coordination, and oversight. Industry associations establish uniform training standards and lead examination and certification processes. Social groups such as trade unions and employer associations participate in collective labor negotiations, coordinate wage levels between employers and apprentices, and help prevent destructive competition for skilled labor within the same industry, thereby maintaining a relatively fair and balanced market environment for enterprises to engage in vocational education.

2.2. Role positioning and operational mode of enterprises in dual vocational education

2.2.1. The principal status of educational enterprises in German vocational education

The agency of a natural person or organization is manifested in a strong sense of subjectivity and the ability to autonomously perform principal actions. For German enterprises, this agency is reflected in two main dimensions:

2.2.1.1. Cultural inheritance of subjectivity and legal recognition of principal actions

Since the Industrial Revolution, Germany's apprenticeship system has evolved from guild-based apprenticeships to factory apprenticeships, with factories directly recruiting apprentices to achieve both inexpensive labor and the transfer of vocational skills. This development effectively shaped the early form of enterprise-led vocational education. Previously, vocational training in enterprises was a private contractual arrangement between apprentice and master, and the state had little influence through vocational education policy [3]. In 1969, Germany officially promulgated the Federal Vocational Education and Training Act, which primarily regulates enterprise-based vocational education rather than school-based programs. Under Germany's federal political system, the "school element" of the dual system follows state legislation and is managed by state education departments, while the "enterprise element" is legislated and governed by the federal government, which holds dual system vocational education legislative authority [4]. The first German vocational education law stipulated that "this Act applies to all vocational education conducted outside vocational schools" [5], explicitly recognizing enterprises as principal actors in vocational education. Subsequent amendments in 2005 and 2019 further refined the Federal Vocational Education and Training Act. The 2019 version specifies that "this Act applies to all vocational education conducted outside vocational schools subject to state school legislation" [6]. The continuous legal refinement of Germany's vocational education framework strengthens and optimizes enterprises' principal status and functions. It defines the vocational education relationship between enterprises and apprentices (i.e., contract signing), specifies the qualifications of enterprises as educational institutions and their staff, establishes enterprises' authority over apprentice examinations [7], and clarifies core responsibilities such as educational provision and remuneration obligations. Thus, throughout Germany's social and economic development, enterprises' subjectivity and principal actions in vocational education have combined both the spontaneity driven by labor-utilization interests and the cultural inheritance of social educational participation. This dual nature has been continually recognized and consolidated within the framework of modern German vocational education law.

2.2.1.2. Educational enterprises as the main force in implementing vocational education

The goal of vocational education is to cultivate professionals with the necessary qualifications and competencies for specific occupations or positions, enabling them to quickly adapt to the work environment and proficiently apply technical skills in practical scenarios. Therefore, the ideal learning environment for developing technical and skilled talent is one in which learners are placed directly within real production or

service contexts. The alignment between enterprise work environments and vocational talent cultivation makes enterprises the inevitable core actors in vocational education. Compared with vocational schools, German educational enterprises shoulder approximately 70% of the responsibility for practical skills training, with the overall education and training time accounting for more than 60% of the entire talent development process [8]. During this process, enterprises invest intensively in key elements such as positions, equipment, human resources, technology, and environment, providing apprentices with systematic training in real work settings while involving them directly in actual enterprise work processes [9].

2.2.2. Direct investment by educational enterprises as confirmation of principal responsibility

Enterprises, as market-oriented actors, fundamentally pursue maximization of economic benefits, and their limited resources are primarily allocated to production and business operations. From a stakeholder perspective, however, German enterprises participate deeply in national vocational education to cultivate high-tech skilled workers who meet the enterprise's development needs, thereby supporting their own long-term growth [10]. The investment in talent cultivation is driven by the enterprise's recognition of skilled personnel as a core production factor, ultimately serving the enterprise's pursuit of future economic benefits and sustainable development. This demonstrates that enterprise investment in vocational education represents a conversion of part of the economic function of current production resources into educational functions, transforming them into teaching resources for vocational training. R. B. Kozma, L. W. Bell, and G. W. Williams identified five essential elements in university classroom teaching: Teacher, Student, Teaching Material, Medium, and Environment [11]. Examining educational enterprises' investment in apprentice training reveals a comprehensive, integrated, and high-quality deployment of these resource elements.

