Performance Evaluation of Industry-Education Integration in Higher Vocational Colleges: An Evidence from China

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Abstract—The integration of industry and education promotes the cooperation between colleges and enterprises, and contributes to regional development. This paper aims to evaluate the performance of industry-education integration in higher vocational colleges of the Yangtze River Delta. Firstly, 138 higher vocational colleges were selected from the Yangtze River Delta as the research samples. Then, a comprehensive evaluation system was designed, including 11 evaluation indices. On this basis, the 2018 data of the samples were evaluated from the perspectives of faculty, teaching, scientific research, and service. The results show that, in the Yangtze River Delta, the higher vocational colleges generally do well in industry-education integration, but the integration level varied greatly from college to college; the performance of some indices should be further optimized.

Keywords—Industry-education integration, higher vocational colleges, performance evaluation, Yangtze River Delta

1 Introduction

The industry-education integration refers to the optimal configuration and great integration of elements between colleges and industry by fully relying on and utilizing various resources, in order to achieve in-depth cooperation and overall development. Such integration creates opportunities of development for higher vocational colleges. In the long-term operation of schools, higher vocational colleges have begun to focus on the introduction of industry elements in terms of source of students, faculty, and courses, and the integration of industry and education will help them further expand their advantages and improve quality. The development process of industry-education integration is shown as follows:

1.1 Preliminary exploration of the industry-education integration reform

Since the reform and opening-up, especially after the 1990s, China has entered the peak period of economic growth, but there also exist some problems in the industrial technology and international competitiveness, which strongly calls for the combination of industry, university, and research. The experience of many countries also showed that industry university cooperation has become a new trend in the development of international higher education. In the face of the new situation, the concept of China's higher education has gradually changed, and more and more attention has been paid to strengthening the connection with the industry, so as to promote the targeted functions of teaching, scientific research and service of colleges and universities. At the institutional level, a series of documents in the field of education have been promulgated, e.g., the Decision on Education System Reform issued by the Central Committee of the Communist Party of China stated "Strengthening the relationship between higher education institutions and production, scientific research and other aspects of society" [1]; The Outline of China Education Reform and Development promulgated in 1993 also advocates the joint operation of schools based on the integration of industry and education. Meanwhile, in terms of practice, many colleges and enterprises have launched cooperative education. Some colleges regard students' regular internships as one of their courses, and enterprises and institutions provide practice bases and send professionals to guide students; some others provide training for on-duty employees in an organized manner, use their own technological advantages to help the industry solve existing problems, and be entrusted by enterprises to develop high-tech products. Although at this stage, colleges and universities have increasingly attached importance to enterprise, industry and social service issues, and have achieved certain practical experience in cooperation, there are still many problems to be clarified, and the degree of cooperation needs to be further strengthened.

1.2 The gradual advancement of the industry-education integration reform

The period from the end of the 1990s to the beginning of the 21st century was critical for China's modernization, which also proposed higher requirements for the structure and types of higher education. The demand for high-level skilled talents is increasing with the development of economy and society. The combination of production and education has been emphasized in relevant policies. At the same time, more diversified practices have been started. At this stage, the documents such as the Vocational Education Law of the People's Republic of China, Decision on Vigorously Promoting the Reform and Development of Vocational Education, and Decision on Vigorously Developing Vocational Education were issued, which not only refined various national policies and regulations, but also increasingly diversified the reform of different colleges and universities. As early as February, 2007, Zhejiang Technical Institute of Economics and Zhejiang Materials Industry Logistics Investment Co., Ltd. established the first logistics industry college in Zhejiang Province, reflecting the in-depth cooperation between the dominant majors of the colleges and leading enterprises in the industry [2]. Based on the regional industrial characteristics and economic

needs, Zhongshan Polytechnic has explored the development path of professional town and industry colleges following the idea of "one town, one product, and one specialty" [3]. Tianjin Vocational College of Mechanics and Electricity carried out the exploration of the "pre-employment" talent training model, i.e., the employer selects outstanding talents from the sophomore and junior students as the talent reserve and training targets [4]. In this period, many colleges and universities, especially higher vocational colleges, paid more and more attention to cooperation with enterprises, and achieved remarkable results through a series of measures.

