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The Status and Optimization Countermeasures of Specialty Setting in Shanghai Higher Vocational Education in the Context of Industrial Upgrading

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Abstract: From the perspective of Shanghai's industrial transformation and upgrading, an empirical analysis of the matching degree between the vocational specialty settings in Shanghai in 2023 and the industrial structure reveals that to a certain extent, the specialty structure of Shanghai's higher vocational colleges has adapted to the development needs of the city's industry. However, there are issues such as low specialty concentration and aggregation, and irrational distribution of specialty points. Vocational education in Shanghai should be led by government macro-control and multi-party dynamic adjustment, expanding the enrollment scale of key industries and strategic emerging industries, focusing on building key characteristic specialty groups, promoting school-enterprise cooperation in specialty construction, and upgrading the digitalization of specialties to enhance the matching degree between specialty settings and industrial development.

1. Introduction

In recent years, the continuous development and improvement of China's vocational education system have cultivated a large number of talents with intermediate and advanced professional skills. They have played a key role in improving the overall quality of the labor force, promoting comprehensive economic and social progress, and aiding industrial transformation and upgrading. Ideally, the vocational education of higher education institutions should complement and achieve a win-win situation with the regional economy, forming a mutually encouraging synergistic effect. However, in practice, the specialty settings of higher vocational education often struggle to keep up with the pace of industrial adjustments and fail to fully adapt to the new demands of industrial upgrading. [1] Higher vocational colleges should deeply understand the leading industries and industrial chain composition of their region, accurately grasp their own specialty characteristics for specialty setting and positioning, provide strong talent support for industrial development, and promote local economic development.

To deepen the reform and enhancement of the discipline specialty structure, in February 2023, the Ministry of Education and four other departments issued the "Plan for the Adjustment and Optimization of the Structure of General Higher Education Disciplines and Specialties" [2], which sets

a goal to structurally optimize and adjust about 20% of higher education disciplines and specialties by 2025. The plan emphasizes the establishment of innovative disciplines that will match emerging technologies, industries, models, and market trends, while gradually phasing out disciplines and specialties that do not adapt to the current economic and social development.

2. Analysis of the Current Status of Economic Development and Industrial Structure in Shanghai

As China's economic center, Shanghai's economic aggregate has always been at the forefront of the country, showing a steady and progressive trend in economic development. Shanghai's Gross Domestic Product (GDP) grew from 2.32 trillion yuan in 2013 to 4.72 trillion yuan in 2023, ranking first in the country, with a per capita GDP of 190,800 (all data in this article are calculated and organized based on the National Vocational College Specialty Setting Management and Public Information Service Platform and the relevant data of the Shanghai Municipal Bureau of Statistics). The "14th Five-Year Plan and 2035 Long-Term Goals Outline for National Economic and Social Development of Shanghai" [3] proposes that to adapt to the trend of a new round of technological revolution and industrial transformation, Shanghai will accelerate the formation of a high-end industrial cluster that promotes the strategic emerging industry and the digital transformation of traditional industries, and deeply integrates advanced manufacturing with modern services.

The GDP of Shanghai in 2021-2023 were 432.1485 billion, 446.5280 billion, and 472.1866 billion yuan, respectively. The added value of the primary industry was 9.997 billion, 9.695 billion, and 9.609 billion yuan, respectively, the added value of the secondary industry was 114.4932 billion, 114.5843 billion, and 116.1297 billion yuan, respectively, and the added value of the tertiary industry was 316.6556 billion, 330.9742 billion, and 355.0960 billion yuan, respectively. In 2023, Shanghai's GDP grew by 5.0% compared to the previous year, with the growth rates of the primary, secondary, and tertiary industries being -1.5%, 1.9%, and 6.0%, respectively. In 2022, due to the impact of the epidemic and the complex and severe domestic and international economic environment, the GDP decreased by 0.2% compared to the previous year, with the primary industry decreasing by 3.5%, the secondary industry decreasing by 1.6%, and the tertiary industry still maintaining a growth of 0.3%. In the past five years, the tertiary industry has always maintained a high growth rate, the secondary industry has slowed down in the past two years, and the primary industry has been on a downward trend for five years, with the rate of decline slowing down.