2.2.2.1. Teaching staff: integration of production and education talent

In German educational enterprises, teachers responsible for apprentices are called enterprise trainers (commonly referred to as "masters"). The German Vocational Training Act (BBiG) specifies requirements for enterprise trainers: first, trainers must possess both personal and professional qualifications to recruit apprentices and conduct vocational education; second, enterprise trainers must have the necessary professional knowledge, skills, and competencies to teach the mandated vocational curriculum, as well as a theoretical foundation in vocational and labor education, supported by relevant work experience. Trainers must also pass graduation or nationally recognized examinations in the corresponding professional field to obtain formal qualification. Thus, enterprises possessing dual-qualified personnel—combining teaching and professional technical abilities—constitute the core resource and key force for delivering vocational education, and are a crucial condition for ensuring the quality of vocational talent cultivation in Germany.

2.2.2.2. Learners: integration of student and production roles

Students in German vocational education simultaneously hold dual identities as quasi-employees and learners, reflecting a distinctive feature of the dual system. Enterprises recruit apprentices first, followed by enrollment in vocational schools. The enterprise-apprentice relationship is formalized through vocational education contracts, with enterprises often hiring suitable apprentices as future employees. This quasi-employment relationship enhances enterprises' commitment—both in awareness and action—to their educational provision. Consequently, the quality of apprentice training directly determines the future skill level of the enterprise's workforce, serving as a critical driver for enterprises to invest deeply in the vocational education process.

2.2.2.3. Learning environment: integration of production and education spaces

German educational enterprises have established systematic learning bases, which fall into two main types: one type consists of large enterprises providing authentic production workshops, job stations, or workplaces that serve as teaching venues closely linked to vocational education; the other type combines production posts

with enterprise education centers to create skills training bases. These bases include integrated specialized classrooms, simulated companies, learning islands, and other facilities [12], offering students practical instruction directly related to vocational knowledge and skills. The integration of production and education spaces achieves the convergence of workplaces and training sites, production facilities and training equipment, professional interactions and teacher-student interactions, as well as enterprise culture and labor culture. Students engage in immersive learning within these "scenario-based" work environments, gaining essential knowledge, techniques, and skills from work processes while developing comprehensive vocational abilities and achieving practical learning outcomes. Simultaneously, they experience the enterprise's culture, peer relationships, and workplace atmosphere, constructing a multi-dimensional understanding of the professional world and acquiring culturally enriched learning experiences. German educational enterprises employ both hybrid (open) environments that combine production and training, and dedicated (closed) training environments, and the diversity of these learning spaces effectively supports talent development.

2.2.2.4. Curriculum: integration of standardization and specialization

In Germany, educational enterprises and vocational schools assume separate but complementary responsibilities: enterprises focus on practical training while schools handle theoretical instruction. Their curricula are independently organized yet coordinated, forming a "theory–practice complementary" system. To achieve this integrated approach, institutionalized and standardized curricula are established. For educational enterprises, standardized training guidelines—known as "Vocational Training Regulations"—are determined through negotiations among trade unions, employer associations, and the government. For vocational schools, governments develop corresponding teaching syllabi based on these regulations. Both the training regulations and syllabi are dynamically updated to reflect changes in occupational requirements, ensuring precise alignment between enterprises and schools and smooth continuity in vocational education.

On the basis of standardized content, educational enterprises may also provide specialized training tailored to their own technical and operational needs, as well as the individual knowledge and competency requirements of potential employees.

2.2.2.5. Media and methods: blended learning in real and virtual spaces

Enterprises' production and operational sites provide the most effective spatial medium for apprentice practical learning. In authentic work settings, enterprise trainers employ action-oriented, work-process-based instructional methods. Apprentices progress from mastering individual skills and correctly using work equipment to gradually assuming increasingly complex tasks [13]. This work-based learning approach stimulates apprentices' engagement and initiative in vocational practice, creating a highly effective learning process. In this mode, the gap between learning and work is bridged, and static knowledge, techniques, and skills are directly applied in practice, forming an integrated vocational training system. Furthermore, learning in real work scenarios enhances apprentices' adaptation to workplace roles, overall work planning capabilities, and social interaction skills, supporting their future integration into society.

