Discussion on the Reform Path of Modern Vocational Education from the Perspective of Industry-Education Integration

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Abstract: *Under the wave of the digital economy, technological fission and industrial reconstruction have forced vocational education to break through the dual fragmentation of "education - industry", and its reform effectiveness has become a key variable in the competition for national technological sovereignty and the guarantee of industrial security. This article focuses on three major propositions: the collaborative breakthrough of "technology - talent", the reengineering of social mobility mechanisms, and the reconstruction of global industrial chain rules. It proposes a reform path targeted at "the integration of the four chains" : By building a digital twin platform of "dynamic perception of industrial demand - real-time response of educational supply", it breaks the information cocoon and cognitive lag between schools and enterprises. Taking the "industry college" as the fulcrum, embedding the real R&D scenarios and production processes of enterprises, a symbiotic mechanism is formed where "technological iteration drives course evolution and teaching scenarios feed back to process innovation". Innovate the mutual recognition system of "dual positions and three roles" (teacher - engineer - technology broker), and open up the transformation channel between the accumulation of technical skills and industrial innovation; Establish a three-dimensional evaluation system of "technology contribution rate + job competence + social service efficiency", and promote vocational education to shift from "talent matching" to "value symbiosis". The "multi-party co-governance" model of China's integration of industry and education is exporting Chinese standards through carriers such as the "Lu Ban Workshop", providing a new paradigm of "education chain - industrial chain" co-evolution for the modernization of global vocational education.*

Keywords: *Integration of industry and education; Modern vocational education; Reform path*

1 Significance of the project

The global industrial reshuffle driven by Internet technology is accelerating. Technological changes are reshaping the labor supply structure at an exponential speed. Vocational education has become independent from the original education system and a key part of the country's new knowledge innovation system. The vocational education reform in the context of industry-education integration is not only a targeted measure to address the structural imbalance between "education and industry", but also a key transformation related to the implementation of the national new knowledge strategy, the maintenance of social distribution-based justice, and the competition for the global industrial agenda. It is also the practical implementation of the modernization of vocational education. It is also a firm response to the question of "What education should become" under the era proposition of "How education can serve the future of industries", that is, to achieve the synchronous evolution of the educational paradigm and the industrial ecosystem by taking the "education chain - talent chain - industrial chain - innovation chain" as the four-in-one breakthrough point.

The integration of industry and education offers a fundamental solution for the reform of vocational education to break free from the dual constraints of "technology - talent". At present, the situation that China's industries encounter when crossing the "medium technology trap" is that "high-end technologies cannot be sustained", and many key technologies in international cutting-edge fields are "strangled". There is a shortage of high-end talents, with a gap of tens of millions of technical and skilled personnel needed to meet the demands of fields such as artificial intelligence and quantum computing. Vocational education, as a "reservoir" for the accumulation of technical skills, its reform is directly related to whether the "intermediate technical trap" of industries can be overcome. Through the institutionalized reconstruction of the deep integration of industry and education,

vocational education can break through the fragmentation of a single discipline and build an integrated development ecosystem of "technological breakthroughs - talent cultivation and utilization - technology transfer". The "industry-university-research-application" element demand is "hand-in-hand". Schools and enterprises jointly build "joint laboratories", embedding enterprise research topics into teaching and transforming teaching activities into courses. Students participate in technological breakthroughs to hone their "hardcore skills", while teachers become enterprise technology brokers, providing support for the transformation of enterprise patent technologies into small and medium-sized enterprises, thus forming an "education feeding back to enterprises" model. Therefore, "integration of industry and education" not only resolves the urgent problem of "talent shortage" for enterprises, but also enhances the resilience of the industrial supply chain with "technological support", helping to solve the "bottleneck" predicament[1].