1.3 The deepening of the industry-education integration reform

In addition to vigorous growth in quantity, the quality and connotation in higher education have also received more attention in recent years. Under the new situation that China's economy has entered the stage of high-quality development and higher education has entered the late stage of popularization, colleges and universities must pay more attention to the problems of characteristics and quality. The number and scale of higher vocational colleges have become stable, it has become an urgent task to improve the quality, and conforming to the trend of industry and education integration has become an important way to use advantages to show characteristics. In December 2017, the General Office of the State Council issued Several Opinions on Deepening the Integration of Industry and Education, stating the necessity and significance of "deepening the integration of industry and education, and promoting the organic connection of the education chain, the talent chain and the industry chain and innovation chain. The policy is elaborated from the aspects of constructing the overall development pattern of industry-education integration, strengthening the important role of enterprises, promoting the talent training reform of industry-education integration, promoting the coordination of industry and education supply and demand, and improving the policy support system. Higher education must greatly contribute to economic development and industrial upgrading. The industry-education integration is a strategic planning for the entire field of education, especially vocational education. It is no longer a simple combination of industry and academia, or loose cooperation between colleges and enterprises, but the in-depth involvement of enterprises and the fundamental changes of colleges on the basis of respecting the laws of education and meeting the industry needs. Therefore, it’s necessary for colleges, including higher vocational colleges to focus more on the quality development and performance improvement of the industry-education integration.

2 Literature Review of Industry-Education Integration

2.1 Connotation research on industry-education integration

The connotation of the industry-education integration is continuously enriched. At first, it’s only used as a talent training model. For example, the American Vocational Association defined cooperative education as a combination of theoretical study and

real work experience. The World Association for Cooperative Education has made further improvements to highlight the compatibility of the two. Later, the integration of industry and education gradually emphasized the cooperative relationship between schools and enterprises. It's believed that this integration is a cooperative activity between higher education and industry to enrich the education process and provide support to the industry. In recent years, it has been increasingly regarded as a systematic institution. Tang et al. [5] took it as a cooperative activity, relationship, and mechanism of resource sharing, complementary advantages, and demand matching. Ma and Guo [6] summarized it as the integration of industry advanced technology, excellent culture and development needs into education teaching resources and processes.

2.2 Evaluation research on industry-education integration

Scientific evaluation is required for deepening the integration of industry and education. HellstrÖm and Jacob, [7] proposed that the performance evaluation system of industry-education cooperation should include the indicators such as productivity, financial benefits, education, publications, and patents. Rossi and Rosli [8], based on a survey of 131 British universities, set up a knowledge transfer index system with five dimensions.

Kauppila et al. [9] designed an evaluation framework for cooperation between universities and enterprises based on the EFQM model. Liu et al. [10] discussed the influencing factors of four modes of integrating the industry and education, and established a relation model between the two. Tong and Chen [11] performed a coding analysis for the text using the NVIVO11.0 and built an effect enhancement model of collaborative education.

2.3 Research on countermeasures for the industry-education integration

Based on the existing problems, domestic and foreign scholars have proposed corresponding countermeasures. Wright et al. [12] used survey data to analyze the types of cooperation models between colleges and industry based on the technology stage. Xing and Li [13] made recommendations through a survey of 75 private colleges. Jiang [14] proposed to change the college evaluation standards and mechanisms, improve the results transformation mechanism, and achieve the transformation of scientific research results. Shi and Hao [15] believe that the integration of industry and education should insist on space, time, technology, and system thinking. Zhou and Chen [16] discussed the realization path from the perspective of the synthesis, organism, and symbiosis of the industry-education integration. He [17] emphasized the need to form a four-level integration system of individual, organization, inter-regional organization, and state.