In recent years, with the rapid development of digital and intelligent technologies and the ongoing digital transformation of German enterprises, virtual workspaces have become an important supplement to real work environments. Consequently, enterprises have diversified and flexibly combined online and offline training methods, which are now widely applied in educational enterprises.

2.2.2.6. Educational funding: enterprises as primary investors in vocational education

Enterprises' financial investment in training serves as a key indicator of their principal role in vocational education. Funding is primarily allocated to organizing training activities, professional trainer salaries, and apprentice remuneration. Specific requirements for apprentice wages are detailed in the German Vocational Training Act (BBiG) and formalized in contracts between enterprises and apprentices. Statistics indicate that

German enterprises and the federal government contribute to vocational training funding at an approximate ratio of 7:3. As economically "boundedly rational" actors, enterprises' willingness to invest substantial training resources reflects a long-term cost–benefit calculation: by continuously improving the quality of apprentice education, enterprises secure human capital essential for future survival and development [14], optimizing both the value of investment and its output.

The analysis above demonstrates that the combination of legal mandates on enterprise resource investment and enterprises' autonomous, expectation-driven contributions reinforces both the principal role and functional capacity of enterprises in vocational education.

3. The synergistic role of industry associations and government in empowering educational enterprises

3.1. Historical evolution of industry associations' role in vocational education

The apprenticeship system is considered the earliest form of vocational education [15]. Historically, German industry associations (hereafter referred to as "guilds") have participated in vocational education in a manner that evolved progressively alongside the development of the apprenticeship system. German guilds emerged early and were numerous, playing a prominent role in the initial national skill formation system. At this stage, guilds served as training providers, simultaneously employing inexpensive labor and ensuring effective transmission of skills. With the advent of the Industrial Revolution and the mechanization of production, large numbers of apprentices entered factories, and the guild apprenticeship system transitioned to a factory-based apprenticeship system. Despite the decline of traditional guild apprenticeships, guilds did not exit the national skill formation system. On the contrary, due to their dominant position in Germany's economic and social governance and their retained industry autonomy, guilds continued to participate in the governance of factory apprenticeships. Their responsibilities included regulating apprentice labor, maintaining production order, defining the responsibilities and obligations of apprenticeship participants, and supervising apprenticeship contracts [16]. Simultaneously, through negotiations and interactions with secular authorities, guilds secured a stable legal status [17], acquiring quasi-public authority. Through this series of politically strategic actions related to organizational interests, German guilds underwent their first role transformation—from skill trainers to regulators of factory-based apprenticeship training. The establishment of their supervisory role within the national skill formation system laid the foundation for the development of Germany's dual vocational education system. The German Vocational Education and Training Act explicitly stipulates that guilds, as competent authorities, are responsible for managing dual vocational education within their respective sectors [18]. Thus, guilds completed a second role transformation—from historically constrained regulators to authoritative supervisory bodies for educational enterprises endowed with professional and public-law authority.

3.2. Regulatory and protective role of industry associations in enterprise training

Industry associations in the economic sector exhibit a high degree of organizational self-governance among enterprise groups and possess quasi-public authority granted by law, positioning them to directly manage educational enterprises within the dual vocational education system.

According to the 2019 version of the German Vocational Education and Training Act (BBiG), industry associations manage dual vocational education through specialized vocational education committees. Each committee comprises six employer representatives, six employee representatives, and six teachers from

vocational schools, creating a cross-sectoral platform representing the interests of both the business and educational communities. As the competent authority for educational enterprises, industry associations' management spans the full cycle of vocational education: preparation, implementation, and assessment. Specifically, during the preparation phase, they handle enterprise qualification certification and vocational education contract management; in the implementation phase, they supervise the quality of enterprise vocational education operations; and in the assessment phase, they organize mid-term and final examinations for apprentices. The supervision provided by industry associations is crucial for ensuring the compliance, fairness, and effectiveness of vocational talent cultivation.