From the perspective of the "horizon", promoting the reform of "common prosperity" in vocational education is a "wall-breaker" for establishing a channel of "serving the country through skills" and reconstructing the order of social mobility. Vocational education has long been "shackled" by the perception of "academic qualifications above all", and skilled workers are facing the dual pressure of "income ceiling" and "occupational stigmatization". For the in-depth development of industry-education integration, it is necessary to break the employment discrimination based solely on academic qualifications through "institutional innovation" and reshape the value coordinates of technical and skilled talents. The construction of an intercommunication and mutual recognition mechanism between "modern apprenticeship system" and "job competency certification", embedding enterprise job standards into the vocational education system, enables skilled workers to enjoy professional respect equivalent to that of knowledge-based talents. Taking "empowering rural construction with vocational education" as the key point, county-level vocational education institutions will be built into "dual centers" for technological breakthroughs in agriculture, rural areas and farmers and the cultivation of local talents, aiming to cultivate "new farmers" who are proficient in digital agricultural technology and good at business management, providing talent impetus for the economic take-off of counties. Such reforms are a response to the practical needs of building a skity-oriented society under the goal of "common prosperity". Moreover, by enhancing the "dual return rate" and "dual status" of technical and skilled talents, they reconstruct the value consensus that "labor is glorious and skills are precious", thereby fundamentally optimizing the vocational education ecosystem.

The third is the reform of vocational education, which aims to achieve the competition for the right to speak on international rules and the reshaping of "Chinese standards" from the "high ground" of global competition and cooperation. With the acceleration of the global industrial chain reconstruction, the "de-Westernization" of educational standards is accelerating. Vocational education, as a "translator" of technical standards and industrial rules, has a typical demonstration significance in its reform direction. Compared with the "dual system" model dominated by Chinese and German capital and the capacity and performance-oriented model of TAFE in Australia and New Zealand, the reform of the industry-education integration model in China more highlights the advantages of the multi-subject multi-governance system of "government - industry - enterprise - school". By leveraging advanced models such as the pilot mixed education system and the 1+X certificate system in the "National Vocational Education Reform Pilot Zone", we provide developing countries with "low-cost and high-efficiency" vocational education solutions that integrate industry and education. Under the background of the "Belt and Road Initiative", China has been exporting its vocational education model of integrating industry and education to overseas markets through institutions such as "Lu Ban Workshops" and "Silk Road Colleges". It has transformed national standards in equipment manufacturing and new energy technology into technical and skills training for countries along the routes, serving Chinese enterprises' "going global" and demonstrating China's responsibility as a major country in education. This kind of reform and innovation that is "based in China and oriented towards the world" is accelerating the competition for the right to speak in international rules and promoting China's transformation from a "participant" in the global industrial chain to a "rule-maker"[2].

The ultimate issue in the development of vocational education is to reconstruct the symbiotic system of "education - industry" and promote the leap of the vocational education model from "running schools within walls" to "open school operation". Introduce the enterprise production process into the teaching field through the "industry college" approach, and build vocational education

colleges into those with dual functions of "cultivating talents" and "researching and developing technologies". Through measures such as "education surcharge deduction" and "tax additional deduction", enterprises' education expenses are incorporated into the national innovation incentive mechanism, transforming vocational education from a "cost center" into a "value center". This reform is not merely a redefinition of the essential attributes of vocational education; it can even trigger new hotspots in interdisciplinary fields such as "industrial education", providing Chinese wisdom for the development of vocational education worldwide. Under the mutual promotion of theoretical achievements and practical innovation, vocational education will provide an "accelerator" function for industrial progress, a "stabilizer" role for social upward mobility, and an "engine" impetus for national competitiveness, building a "people" and "intelligence" high-speed rail platform for China to transform from a "manufacturing giant" to a "manufacturing giant".

2 Synthesis of research

The integration of industry and education in higher vocational education is a key and hot issue in the teaching reform of vocational education. The development and update of the theory and practice of industry-education integration have always been closely related to the upgrading of the world's industrial structure and the changes in teaching reform methods. After the "dual system" practice in Germany at the end of the 20th century attracted worldwide attention, the research on the teaching reform of industry-education integration underwent a paradigm shift from "school-enterprise cooperation" to "symbiosis" of industry and education, achieving a "double helix of education and industry". Theoretical breakthroughs have been made in the integration of industry and education in higher vocational education, with the main research perspectives being "innovation of policy tools, reorganization of governance system structure, and ecological development". Although current academic research closely follows the cutting-edge hotspots and focuses on issues such as "the development of the digital ecosystem and the transformation of the knowledge economy", the technological and industrial revolutions based on the digital economy have gradually emerged. In terms of explanatory power and practical guidance, they are already facing certain crises[3].