In short, the research on the industry-education integration has become one of the focuses in the academic community in recent years, including performance evaluation. But there is still a lack of in-depth research based on empirical data.

3 Index Design for Performance Evaluation of Industry-Education Integration in Higher Vocational Colleges

In this study, 138 higher vocational colleges were selected from the Yangtze River Delta as the research samples, 2018 data was used for analysis, and the annual report on the quality of higher vocational education, the official website information of the State Intellectual Property Office and each college were taken as data sources. Then, a comprehensive evaluation system was designed (Table 1 and 2).

Table 1. Performance Evaluation Index System of the industry-education Integration in Higher Vocational Colleges

No.	Index	Content
X1	Ratio of double-qualified teachers	The percentage of double-qualified teachers to the total number of full-time teachers
X2	Annual class hours of part-time enterprise teachers per student	The total amount of class hours of part-time enterprise teachers that year, based on the average level of the number of students in college
X3	Proportion of graduates staying in local employment	Percentage of local employment in the total number of graduates
X4	Employer satisfaction of graduates	Percentage of employer satisfaction with graduates
X5	The amount of vertical scientific research funds received per teacher	Vertical scientific research funds obtained for each full-time teacher
X6	The amount of technical services funds received per teacher	The technical contracts signed with natural persons, legal persons and other organizations, and the funds involved in international scientific and technological cooperation projects, based on the average level of the number of full-time teachers
X7	Number of invention patents per teacher	Invention patents that have been authorized and announced based on the average level of the number of full-time teachers
X8	Economic benefits generated by technical services per teacher	Relevant services for natural persons, legal persons and other organizations, and the economic benefits generated in international scientific and technological cooperation projects, based on the average level of the number of full-time teachers
X9	The amount of non-academic training per teacher	The received funds for non-academic training for the society, based on the average level of the number of full-time teachers
X10	Daily public welfare training service per teacher	The scale of free training provided to the society according to the average number of full-time teachers
X11	The amount of technical transactions funds received per teacher	The government or enterprise purchases patents and technologies of universities through the technology market to the account, and the average level is calculated based on the number of full-time teachers

Table 2. Basic information of the samples

Basic information		Quantity	Percentage (%)
Region	Shanghai	19	13.77%
	Zhejiang Province	32	23.19%
	Jiangsu Province	52	37.68%
	Anhui Province	35	25.36%
Scale	Below 5,000	37	26.81%
	5,001-10,000	73	52.90%
	10,001-15,000	25	18.12%
	Above 15,000	3	2.17%
Category	Engineering	55	39.86%
	Comprehensive	43	31.17%
	Finance	18	13.04%
	Medicine	11	7.97%
	Teachers	3	2.17%
	Agriculture and Forestry	3	2.17%
	Art	2	1.45%
	Sports	2	1.45%
	Language	1	0.72%

4 Data Analysis for Performance Evaluation of Industry-Education Integration in Higher Vocational Colleges

4.1 Analysis for mean and standard deviation

The mean and standard deviation can reflect the overall level of the samples and the degree of differences within the groups to a certain extent. Table 3 below lists the mean and standard deviation of the overall sample and the 11 indices in four regions.

Table 3. Means and standard deviations of 11 indices

Index	Mean of overall sample	Standard deviation of overall sample	Mean of Shanghai samples	Standard deviation of Shanghai samples	Mean of Zhejiang samples
X1	0.71	0.19	0.61	0.17	0.85
X2	9.44	6.92	5.81	4.64	10.21
X3	0.57	0.23	0.70	0.12	0.53
X4	2.39	0.49	2.38	0.51	2.13
X5	0.81	1.28	1.19	1.46	1.01
X6	7.39	66.41	41.32	179.12	1.99
X7	0.15	0.22	0.01	0.03	0.19
X8	7.53	22.43	0.18	0.64	15.92
X9	1.89	2.41	2.16	2.98	2.91
X10	117.56	254.03	24.19	44.75	171.32
X11	0.73	1.47	0.01	0.04	0.97
Index	**Standard deviation of Zhejiang**	**Mean of Jiangsu samples**	**Standard deviation of**	**Mean of Anhui samples**	**Standard deviation of**