3.3. Legal regulatory role of the German government over educational enterprises

Germany is a federal state, and its states enjoy a degree of autonomy in educational administration. Within the dual vocational education system, state education departments manage vocational schools, while the federal government exercises direct administrative authority over educational enterprises. On one hand, the federal government, through the Federal Ministry of Education and Research, regularly reports on the implementation and development trends of vocational education in enterprises, providing professional guidance for policymaking. On the other hand, in response to changes in the socio-economic structure and labor demand, the German federal government continuously works to optimize and refine laws and regulations. The 2019 third revision of the Vocational Education and Training Act (BBiG) optimized aspects such as vocational education objectives, management structures, stakeholders' rights and responsibilities, and qualification requirements for training enterprises [18]. These legal improvements provide stronger support for the dual system to adapt to Industry 4.0 and meet the demand for highly skilled labor.

3.4. Financial support role of the german government for educational enterprises

As core providers of vocational education, educational enterprises bear substantial training costs. Recent German education statistics indicate that enterprise investment in vocational education exceeds public funding [8]. To encourage enterprises to remain actively engaged and to alleviate their financial burden, the federal government employs three funding strategies: First, direct subsidies: Federal and state governments provide financial support from national budgets to develop vocational education. Second, indirect subsidies: Enterprises can deduct a portion of their vocational training expenditures from national taxes. Third, training cost subsidies: The government provides subsidies for the training of both apprentices and trainers. Since 2008, Germany has implemented a nationwide Federal Training Bonus policy [19]. This policy offers dynamic training subsidies to educational enterprises based on their own training investment. Enterprises receive full subsidies when the vocational programs they offer align with national development priorities. Through these economic incentives, the German government ensures relatively stable and predictable financial support, attracting capable enterprises to participate in vocational education.

3.5. Top-level coordination by the federal government for school–enterprise core actors

In Germany's dual vocational education system, educational enterprises and vocational schools are managed by different competent authorities and focus on different teaching tasks in terms of both quality and quantity. This arrangement places higher demands on the coordination between these two core actors. Under the dual system, enterprises and schools do not engage in direct educational interactions; instead, their cooperation is top-down coordinated by federal and state governments. Under federal oversight, educational enterprises and vocational schools align their activities according to training regulations and teaching syllabi. The federal government first consults with social partners—including trade unions and employer associations—to

establish enterprise training standards, forming the training regulations. The teaching syllabi for vocational schools, drafted by the Conference of Ministers of Education (KMK), are dynamically updated based on these training regulations. Both documents carry mandatory legal authority nationwide, ensuring standardized, coordinated, and continuous implementation of teaching between schools and enterprises.

4. Pathways and operational mechanisms of German educational enterprises' core practices

The optimal realization of the core functions of educational enterprises in Germany owes much to the stable supply of internal and external resources within the dual vocational education ecosystem, the reasonable role distribution and close collaboration among multiple participating actors, and the shared recognition of the value of deep enterprise participation in vocational education. Together, these factors support and ensure the high-quality implementation of vocational talent development while continuously advancing the internal development of the educational enterprises themselves. The main pathways and operational mechanisms of German educational enterprises' core practices can be summarized in five aspects:

4.1. Multi-level regulation as the foundation: legal framework solidifies enterprise responsibilities

Policies, regulations, and laws issued by the federal government, state governments, and regional guilds define and assign the specific responsibilities and requirements of educational enterprises at every stage of vocational education. Governments at all levels and social industry organizations play a guiding and regulatory role, constructing a comprehensive and rigorous framework of enterprise responsibilities through the formulation and refinement of laws and policies such as the Vocational Education and Training Act (BBiG), Crafts Ordinance, Trainer Qualification Regulations, Youth Labor Protection Act, and Labour–Management Agreements Act. These responsibilities not only establish and consolidate the position of educational enterprises as core providers of vocational education but also provide authoritative and normative guidance for operational implementation, laying a solid legal and regulatory foundation for enterprises to carry out vocational training fully, effectively, and in compliance with the law.