On the other hand, scholars' attention to policy tools mostly focuses on the institutional supply and policy incentive mechanisms needed for the integration of industry and education. Regarding the research on "institutional supply" for the integration of industry and education, Some scholars have introduced and compared the "academial-vocational" dual system talent cultivation model of German Universities of Applied Sciences (FH) and the "competency-based" curriculum development model of Australian TAFE, as well as other "system transplantation" experiences and models, providing valuable experiences and model references for China to further promote school-enterprise cooperation and form an integrated development system of industry and education. In response to the predicament of "schools being enthusiastic but enterprises being cold" in the integration of industry and education, the academic circle has proposed research on policy tools such as mixed-ownership education, the 1+X certificate system, and the deduction of education surcharges, and has arranged policy tools on a case-by-case basis to effectively match the development needs of the industry. However, empirical studies on most policy tools show that currently, when most policy tools are implemented in enterprises, they do not "align" with the demands of industrial development. This is mainly manifested in meeting the short-term labor needs of enterprises through low-cost cooperation such as order classes. Therefore, there is a certain "incentive mismatch" in the process of integrating these policy tools into the construction of the production factor development ecosystem of industry-education integration. The phenomenon that the matching degree between this policy tool for integrating industry and education and the demands of industrial development is not high reflects from the side the practical need for the transformation of the vocational education governance system from a "single administrative subject" to a modern "multi-governance" system.

Therefore, institutional reconstruction is a new round of research hotspot. In the face of the increasingly diverse and complex relationship among "government - industry - enterprise - school", researchers have begun to focus on the institutional design of "collaborative governance". Some studies suggest that one of the major institutional advantages of China's integration of industry and education lies in the mechanism and system of "concentrating resources to accomplish major tasks", but it has also brought about a series of problems - the interest barriers among government departments and the standard division among functional departments. For instance, vocational

education and technical education are respectively under the jurisdiction of the education and human resources and social security departments, which leads to a "dual track" of graduation certificates and vocational qualification certificates, increasing the difficulty for enterprises to select talents. To this end, some places have launched "pilot" credit banks, aiming to achieve to varying degrees that "the results of all kinds of education and training can be claimed from each other". However, there are practical difficulties such as inconsistent standards for measurement credits and insufficient willingness of enterprises to invest. This requires the reform of the governance system in vocational education to break away from the traditional "patchwork" system thinking and build a collaborative governance based on the industrial chain ecosystem[4].

Third, the concept of ecological development. Under the background of digital empowerment, the ecological characteristics of the four elements of "technology - talent - capital - data" presented by industrial upgrading have triggered in-depth thinking in the industry about the vocational education ecosystem, and thus given rise to the proposition of "vocational education ecosystem" with critical value, advocating that vocational education in the perspective of industry-education integration be regarded as a "technological and skill innovation point" and integrated into the local industrial innovation ecosystem. For instance, Huawei has jointly established the "Kunpeng Industry College" with Shenzhen Polytechnic, integrating enterprise innovation practices into the teaching activity system. It also transforms the technologies from real projects into teaching cases and project-based course resources, enabling students on campus to participate in solving technical problems of enterprises like Huawei. At the same time, it cultivates the research and development capabilities of the teaching staff in the industry-education integration base. By reverse-outputting technical skills to solve technical problems and further obtaining the "golden key" of higher education, teaching projects and technological achievements can be produced, thereby highlighting the characteristics of vocational education and forming a value creation ecological relationship of "education empowering industries". This effectively breaks away from the original path dependence of in-depth cooperation between schools and enterprises in the form of "resource exchange". However, whether it is ultimately universal and how to provide an ecological development path with universality have become urgent topics to be explored.

Draw on international comparative cases to construct an international comparative perspective on vocational education reform. For example, the basic prerequisite for enterprises to deeply participate in vocational education in Germany's "dual system" is to establish a complete legal guarantee system for vocational education and autonomous institutions such as industry associations. "Vocational schools in Singapore's 'teaching factories' can achieve seamless connection between the education system and the industrial system in a' real production environment '." However, domestically speaking, the lack of manufacturing powerhouses in major manufacturing countries, the imbalance in regional development caused by the "reverse Matthew effect", and the traditional perception formed and continued in the era of "small-scale peasant economy" all determine the premise that "foreign countries" can only "adapt to local conditions" to "imitate and act". Therefore, it is necessary to base on its own reform and opening up and innovate the education model. In recent years, some localized studies of the "Chinese solution" have begun to emerge. For instance, the "Lu Ban Workshop" has been assisting countries along the "Belt and Road Initiative" in exploring the path of "education going global" by exporting China's equipment manufacturing and vocational education standards. This is actually a fundamental shift from the status of a "learner" to that of a "contributor", with a clear direction and a leading role in transcending development. It marks a new starting point for vocational education research in China, indicating that vocational education research in China has already acquired a profound global perspective and a sense of global responsibility[5].