Overall, the industrial structure of Shanghai in the past three years has shown a typical "three-two-one" industrial development pattern, with the added value ratio of the industrial structure adjusted from 0.23:26.49:73.27 in 2021 to 0.20:24.59:75.20 in 2023. The proportion of the primary and secondary industries continues to decrease, while the proportion of the tertiary industry increases. The tertiary industry occupies an absolute dominant position, indicating that Shanghai has formed an industrial structure dominated by the service industry.

3. Analysis of the Current Status of Specialty Setting in Shanghai Higher Vocational Colleges

In October 2023, the Shanghai Municipal Education Commission issued the "Ten Measures to Promote the High-Quality Development of Shanghai Higher Vocational Education" [4], which mentioned maintaining a scientifically reasonable specialty scale, adding a number of specialties serving the three leading industries and six industrial clusters, revoking a number of specialties that do not adapt to the economic and social development of Shanghai, making full use of digital technologies such as artificial intelligence, promoting the digital upgrading and transformation of a number of traditional specialties, and continuously building a number of high-level specialty groups.

3.1. Coverage of Specialty Setting in Shanghai Higher Vocational Colleges

In 2021, the Ministry of Education of China issued the "Vocational Education Specialty Catalog (2021)" (hereinafter referred to as the new "Catalog"), which uniformly uses the three-level classification of specialty categories, specialty classes, and specialties, and integrates the design of different levels of vocational education specialties, with a total of 19 specialty categories, 97 specialty classes, and 1349 specialties, including 744 specialties for higher vocational colleges. [5]

In 2023, among the specialties enrolled by Shanghai's higher vocational education colleges, Shanghai has set up 18 specialty categories covered by the new "Catalog," with a coverage rate of 95%. There are 68 specialty classes, with a coverage rate of 70.1%. Among the 68 specialty classes, Shanghai has set up a total of 247 specialties, with an overall specialty opening coverage rate of 32.9%. Among the 247 specialties, the specialty categories with a coverage rate of more than 50% are tourism, civil engineering and construction, journalism and communication, culture and art, transportation, and electronics and information. The specialty categories with less coverage include resources, environment, and safety, agriculture, forestry, animal husbandry and fisheries, medical and health, public security and justice, and public management and service, with the lowest coverage being the energy, power, and materials category.

3.2. Distribution of Specialty Categories in Shanghai Higher Vocational Colleges

Looking at the specialty setting, the top three specialty categories set by all recruiting schools are finance, commerce, and trade, equipment manufacturing, and electronics and information, and the average number of specialty points in these three categories is also relatively high, indicating that these three categories are more concentrated in the schools. The categories ranked at the bottom are agriculture, forestry, animal husbandry, and fisheries, biology and chemical engineering, public security and justice, energy, power, and materials, and light industry and textile engineering. The average number of specialty points in these categories is also the lowest, indicating that only a few schools offer these categories. Among them, the specialties of agriculture, forestry, animal husbandry, and fisheries are almost all concentrated in the Shanghai Vocational College of Agriculture and Forestry. The specialties of biology and chemical engineering are mainly set in the Shanghai Vocational College of Agriculture and Forestry and the Shanghai Modern Chemical Industry Vocational College. The specialties of public security and justice are concentrated in the Shanghai Public Security College. The two specialties in the energy, power, and materials category are set in the Shanghai Civil Aviation Vocational College and the Shanghai Modern Chemical Industry Vocational College. The specialties of light industry and textile engineering are almost all set in the Shanghai Publishing and Printing College.