4.2. Enterprise direct investment as the core: autonomous resource provision ensures effective talent development

The quality of talent cultivation directly reflects the educational output generated by the resources invested. By supplying high-quality resources for training, educational enterprises ensure the effectiveness of vocational talent development. The provision of integrated, high-quality educational resources constitutes the core value creation and quality assurance function of the enterprise. Under the regulatory framework of the Vocational Education and Training Act and the Trainer Qualification Regulations, German educational enterprises invest comprehensively in apprentices' development through human resources, finances, physical assets, technology, and learning environments. Regarding teaching staff, enterprises employ highly qualified trainers with recognized national credentials and dual expertise in professional practice and pedagogy. Financially, enterprises bear substantial costs, including apprentice wages and training expenses. For practical teaching resources, enterprises allocate production resources for educational purposes and provide specialized training resources, including equipment, technical tools, production projects, and multifunctional learning spaces. The return on these high-cost investments depends on the high quality of talent development. Talents, as core resources, enhance enterprise productivity and competitiveness, which in turn encourages continuous, high-

quality enterprise participation in vocational education. This creates a self-reinforcing "investment–return" feedback loop that continually strengthens enterprises' core role in vocational education and drives the effective implementation of talent development programs.

4.3. Multi-actor collaboration as the key: coordinated action enhances educational enterprise functions

Consensus and coordinated action among multiple actors are essential for ensuring that educational enterprises effectively implement vocational education. In the dual vocational education system, the primary coordinating actors are the federal government and industry associations. The federal government mainly provides policy coordination through legal frameworks and financial incentives, while industry associations provide educational coordination through vocational education consultation, implementation guidance, training quality monitoring and improvement, and resolution of apprenticeship contract disputes. The federal government and industry associations leverage their complementary functional and resource advantages. Functionally, the actors enhance consultation and communication within the management system, build broad consensus, and enable full-cycle oversight of enterprise-based vocational education, ensuring that training consistently follows established standards, plans, and objectives. In terms of resource coordination, the government and industry associations ensure institutionalized provision of two critical elements—funding and teaching standards—greatly increasing enterprises' initiative and depth of participation. Multi-actor collaboration also enhances the professionalization of educational enterprises' vocational education practices.

4.4. Recognition of skills transmission as the core: balancing self-interest and social value

Historically, the German enterprise apprenticeship system has over a century of cultural legacy. Even with the establishment of modern public vocational schools, enterprises have retained their core role in vocational education, serving as an indispensable actor. German enterprises' adherence to the apprenticeship tradition is rooted in the recognition of its value for both maintaining core competitiveness and fulfilling social responsibility, especially in the context of globalization, diversification, and increasing complexity in socio-economic development. In today's fast-changing socio-economic environment, human talent is a critical competitive resource. Enterprises cultivate apprentices to obtain highly skilled workers aligned with their specific needs, thereby supporting sustainable corporate development. The benefits of talent investment reinforce enterprises' engagement and deepen their understanding of the value of vocational education. Enterprise investment in apprentices is not merely a cost but a predictable source of economic return; providing vocational education to society simultaneously contributes to human resource development and talent reserves.

Beyond fulfilling internal labor needs, enterprises facilitate talent mobility, enhance social recognition, and improve transparency in educational and labor markets [13]. Apprenticeship programs respond to broader socio-economic development and labor market demands, driving industrial transformation, sector development, technology application, and workforce supply. In doing so, enterprises achieve significant social contributions and value creation. Under government policy coordination and governance guidance, enterprises as core actors of vocational education shift from a focus on purely economic value to a coupling of economic and social value [20], achieving a higher-level balance between self-interest and altruistic objectives (see Figure 1).