The concept map of industry-education integration is shown in Figure 1. Existing research on the integration of industry and education has shown that the theory of the integration of industry and education has initially formed the disciplinary connotation concepts of vocational education (employment orientation, school-enterprise collaboration), the integration of industry and education (group cooperation, interest correlation), and industrial transformation and upgrading (quality improvement and efficiency enhancement, machine substitution), as well as the innovation of school-enterprise cooperation models in vocational education, the integration mechanism of the industrial chain, and the in-depth participation of enterprises. It has laid a solid foundation for the reform of industry-education integration in vocational education. However, there is room for

refinement and deepening in the concept and mechanism of industry-education integration in both theory and practice: First, break away from the paradigm of "internal optimization of the education system" and establish an analytical framework within the industrial chain ecosystem; Second, attach importance to the law of technological and skill replacement in the digital economy era, and model and predict dynamic capability demands. Third, attach importance to the "humanistic logic" of vocational education and solve the dualism problem of technical rationality and humanistic care. Based on this, future research on the integration of industry and education needs to explore the micro-mechanism of the integration of the "education chain - talent chain - industrial chain - innovation chain", and discuss the Chinese path for the modernization of vocational education in China[6].

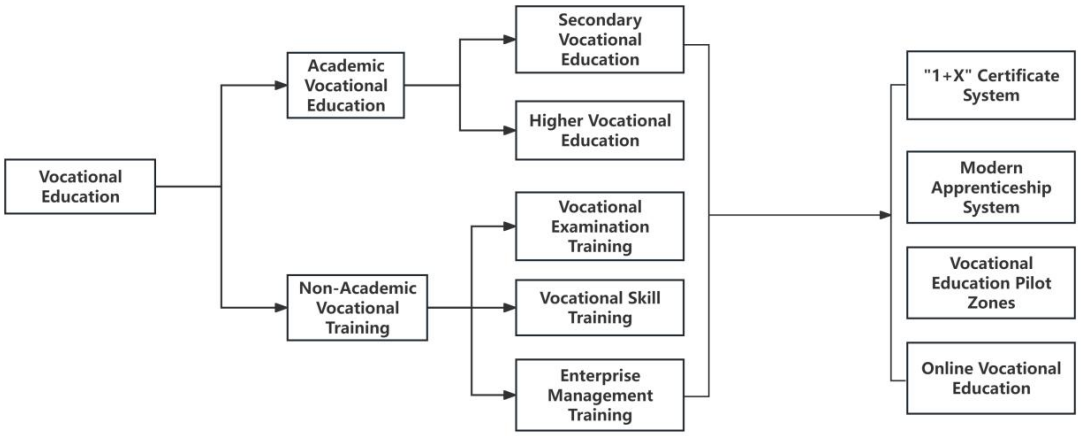

Figure 1:Classification and Development Modes of Vocational Education

3 Analysis of the current situation

3.1 The discontinuity of information interaction and cognitive dislocation

The information imbalance between vocational education subjects and industries has risen from a communication issue to a barrier to the thinking mode of cognitive subjects. Schools are the main body of vocational educators, and the knowledge production process maintains the disciplinary thinking framework. In contrast, industries are constantly updated with technological logic based on market demand. The knowledge production paradigms they uphold are fundamentally different. Schools' understanding of industries mostly starts from the detailed skills of production positions, and they lack an understanding of the changes in the connotation of job capabilities brought about by technological changes. For instance, in the transformation of traditional industries by artificial intelligence technology, the adaptability of job positions to technological development does not merely require workers to be proficient in applying specific operational skills in production positions. More importantly, it demands that workers possess the ability to perceive data and the intelligent processing ability with algorithmic thinking. However, the content system of vocational education teaching still leans towards the skill teaching of traditional mechanical labor operations. As a result, a knowledge gap is formed between the industry and the industry.