Looking at the number of specialty points, in 2023, the higher vocational education in Shanghai has a total of 696 specialty points (the specialty points in the last two years of the five-year integration of higher and secondary vocational education are not counted repeatedly). The top four specialty categories in terms of the number of specialty points are finance, commerce, and trade with 101, culture and art with 99, equipment manufacturing with 89, and electronics and information with 75, with a total of 364 specialty points, accounting for 52.3% of the total number of specialty points. The categories ranked at the bottom are light industry and textile engineering with 7, biology and chemical engineering with 6, public security and justice with 6, energy, power, and materials with 2.

3.3. Concentration and Aggregation of Specialties in Shanghai Higher Vocational Colleges

"Specialty concentration" reflects the popularity of a certain professional field in various educational institutions. If a specialty is offered by many colleges, it indicates that the specialty is

widely distributed, resulting in a lower specialty concentration; on the contrary, if a specialty is only offered by a few colleges, it usually means that these colleges have significant expertise and characteristics in this field, with a higher specialty concentration.[6]Among the 247 higher vocational specialties offered in Shanghai, 126 specialties have only one specialty point institution, 45 specialties have two specialty point institutions, 20 specialties have three specialty point institutions, and the remaining 56 specialties have an average of 9 specialty layout institutions. The top five specialties in terms of the number of layout points are mechatronics technology, big data and accounting, international business, modern logistics management, and hotel management and digital operation. This reflects that some specialties in Shanghai's higher vocational colleges have a high repetition rate in setting and lack differentiation.

"Specialty aggregation" describes the proportion between the number of specialty categories in a certain discipline field in educational institutions and the total number. If a college offers a variety of discipline specialty categories and the specialty distribution is relatively wide, then its specialty concentration is low; on the contrary, if the college's specialty setting is relatively concentrated and has more specialties in certain discipline fields, it shows a higher specialty concentration. The specialty concentration can be quantitatively assessed by calculating the ratio of the total number of specialties to the total number of discipline specialty categories. [6]The number of discipline specialty categories set by the same school should not be too many, and the existing educational resources should be fully utilized to focus on several specialty categories and improve the efficiency of running a school. The college with the highest specialty aggregation in Shanghai's higher vocational colleges is the Shanghai Film Art Vocational College, followed by the Shanghai Communications Vocational College, the Shanghai Arts and Crafts Vocational College, and the Shanghai Publishing and Printing College. These colleges have formed distinctive specialty groups in some specialty categories. Only 13 colleges have a specialty aggregation greater than 3, and overall, the specialty aggregation is not high. There are 20 colleges that offer more than 6 specialty categories, which reduces the specialty aggregation.

4. Analysis of the Matching Degree between Specialty Setting in Shanghai Higher Vocational Colleges and Industrial Development

4.1. Distribution of Shanghai Higher Vocational Specialties in the Three Industries

According to the industrial structure, the specialty categories in the new "Catalog" correspond to industries, specialty classes correspond to industries, and specialties correspond to occupational groups or technical fields. The primary industry mainly involves the agriculture, forestry, animal husbandry, and fisheries category; the secondary industry involves 8 specialty categories such as 42 resources, environment, and safety, 46 equipment manufacturing, and 49 food, drugs, and grain; the tertiary industry involves the remaining 10 specialty categories such as 50 transportation, 51 electronics and information, and 53 finance, commerce, and trade. [7]

In 2023, the coverage rate of specialties in Shanghai's higher vocational college facing the tertiary industry was the highest, and most of the specialties facing the primary and secondary industries have not been set up. In terms of the proportion of the number of specialties, there were 11 specialty points for the primary industry in 2023, accounting for 1.58% of the total number of specialty points, 176 specialty points for the secondary industry, accounting for 25.29% of the total number of specialty points, and 509 specialty points for the tertiary industry, accounting for 73.13% of the total number of specialty points. The ratios of the number of specialties and the number of specialty points corresponding to the three industries are 3.64, 28.34, 68.02, and 1.58: 25.29: 73.13, respectively, all of which clearly show a "three-two-one" pattern, consistent with the overall industrial structure development trend of Shanghai.