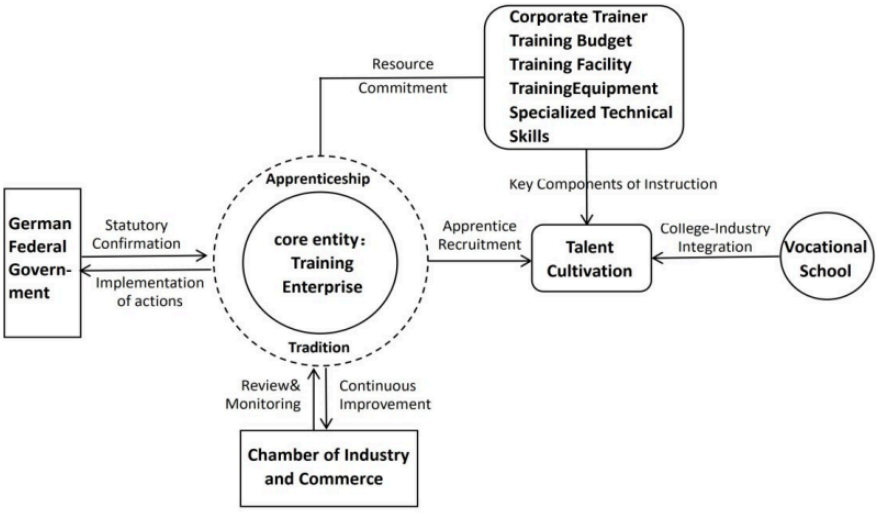

Figure 1. Roadmap for German educational enterprises in primary roles and implementation

4.5. Collaborative operational mechanism of multi-actor participation

Germany's dual vocational education system operates through collaboration among federal and state governments, the Federal Institute for Vocational Education and Training (BIBB), industry associations, enterprises, schools, and social partners (trade unions and employer associations). These actors represent governmental, research, social, market, educational, and economic interests, reflecting the system's "cross-boundary" nature in practice. Within the federal government's legal and policy framework, each actor assumes distinct roles and functions, forming a coordinated community encompassing six dimensions: government, economy, industry, enterprise, school, and research. The system operates with a three-tier structure: the core layer of vocational education organization and implementation, the governing layer responsible for planning and supervision, and the support layer providing research and advisory functions. Within this framework, actors at different levels perform their respective responsibilities in a coordinated manner. Their combined efforts ultimately converge on the core educational implementers—educational enterprises and vocational schools—jointly ensuring the quality of vocational talent development.

5. Insights from the practice of German educational enterprises for the construction of China's industry–education integrated enterprises

China has now entered a stage of high-quality development in modern vocational education, aiming to create a new ecosystem in which the education chain, talent chain, industry chain, and innovation chain are organically connected. In this context, it is crucial to leverage enterprises as key actors in vocational education. The practice of German educational enterprises offers valuable insights for the development of industry–education integrated enterprises in China.

5.1. Establish a stable and binding institutional framework to clarify the responsibilities of industry–education integrated enterprises

At the macro level, the German federal government defines the responsibilities of educational enterprises through legislation, providing a clear guide for their role in vocational education. For China, the construction of industry–education integrated enterprises is an important measure to address industrial structural transformation, technological innovation, and the alignment of talent supply with industry demand. The government, as the planner of modern vocational education governance, plays the most authoritative and effective role in promoting industry–education integration. First, national legislation should explicitly establish enterprises as key actors in vocational education. The 2022 revision of China's Vocational Education Law has legally defined the responsibilities and obligations of enterprises in vocational education, explicitly confirming the role of industry–education integrated enterprises. Legal frameworks ensure that enterprises participate in vocational education in accordance with law, order, and educational needs. Second, pilot programs for industry–education integrated enterprises should be implemented under the guidance of national and provincial authorities. These programs should define detailed standards, requirements, and responsibilities covering the entire process—from enterprise qualification approval, vocational education implementation, to talent cultivation evaluation. Such measures provide clear guidance and standards for enterprises to participate deeply in vocational education, ensuring that their practices are standardized, regulated, and aligned with national development needs. By establishing comprehensive institutional and legal foundations, China can solidify the lawful, orderly, and effective participation of enterprises in vocational education.