The predicament of enterprises' motivation to participate in the integration of industry and education has lengthened the distance of information communication between the two sides. Most enterprises regard vocational education as an investment in human capital rather than industrial capital. Enterprises are more inclined to complete the tasks of social recruitment, that is, to screen the labor force from the perspective of the economic tasks of the enterprise rather than the talent incubation of human capital investment. At the same time, they also neglect the sustainable development ability of talent cultivation under the "order class" cooperation form.

Firstly, the mechanisms of vocational colleges themselves are not perfect. The setting of majors lags behind the development of the industry. There is a lack of scientific analysis in the establishment and development of new majors. The development of courses lacks technical support. The publication cycle of technical textbooks is more than several years, which cannot accurately reflect the technological innovation of the industry. Such an information mechanism has led to the continuous "misaligned" operation of vocational education supply and industrial demand. The professional talents it cultivates have problems such as aging skills or a single ability structure, which cannot meet the requirements of industrial transformation and upgrading[7].

3.2 The disruption of the education system and the fragmentation of resources

First, the phased characteristics of "terminal" talent cultivation are incompatible with the "continuous" demand for industrial talents. Most vocational college education is "terminal" education that ensures employment upon graduation. However, modern industrial talent demands that workers possess "continuous" lifelong learning capabilities. This has led to the talent cultivation process being artificially and uniformly divided into two stages: the "school education stage" and the "enterprise training stage", lacking necessary connections. For instance, during students' on-the-job internships, vocational colleges simply send them all to enterprises for internships without providing necessary pre-job training and process guidance. As a result, internships often turn into a form of cheap employment.

The fragmentation of systems restricts the in-depth integration of resources between schools and enterprises. The management, operation, allocation, evaluation systems and mechanisms of the education sector and the industrial sector are quite different, and it is difficult for the two parts to establish complementary platforms. At present, vocational schools can only accept administrative management and have limited autonomy in aspects such as student recruitment, specialties, courses and employment. Enterprises are deeply constrained by the benefit-oriented approach and find it difficult to pay much attention to their short-term costs. The resources of schools and enterprises are always in a process of "physical superposition" and "chemical combination".

Second, the vocational qualification certificate system in the employment system is disconnected from the industrial skills certification system. Professional qualification certificates are organized by educational functional departments, focusing on knowledge acquisition, while industrial skills certifications are organized by industry enterprises, emphasizing skills assessment. There are huge differences between the two in terms of certification standards, assessment models, and the use of effectiveness. This leads to students being regarded as uncertified by enterprises even after obtaining numerous certificates at school. As a result, enterprises have to organize additional skill certifications, causing another waste of social resources.

3.3 The distortion of the evaluation mechanism and value deviation

The "administrativeization" of the evaluation index system for vocational colleges. The evaluation index system led by the education department focuses more on objective and visible indicators such as the amount of resource allocation, the number of school buildings, full-time teachers, and scientific research projects, rather than paying more attention to the quality of talent cultivation and the ability to serve society as in general educational institutions. Some vocational colleges regard the indicators of assessment and inspection as their main tasks, which affects the deepening of industry-education integration in vocational colleges. For instance, in order to meet the proportion target of "dual-qualified" teachers, schools adopt centralized training to obtain the qualification of "dual-qualified" teachers, but this has not truly promoted the improvement of teachers' practical abilities[8].

The second is the deviation of evaluation standards - the absence of enterprises as the main body and institutional deficiencies have led to the evaluation standards deviating from the industrial sector. At present, based on the objective reality that the autonomy of vocational colleges is relatively low, in the setting of the evaluation mechanism, it is common to regard enterprises as institutions that use the labor force, without effectively granting enterprises the right to participate in the evaluation. The real

demands of enterprises often cannot be reflected in the evaluation indicators. Vocational colleges will "tailor-make" their talent cultivation goals based on the standard indicators determined by the education department for school evaluation and ranking. The students they cultivate often have no connection with the employment demands of the industry. The distortion of the evaluation mechanism has led to vocational education being "satisfactory to the education department but not to enterprises".

First, the utilitarian use of evaluation has restricted the deepening of reform. At present, the evaluation results of vocational education mainly focus on ranking schools and applying for projects. The guiding role of serving the improvement of vocational education and teaching is not prominent. After schools receive excellent grades, they lack the motivation to make further efforts, which leads to the predicament of "filling in the gaps before evaluation and relapsing old problems after evaluation" in the reform of industry-education integration in colleges and universities. This makes the reform of vocational education like a "fortress on the beach". Degenerate into formalism.