	samples		**Jiangsu samples**		**Anhui samples**
X1	0.06	0.81	0.11	0.51	0.19
X2	3.89	13.69	7.95	4.43	3.34
X3	0.24	0.62	0.23	0.45	0.23
X4	0.57	2.44	0.46	2.55	0.35
X5	1.38	0.77	1.14	0.49	1.25
X6	2.14	3.13	4.42	0.21	0.87
X7	0.19	0.27	0.26	0.01	0.02
X8	34.78	9.99	22.53	0.18	0.65
X9	2.34	1.61	1.49	1.26	2.97
X10	183.25	93.82	138.87	154.36	435.39
X11	1.54	1.32	1.86	0.02	0.06

The performance of higher vocational colleges in different regions varies in terms of 11 indices. From the above table, it can be found that 3 indices of the Shanghai sample, 8 of the Zhejiang sample, 7 of the Jiangsu sample, and 2 of the Anhui sample were higher than the mean value. Specifically, the ratio of double-qualified teachers in Zhejiang and Jiangsu reached more than 80%; the amount of annual class hours of part-time enterprise teachers per student in Jiangsu ranked first, followed by Zhejiang; the percentage of graduates staying in the local employment in Shanghai was the highest; Anhui had the best performance in employer satisfaction with graduates; the vertical research funding per teacher was higher than the mean both in Shanghai and Zhejiang; Shanghai far exceeded the other three regions for the amount of technical services funds received per teacher; Anhui had the most invention patents per teacher, Zhejiang Second; Zhejiang and Jiangsu ranked first and second in the economic benefits of technical services per teacher; Zhejiang and Shanghai were higher in the amount of non-academic training for teachers; Zhejiang and Anhui performed better for public welfare training services per teacher; the amount of technical transactions funds received in Jiangsu and Zhejiang was higher than the mean.

Through analysis for the standard deviations of 11 indices, it can be found that the ratio of double-qualified full-time teachers, the proportion of graduates staying in local employment, and the number of invention patents per teacher had the smallest standard deviations, indicating that the higher vocational colleges in the Yangtze River Delta have made great progress in hiring teachers with practical abilities and industry experience, and the gap between them is small. The Yangtze River Delta region is generally more developed, so it's an ideal place to work, and the proportion of graduates employed locally is generally higher, close to or up to 50%. Higher vocational colleges in the four regions scored less in the invention patent acquisition, which needs further improvement. The standard deviation of the three indices such as the daily public welfare training service per teacher, the amount of technical services funds per teacher, and the economic benefits generated by the technical services per teacher were the maximum; the daily public welfare training service differs due to the importance of each college, and the latter two indices are both related to technical services, indicating that these colleges are different distinctly in their strength of undertaking socially entrusted projects.

4.2 Correlation analysis

Correlation analysis can describe the degree of closeness between things, expressed by the correlation coefficients. As the absolute value of the correlation coefficient is closer to 1, the correlation between the two variables becomes greater. Table 4 below shows the correlation analysis of 11 indices.

From Table 4 above, it can be seen that there are high correlations between variables, i.e., between the ratio of double-qualified teachers and the indices representing the scientific research ability in higher vocational colleges such as the amount of vertical scientific research funding per teacher, the amount of technical service funds per teacher, the number of invention patents per teacher, and the economic benefits generated by the technical service per teacher; between the ratio of double-qualified teachers and the indices meeting the market demands such as the amount of non-academic training, the daily public welfare training service per teacher, and the amount of technical transactions funds received; between the ratio of double-qualified teachers and the indicators such as the annual class hours of part-time enterprise teachers per student and the proportion of graduates staying in the local employment; between the employer satisfaction of graduate and the proportion of graduates staying in local employment. The above indices are all significantly correlated at the 1% level.