5.2. Integrated allocation of industry–education resources to promote direct enterprise investment

The quality of talent cultivation in industry–education integrated enterprises largely depends on the quantity and quality of enterprise-provided educational resources. First, enterprises should strengthen the selection, training, and certification of skilled mentors. In German educational enterprises, high standards of selection and strict certification ensure the quality of enterprise teaching staff. As core actors in vocational education, these mentors are the "soul" of enterprise training, requiring high personal integrity and professional competence to deliver high-quality talent development. Enterprises should establish rigorous selection criteria to ensure that mentors possess both ethical character and technical expertise. Selected mentors can receive education and training through school–enterprise collaborative platforms, and local education authorities should provide certification of their teaching qualifications. This ensures that enterprise mentors meet "dual-qualified" teacher standards and simultaneously promotes the optimization and improvement of school–enterprise dual-teacher teams. Second, enterprises should consolidate relevant resources and transform productive resources into educational ones. Production resources such as facilities, equipment, management systems, technical tools, and data should be adapted for educational purposes without affecting normal operations. This allows talent cultivation to closely align with real production scenarios, providing apprentices with authentic workplace learning experiences and achieving the goal of developing high-level technical skills. Finally, industry–education integrated enterprises should allocate an appropriate proportion of operational costs to vocational education, providing reliable funding for apprentice salaries, training programs, and other educational expenses. Optimized allocation and integration of industry–education resources as direct investment ensures that enterprises' deep participation in vocational education effectively improves talent cultivation outcomes and quality.

5.3. Leverage the supervisory and guiding role of industry vocational education teaching steering committees to ensure the quality of talent development in industry–education integrated enterprises

China's social, political, and economic context differs from Germany, so the role, status, and operational mechanisms of industry associations are also distinct. Currently, Chinese industry associations do not participate in vocational education as independent entities. Instead, they have established industry vocational education teaching steering committees (hereinafter "Teaching Steering Committees" or TSCs), integrating enterprises, vocational colleges, universities, and research institutions onto a single platform for consultation and collaboration. This model forms a uniquely Chinese pathway for industry participation in vocational education. In the process of technical skills talent cultivation, TSCs can fully leverage their resource aggregation advantages to provide consulting, services, evaluation, and supervision to enterprises, thereby promoting industry–education integration. Specifically: Division of Responsibilities: National and local TSCs can correspond to central- and provincial-level administration of industry–education integrated enterprises, providing comprehensive guidance and oversight. They ensure that enterprises comply with standards in all stages of vocational education and support enterprises in exploring and implementing deep engagement pathways, preventing deviation from the intended integration goals. Guidance on Talent Development: TSCs advise on the objectives and processes of technical skills training, ensuring enterprises achieve their talent cultivation targets and maintain coordinated efforts in school–enterprise collaboration. Coordination of School–Enterprise Roles: TSCs align the teaching responsibilities between enterprises and vocational schools. By mobilizing all four types of participants—industry, enterprise, school, and research institutions—TSCs facilitate integrated collaboration in setting training standards, designing curricula, and developing training methods, while providing guidance and services for enterprise-led talent development. Quality Supervision: TSCs monitor and evaluate the quality of talent development through on-site inspections and digital platforms, ensuring that industry–education integrated enterprises meet high standards in vocational education outcomes.

5.4. Enrich and combine external resource support to establish a targeted incentive mechanism for enterprises

In Germany, the federal government provides multiple forms of financial support to educational enterprises, which both incentivizes participation and reduces cost pressures. In China, industry–education integrated enterprises are cultivated through a "build first, certify later" approach. Certified enterprises in the approved directory receive various forms of support. At the national level, a "financial + fiscal + land + credit" multi-factor incentive policy has been proposed. At the local level, some provinces and cities have issued detailed implementation measures—for example, Nanning in Guangxi Province issued the Measures for Further Promoting Open Cooperation in Industry–Education Integration, specifying practical execution methods and quantitative standards. However, many regions have yet to implement such policies comprehensively. Enterprises undertaking industry–education responsibilities must invest in capital, technology, knowledge, facilities, management, and human resources. The associated costs may create resistance for profit-driven enterprises. To transform these challenges into motivation, governments must implement incentive mechanisms and provide diversified resource support and value-added returns: Tracking and Evaluation: Conduct surveys to understand the real educational input of enterprises during vocational training, providing accurate data to inform targeted external resource support. Policy Refinement and Implementation: Accelerate the development of detailed national and local policies for multi-factor incentives, increasing external resource supply and stimulating enterprise engagement in vocational education. Recognition and Incentive Activation: Gradually certify early-stage enterprises, implement the corresponding incentive benefits, and leverage the