3.4 The shackles of the institutional environment and the imbalance of interests

The imperfect supply of systems has limited the depth of integration between industry and education. The laws and regulations do not clearly define the rights and responsibilities that enterprises should enjoy and bear in school-enterprise cooperation, and lack guidance. For instance, tax preferential policies and financial support are not in place, and the cost of benefits that enterprises have to pay for participating in vocational education is relatively high. There is a serious lack of guidance, and the motivation for cooperation between schools and enterprises is insufficient, which makes it difficult for school-enterprise cooperation to effectively integrate industry and education[9].

The issue of distribution of benefits from the integration of industry and education. Under the development situation of industry-education integration dominated by the improvement of the quality of education and teaching in vocational colleges, the pursuit of benefits by enterprises and schools, and the pursuit of industrial technology development by the government, there exist substantial and obvious issues of interest coordination. Since the integration of industry and education is a short-term cooperation based on project-based systems and has not established a long-term and stable mechanism for sharing benefits, after the completion of the cooperative project, vocational colleges often take the cost of undertaking horizontal projects from enterprises as the main source of income. However, there are no relevant regulations between schools and enterprises regarding the intellectual property rights of research results and their benefits. In this way, it is very likely to cause the breakdown of the cooperative relationship after the completion of the project.

The fragmentation of the governance pattern has increased the difficulty of reform. Vocational education is linked to multiple departments such as education, human resources and social security, and economic and information technology. However, there is a lack of unified overall coordination among these relevant departments in terms of policy formulation, resource input, and standard setting. The phenomena of conflicting policies and resource division are obvious, and the standards of the vocational education system are inconsistent. For instance, vocational college graduates receive both academic qualification certification from the education department and vocational skills level certification from the human resources and social security department, which increases the difficulty for graduates to find jobs. The fragmented governance pattern of vocational education makes it hard for industry and education to be integrated in a coordinated manner.

The solution to the integration of industry and education is the reform of the "education supply side". That is, abandon the outdated educational logic and establish an industry-oriented market response system; Break down the educational walls between schools and society and build a mutually beneficial and win-win community with a shared future; Break the fragmented thinking of evaluation and build a multi-party collaborative accountability mechanism. Only in this way can the integrated win-win situation of vocational education and industrial development be achieved, thereby serving the driving force transformation of economic growth.

4 Research and Practice Content

4.1 Reconstruct the knowledge production paradigm and build a two-way enabling information hub

To weaken the gap between vocational education and industrial knowledge paradigms, a fluid and diverse information exchange system should be established. It is necessary for vocational education colleges to overcome the disciplinary thinking orientation and establish a two-way and mutually promoting curriculum setting mechanism of "industrial demand - talent cultivation". Firstly, a course design decision-making group should be established, led by enterprises and composed of technical personnel, key teachers from vocational colleges, and scholars from third-party institutions. This group should track and analyze the prediction of the cutting-edge of industrial technology and the reshaping of job capabilities, and integrate the concepts of artificial intelligence algorithm thinking at the forefront of technology and data technology management of industrial Internet into the course design. Secondly, relying on the school-enterprise community platform mechanism of "industry college + technology laboratory", enterprises can design actual projects as practical training teaching plan libraries, and the technical and breakthrough projects of vocational education colleges can be transformed into school-based scientific research topics, completing a collaborative operation of technical knowledge production and application[10].

The company needs to change its perception and attitude towards vocational education and introduce it into the strategic human resource system for the company's development. Large companies should participate in organizing school-enterprise alliances, set up special funds for school-enterprise cooperation and training, and take part in the formulation of industry talent standards and industry vocational skills systems through school-enterprise collaboration. For instance, equipment enterprises can cooperate with vocational colleges to establish "Intelligent Factory Training Centers", introducing specific scenarios such as the transformation of digital workshops and the debugging of intelligent production lines into the classroom, allowing students' skills to be iteratively upgraded during their participation in the technological transformation of enterprises. At the same time, a "dual-position mutual employment" model is carried out, where enterprise engineers serve as teachers in schools and school teachers work as engineers in enterprises. Engineers from companies are regularly or irregularly arranged to give lessons in schools, while school teachers follow to enterprises to complete technical breakthroughs and other projects.