Table 4. Correlation coefficients of 11 indices

	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	**X11**
X1	1	0.52	0.27	-0.09	0.29	0.38	0.69	0.55	0.41	0.47	0.55
X2	0.52	1	0.27	-0.00	0.12	0.25	0.60	0.46	0.23	0.36	0.42
X3	0.27	0.27	1	0.23	0.21	0.32	0.22	0.25	0.16	0.14	0.34
X4	-0.09	-0.00	0.23	1	0.08	0.15	-0.06	0.08	-0.07	0.12	0.21
X5	0.29	0.12	0.21	0.08	1	0.39	0.25	0.39	0.34	0.23	0.41
X6	0.38	0.25	0.32	0.15	0.39	1	0.45	0.49	0.24	0.37	0.47
X7	0.69	0.60	0.22	-0.06	0.25	0.45	1	0.67	0.32	0.44	0.61
X8	0.55	0.26	0.25	0.08	0.39	0.49	0.67	1	0.38	0.39	0.65
X9	0.41	0.23	0.16	-0.07	0.34	0.24	0.32	0.38	1	0.42	0.33
X10	0.47	0.36	0.14	0.12	0.23	0.37	0.44	0.39	0.42	1	0.43
X11	0.55	0.42	0.34	0.21	0.41	0.47	0.61	0.65	0.33	0.43	1

4.3 Factor analysis

According to the data structure and evaluation objectives, factor analysis is a more appropriate evaluation method. Table 5 below reflects the factor analysis results of 11 indices. The results show that the rotated 3-factor model is sufficient to explain the differences contained in this data.

Table 5. Factor analysis of 11 indices

	Factor 1	**Factor 2**	**Factor 3**
X1	0.700	0.347	0.066
X2	0.647	0.112	0.046
X3	0.208	0.130	0.380
X4	0.094	-0.075	0.519
X5	0.185	0.379	0.396
X6	0.409	0.212	0.435
X7	0.903	0.162	0.074
X8	0.648	0.294	0.348
X9	0.206	0.801	0.011
X10	0.407	0.402	0.172
X11	0.588	0.253	0.504
SS loadings	2.951	1.323	1.177
Proportion Var	0.268	0.120	0.107
Cumulative Var	0.268	0.389	0.496

In Table 5 above, all load factors form a load matrix, which represents the correlation between a factor and each index. The larger number of load factor indicates a greater correlation. Factor 1 is highly correlated with those indices other than the proportion of graduates staying in the local employment, the employer satisfaction of graduates, the amount of vertical research funding per teacher, and the amount of non-academic training per teacher. Factor 2 is highly correlated to the amount of vertical scientific research funds received per teacher, the amount for non-academic training per teacher, and daily public welfare training service per teacher. Factor 3 is highly correlated to the proportion of graduates staying in the local employment, the employer satisfaction of graduates, the amount of vertical research funding per teacher, the amount of technical service funds per teacher, and the amount of technology transaction funds per teacher.

The SS loadings and Proportion Variance of the three factors indicate the degree of the factor's role in explaining the difference in the overall data, and then calculate the weight of the three factors. Taking Factor 1 as an example, its weight was 2.951 / (2.951+1.323+1.177), and thus the weights of the three factors were 0.541, 0.243, and 0.216. Then, according to the scores and weights of the three factors, a weighted average score was calculated, to rank the performance of 138 higher vocational colleges for the integration of industry and education. The results showed that among the top 10 well-performed universities, 6 were in Jiangsu, and 4 were from Zhejiang; although some colleges of Shanghai and Anhui were in the top 60, they still fell behind in the total numbers of top colleges compared with Jiangsu and Zhejiang. This may be related to the total number of samples in different regions, e.g., Shanghai had only 19 samples. But Jiangsu and Zhejiang still had obvious advantages, i.e., the samples of Jiangsu accounted for 61.67% of the top 60 colleges, which was significantly higher than the 37.68% of the 138 samples, indicating that the integration of industry and education in higher vocational colleges does have a stronger comprehensive strength among the four regions.