demonstration effect of certified enterprises to encourage more enterprises to participate in the construction and cultivation of industry–education integrated enterprises. This approach ensures that enterprises' investment in vocational education is supported, recognized, and incentivized, thereby enhancing their willingness and capacity to actively engage in talent development.

5.5. Strengthen the value guidance of social responsibility to deepen the subjective value recognition of industry–education integrated enterprises

German educational enterprises implement the apprenticeship system with deep social, historical, and cultural roots. The century-long culture of enterprise apprenticeships serves as a foundational value driving enterprises' participation in vocational education. At the same time, the state provides economic incentives—primarily in the form of training subsidies and tax benefits—creating a dual "material + spiritual" motivation that encourages enterprises to assume their primary responsibility for providing high-quality vocational education. This dual motivation yields dual benefits for both enterprises and society: enterprises secure and develop high-level technical talents for sustainable growth, while society receives labor aligned with industry demands and economic development needs. In this way, participation in vocational education allows enterprises to integrate economic and social value.

Historically, Chinese enterprises were once natural participants in vocational education, directly operating secondary technical schools or vocational schools to meet their own development needs. However, during the market economy reforms, the state implemented policies separating social functions from enterprises, and most enterprises gradually withdrew from directly running vocational schools. This reduced both enterprise initiative and available pathways for participating in vocational education [21]. With the current emphasis on modern vocational education and industry–education integration, the state has introduced a range of material and economic incentives to reactivate enterprise engagement. Beyond financial motivation, it is crucial to guide enterprises to reassess their role within the broader strategy of national modernization, and to emphasize cultural and value-based dimensions as part of cultivating high-level enterprises. This involves: Deepening Awareness and Responsibility: Encouraging enterprises to recognize and embrace their role as primary actors in vocational education, reinforcing their sense of mission and accountability in talent development and school–enterprise collaboration. Enhancing Initiative and Contribution: Promoting proactive engagement by enterprises—providing resources, offering expertise, and actively fulfilling their responsibilities in vocational education. Shifting from Instrumental to Value Rationality: Guiding enterprises from a purely tool-oriented perspective focused on economic returns to a value-oriented perspective that integrates social responsibility and long-term societal benefit. Industry–education integrated enterprises should aspire to become exemplars of social and value-driven enterprises, where assuming responsibility for vocational education becomes a conscious mission. By anchoring vocational education in cultural and value-based guidance, enterprises' engagement becomes more sustainable, high-quality, and enduring, ensuring that their contributions continue to generate meaningful societal impact over the long term.

6. Conclusion

This study examines the historical development of educational enterprises within Germany's dual vocational education system and analyzes the practical enactment of their core roles as primary actors in vocational education. The quality and effectiveness of these enterprises' role practice are shaped both by state laws, which legally define their status and responsibilities—enhancing the authority and enforceability of their duties—and by the mature, tightly coordinated mechanisms constructed among multiple societal actors, including

government bodies, industry associations, employer associations, and schools. This multi-actor coordination system not only ensures that German educational enterprises have sufficient educational resources—such as personnel, funding, facilities, and institutional frameworks—to fulfill their core responsibilities, but also provides oversight, consultation, collaboration, and incentives that safeguard and enhance the quality of education. The effective practices of German educational enterprises provide important guidance for China in building industry–education integrated enterprises. Key dimensions include: improving the legal and regulatory framework, ensuring adequate investment of industry–education resources, fostering collaboration among social and organizational actors, implementing precise incentive mechanisms for enterprises, and deepening enterprises' awareness of their responsibility in vocational education to amplify their contribution to national and societal development. These lessons collectively offer a roadmap for promoting high-quality, sustainable industry–education integration in China.

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