Strengthen the construction of the "industry Radar" information processing center within the school, establish a dynamic adjustment mechanism for professional Settings, set up professional development committees with industries, key enterprises in school-enterprise cooperation, and graduates as the main body, conduct a forecast and analysis of the supply and demand of industrial talents once a year, and establish a professional early warning and exit system. Teaching reform and course development should go beyond the teaching and learning experience of individual teachers. Course development should take enterprise technicians, course experts in vocational colleges and graduates as the main body, and carry out modular course development work with the job ability model as the carrier. Teaching reform should take real cases of enterprises as the basic materials for compiling teaching materials, and implement a regular update mechanism of "minor revision once a year and major revision once every three years" for teaching materials to dynamically meet the changes in teaching content and technology.

4.2 Reshape the lifelong education ecosystem and build a collaborative education community between schools and enterprises

To address the awkwardness of the limitations, stages and singleness of vocational college education, it is necessary to explore the "lifelong vocational education model" that combines "school-enterprise-learning - work practice - social further education". Vocational colleges should resolutely change the traditional concept that "education ends after students graduate", conduct dynamic tracking of the learning and growth information of graduates, and continue to provide training and learning opportunities for the career growth of graduates. For instance, by participating in the "Micro-certificate Course Training for Enhancing Vocational Skills" organized by industry associations, graduates can adjust their relevant skills for work in accordance with the development of industrial technology. They can choose courses such as intelligent manufacturing and industrial big

data at vocational colleges at any time, accumulate the credits they have earned, and use them as credit accumulation for entering higher-level studies and connecting with vocational education pathways.

Enterprises and educational institutions establish a "from shallow to deep" talent cultivation and promotion model to achieve a step-by-step advancement from apprentice to assistant engineer to engineer. The school and enterprises jointly build a "modern apprenticeship system". During their studies, students master basic skills, participate in the practical development of projects during their internships, and obtain practical skills qualification certificates recognized by enterprises when they are employed. Enterprises incorporate schools into the strategic system for human resource development and training, assign mentors and customize training plans for students, and use the internship period as a reserve period to enhance their own technical capabilities.

The industry should establish a dual-track certification mechanism with the vocational qualification certificate system, and industry standards should be organically combined with the national "dual-certificate intercommunication" mechanism. Based on industry standards, industry associations, through vocational colleges, implement industry standards in their courses. Students can obtain academic certificates and industry certification certificates upon graduation. For students in electronic information colleges and universities who are trained through industry courses, international industry standards such as Huawei certification and Cisco certification can be used as substitutes to achieve the integration of courses and certificates. The certification results of industry qualification certificates should be recognized by the corresponding institutions, and no secondary certification should be conducted for personnel from other institutions, thereby reducing the employment costs of employers.

4.3 Reconstruct the diversified evaluation system and establish a collaborative mechanism for quality assurance

To reform the administrative nature in the evaluation methods of vocational education, a multi-party participation vocational education quality evaluation mechanism should be established, including government participation, enterprise participation, industry participation and school participation. It is necessary to form an evaluation orientation with the goal of "meeting industrial demands", and take the contribution rate of enterprise technological transformation, the contribution rate of graduates' job competence, social service capacity, etc. as one of the evaluation indicators. The indicator system for evaluating the social contribution of vocational colleges proposed by industry associations, such as the number of enterprises participating in technological transformation projects, the number of technology patents obtained and transformed, and the number of industries participating in the formulation of technical standards, will be regarded as important indicators in the evaluation index system for the social contribution of vocational colleges.

Colleges and universities should play a greater role in the development of vocational education in our country. They should participate in the professional construction, curriculum setting and educational reform, as well as quality assessment of vocational colleges in our country. They should also be involved in the production demands of enterprises and the market demands of products, and introduce the evaluation and feedback of enterprise demands and market demands into the process of talent cultivation. The vocational education evaluation mechanism with enterprises as the main body and leading role is particularly important. Vocational colleges and large enterprises with comprehensive influence should "integrate the two" in formulating talent cultivation plans. The pre-employment adaptation period of college graduates in enterprises, the innovation and application ability of technical level, and the potential for further career development should be taken as evaluation dimensions to make an objective and comprehensive assessment of the educational ability level of higher vocational students cultivated by vocational colleges during their school years. After in-depth cooperation with vocational colleges, automotive manufacturing companies can jointly develop a "quality tracking system" to track students' job performance in various links or positions of the enterprise after they start working, and update the database in real time for reference in professional adjustments and course content modifications.