4.2. Analysis of the Adaptability of Specialty Structure in Shanghai Higher Vocational Colleges and Industrial Structure

To measure the consistency between the structure of higher vocational education specialty settings and the industrial demands of the region, the structural deviation index D can be used to measure the specialty structure and industry structure. The calculation formula for this index is: D = (the proportion of specialty points divided by the proportion of industrial added value) minus 1. When the D value is greater than zero, it indicates that the higher vocational colleges may have too dense settings in some specialty fields; on the contrary, if the D value is less than zero, it means that the settings in some specialty fields may be insufficient. The closer the deviation index value is to zero, the higher the consistency between the specialty settings and industrial demands; the larger the value, the lower the consistency. [8]

As shown in Table 1, the calculated professional-industry structure deviation for the three industries is 6.9, 0.03, and -0.03, respectively, with an average absolute structural deviation of 2.23, and there is some deviation in the fit of each industry. In 2023, the proportion of specialty points for the primary industry in Shanghai is higher than the proportion of added value, showing a positive deviation, and the deviation is relatively high. There is an oversupply of professional and technical personnel corresponding to the primary industry in Shanghai's higher vocational colleges, and the specialty structure needs to be adjusted and optimized. The professional-industry structure deviation for the secondary industry shows a positive deviation, and the professional-industry structure deviation for the tertiary industry shows a negative deviation, with both deviations being relatively small, indicating that the overall professional structure of the secondary and tertiary industries is well matched with the industrial structure.

Table 1: Deviation of Specialty Structure and Industrial Structure in Shanghai Higher Vocational Colleges in 2023

Industry	2023		
	Industrial Structure Ratio	Specialty Point Ratio	Structural Deviation
Primary	0.20	1.58	6.9
Secondary	24.59	25.29	0.03
Tertiary	75.20	73.13	-0.03
Average Absolute Value of Structural Deviation			2.23

5. Discussion

Summarizing the key findings, our research reveals the specialty setting and point ratio of the primary industry in Shanghai is higher than the proportion of added value, and the development is relatively saturated. Relevant colleges should pay attention to the development of modern agricultural science and technology, agricultural informatization, agricultural product processing and marketing, and adjust the curriculum setting and teaching content to meet the development needs of Shanghai's modern agriculture. The number of specialty points for the secondary industry in Shanghai is appropriate, but the distribution of specialty points is unreasonable, and the number of specialty settings is relatively small. In addition to the civil engineering and construction specialty setting coverage rate exceeding 60%, the three categories with the lowest coverage rate of specialty openings are resources, environment, and safety, energy, power, and materials, and water conservancy. Among

them, mechatronics technology, numerical control technology, and automotive detection and repair technology need to control the number of specialty points, and the era of Industry 4.0 should pay more attention to the intelligent transformation and upgrading of existing specialty points. Colleges need to appropriately increase new specialties such as intelligent environmental protection equipment technology, safety intelligent monitoring technology, digital design and manufacturing technology, intelligent manufacturing equipment technology, intelligent connected vehicle technology, new energy vehicle technology, and aviation equipment to cater to the development trend of strategic emerging industries and advanced manufacturing industries. Although the tertiary industry has a relatively large number of specialty points, some specialties are too dispersed and cannot form the advantage of concentrated development, such as big data and accounting, international business, modern logistics management, hotel management and digital operation, nursing, e-commerce, art design, advertising art and design, etc., and the number of specialty points needs to be controlled. The specialty settings of colleges often span multiple specialty categories, and each higher vocational college should fully consider the scale of the specialty category layout, focus on several advantageous specialty categories according to the college's own characteristics, introduce scarce specialties in combination with industrial demands, and timely withdraw backward and surplus specialties.

6. Conclusions

The optimization strategy of specialty setting in higher vocational education is a multi-dimensional and multi-level complex issue, involving many aspects such as education policy, market demand, industrial structure, educational resources, and educational quality.