5 Conclusion

First, the industry-education integration of higher vocational colleges in the Yangtze River Delta region generally is good in performance based on the 11 indices. For example, the average ratio of double-qualified teachers was as high as 71%, and the highest was 94%; the average proportion of graduates staying in the local employment was 57%, and the highest was 95%; 30 vocational colleges received annual technical services funds for the total amount of more than 10 million yuan, and 25 colleges received total annual vertical scientific research funding of more than 5 million yuan; 29 had the total annual non-academic training funds for more than 10 million yuan. This indicates that higher vocational colleges have fully realized the importance of grasping needs, integrating into the industry, and serving the society, and achieved certain results, e.g., they have hired more people familiar with first-line production management practices as teachers to engage in teaching and scientific research; graduate students initially possess the ability to work in the region and win a certain degree of regional recognition; in addition to teaching, they have also begun to accelerate the pace of industry-education integration by undertaking various projects at all levels, while gradually focusing on serving the society to enhance their influence.

Second, the performance development of the industry-education integration in higher vocational colleges of the Yangtze River Delta region is unbalanced. The comparison of the four regions in the Yangtze River Delta shows that in addition to the limited number of samples, the imbalance in the performance development of the industry-education integration in higher vocational colleges is still quite obvious. Generally, higher vocational colleges in Jiangsu and Zhejiang are relatively stronger in the field of industry-education integration, while Shanghai and Anhui still have more room for improvement in this regard. The imbalance is not only reflected between provinces but also within provinces and cities. For example, among the top 30 vocational colleges in Jiangsu, there were 7 in Nanjing, 7 in Changzhou, 5 in Nantong, 4 in Suzhou, 3 in Wuxi, 3 in Zhenjiang, and 2 in Taizhou; among the top 20 vocational colleges in Zhejiang, there were 8 in Hangzhou, 3 in Wenzhou, and 3 in Ningbo; among the top 20 vocational colleges in Anhui province, there were 6 in Hefei, 3 in Huainan, and 2 in Wuhu, and 2 in Tongling. Most of them are relatively developed in the economic levels. The imbalance in the performance level of the industry-education integration in higher vocational colleges is not only related to their own development history, professional characteristics, and college strength, but also deeply affected by the local economic environment, college layout and regional policies.

Thirdly, the performance of some indices in the industry-education integration in higher vocational colleges needs to be optimized. Despite of the good performance of higher vocational colleges, there are still many indices unsatisfactory, especially in providing scientific and technological services and meeting market needs. Although the total funding for vertical scientific research projects in some higher vocational colleges has reached a considerable scale, it is not satisfactory if calculated per teacher. Only 34 vocational colleges have received more than 10,000 yuan of vertical scientific research funds, 51 received more than 10,000 yuan of technical services funds,

and 30 received more than 10,000 technical transactions funds. In addition to funding, the number of invention patents per teacher and the economic benefits of technical services per teacher are also rare; the former was 0 in the 40 higher vocational colleges; the latter in 87 higher vocational colleges was below 10,000 yuan. Thus, the integration of industry and education in higher vocational colleges has been involved in various fields, but it is still insufficient in depth and effectiveness. More efforts are needed to contribute to society and create benefits.

Also, higher vocational colleges in the Yangtze River Delta region need to further explore their own characteristics, make full use of regional advantages, strengthen cross-regional cooperation, optimize relationships with enterprises, grasp policy guidance, and respect market rules, for achieving continuous advancement, gradual deepening, and sustainable development.

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