The application of evaluation results should get out of the utilitarian misunderstanding and form an evaluation feedback mechanism of "continuous improvement". It is suggested that vocational colleges

take the evaluation results as the basis for adjusting majors, optimizing courses and training teachers, and form a quality assurance process of "evaluation - feedback - improvement". "Visual evaluation issue - Setting up practical training equipment;" "Visual Evaluation Issue - Supplement the Practical Training Module". Moreover, it is suggested that the evaluation results be made public to accept public opinion supervision and form a new mechanism of promoting construction through evaluation.

4.4 Optimize the institutional supply system and build a new pattern of collaborative governance

In terms of breaking through the institutional and mechanism obstacles to the reform of vocational education, a "compatible incentive" policy for the integration of industry and education should be established. At the national level, the rights and obligations of enterprises participating in vocational education should be established through the provisions of the "Law on Promoting the Integration of Industry and Education", as well as detailed institutional arrangements for tax incentives, financial support, and land preferences for enterprises involved in vocational education. For instance, it is stipulated that for enterprises deeply involved in cooperative education with enterprises, the investment amount can be deducted from the enterprise income tax according to the prescribed standard proportion, and enterprises in school-enterprise co-built training bases will be given preferential land use indicators, so that both enterprises and education can achieve a virtuous cycle of rewards and benefits.

The division of labor among the stakeholders should go beyond the narrow circle of the project-based system. Within the scope of the project-based system, a "shared common interests" cooperation should be established. It can be attempted to form a "mixed-ownership industrial college" by "school + enterprise", where enterprises can contribute equipment, technology, funds, etc. as shares, and vocational colleges can contribute teachers, venues, brands, etc. as shares, to build a community of interests for enterprises. For instance, in the field of intelligent equipment manufacturing industry, enterprises update equipment and expand markets, while vocational colleges cultivate talents and conduct technological research and development. Profits are distributed according to shares, and business risks are shared together. This has shifted from "short-term cooperation" to "sharing common interests".

Transform the fragmented current situation of traditional vocational education governance and establish a "linkage mechanism" for collaborative governance of vocational education. The government will establish a leading group for vocational education reform, integrate departments such as education, human resources and social security, and economic and information technology, and form a collaborative management mechanism featuring "policy sharing, standard sharing, and resource sharing". For instance, it will integrate the vocational training certificate system with the academic education certificate system, implement the "credit bank" system, and open up promotion channels for skilled workers. A joint conference system for vocational education reform has been established to negotiate and solve deep-seated issues such as property rights and intellectual property rights in school-enterprise cooperation from time to time, which has a significant aggregative effect.

5 Conclusion

Vocational education reform from the perspective of industry-education integration belongs to the "four-chain integration", which is a systematic reform and reconstruction of the structural contradiction between "education and industry", and a mechanism reform oriented towards solving the structural contradiction between supply and demand in talent cultivation. The research on the reform of vocational education from the perspective of "Four-chain integration" reveals its contradictions and predicaments in the information chain, the education chain, the evaluation chain and the institutional chain, and explores the paths from the knowledge production chain, the lifelong education chain, the diversified evaluation chain and the institutional supply chain. In the education chain and information chain, it is necessary to break through the internal optimization thinking and build a dynamic adjustment mechanism oriented by the demand of the industrial chain. In the system chain and interest chain, it is necessary to break through the institutional barriers between schools and enterprises and build interest consortia and symbionies. In the evaluation chain, it is necessary to establish a

multi-evaluation and incentive system and dynamic system for compound subjects, so as to achieve the leap from talent providers to industrial enablers. The "Four-chain integration" vocational education reform involves changes in educational concepts, systems and governance, and is related to the upgrading of national industries, the fairness of social mobility and the discourse power of the global industrial chain. In the future, the "Four-chain integration" vocational education reform still needs to focus on the micro-mechanism of the reform and start from the reshaping of the vocational education ecosystem by digital technology. It is also necessary to focus on putting people first, alleviate the opposition between technological rationality and humanistic logic, and make the reform of vocational education the driving force for industrial upgrading, social class mobility and national competitiveness, so as to promote China's progress towards becoming a "manufacturing power".

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