6.1. Dynamic Adjustment of Specialty Structure under Government Leadership

The government should play its leading role in macro-control, plan the layout of higher vocational colleges' specialties, and establish a system for monitoring and evaluating the structure of vocational education specialties. By regular evaluation and adjustment, ensure that professional development is consistent with industrial demands. The government also needs to establish a talent supply and demand information exchange platform to achieve real-time updates of industry, specialty, and employment information, and establish a docking mechanism between vocational education and industrial development. In addition, the government should organize schools, enterprises, industry associations, and other parties to jointly study industrial development trends and talent demands, provide a scientific basis for specialty setting, and encourage cross-border integration and innovation to promote the development of emerging industries. Higher education institutions should also actively adapt to this trend, adjust specialty settings and curriculum structures, and cultivate talents with cross-border integration capabilities and innovative spirit.

6.2. Optimization of Specialty Structure Based on Regional Characteristics

Localities should adjust and optimize specialty settings according to the talent demands of regional industrial development, give priority to developing specialties closely related to the leading industries, characteristic industries, and emerging industries of the region, such as artificial intelligence, biomedicine, integrated circuits, and new energy vehicles. At the same time, Vocational colleges should gradually eliminate or reduce specialties that do not conform to industrial development trends or have low employment market demands. The setting of new specialties should be based on in-depth research of enterprises, industry associations, and government departments to understand the development status, trends, and talent demands of key industries and strategic emerging industries. On the basis of full demonstration, Vocational colleges can clarify the direction and goals of

enrollment structure adjustment. The government should encourage and support vocational colleges to set up specialties related to key industries and strategic emerging industries, provide enrollment inclination and financial investment, improve teaching conditions, improve talent training quality, and give recognition and rewards to vocational colleges that have made significant achievements in the setting of emerging specialties and talent training.

6.3. College Positioning and Construction of Characteristic Specialty Groups

Vocational colleges should deeply analyze their own educational conditions, combine with the economic development and industrial demands of the region, clarify their own positioning and development direction. And they should control the number of specialties, improve the aggregation of specialties, and avoid blindly pursuing popular specialties. Colleges should select specialties with development potential and market demand as key development objects based on market research and their own conditions, and integrate regional culture and industry characteristics into specialty construction to form distinctive specialty groups. The specialties within the characteristic specialty group should be related and complementary, and improve the overall competitiveness by strengthening the exchange and cooperation between specialties.

6.4. School-Enterprise Cooperation to Build Specialties and Construct Industry-Education Integration Training Bases

Local government should standardize the formulation and implementation of vocational education specialty talent training programs, and promote in-depth cooperation between vocational colleges and enterprises. Both parties should develop cooperation plans and implementation plans based on understanding each other's needs and advantages. Schools can adjust specialty settings and curriculum structures according to enterprise needs, introduce advanced enterprise technology and management experience, and make teaching content closer to actual production and service processes. Enterprises can participate in curriculum setting and textbook compilation to ensure the cutting-edge and practicality of the curriculum. Both parties can carry out teacher exchange, improve teaching and research levels, jointly carry out technology research and development and achievement transformation, promote scientific and technological innovation and industrial upgrading. Both the school and the enterprise jointly build industry-education integration training bases, provide venues and infrastructure, introduce equipment and technical support, and improve students' practical and innovative abilities.

6.5. Strengthen Digital Literacy and Skill Training, and Upgrade Specialties Digitally

According to the needs of the digital economy era, Vocational colleges should integrate the latest digital technology and applications into the professional curriculum system by adding courses related to digital skills such as artificial intelligence, cloud computing, programming languages, and data analysis, ensuring that teaching content keeps pace with industrial digitalization. And they also should strengthen teacher training, improve teachers' digital literacy and skill levels, encourage teachers to participate in digital teaching reform and research, and promote innovation in teaching methods and means. Colleges could build a digital teaching resource platform, integrate high-quality teaching resources, provide rich learning resources and learning methods, and use information technology means, such as online education platforms and remote teaching, to provide flexible and diverse learning methods for students, and cultivate high-quality talents with digital thinking, mastering digital skills, and adapting to the needs of the digital era.

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