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Research on Quality Evaluation Index System of Industry-teaching Integration in Higher Vocational Colleges under Stakeholder Perspective

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ABSTRACT

As a key way to improve the quality of education in higher vocational colleges, the improvement of the effect evaluation mechanism is of great significance to promote the deep integration of education and industry. Based on the needs of multi-stakeholders such as government, industry, enterprise, school and teacher, this study constructs a comprehensive evaluation model by using literature analysis, analytic hierarchy process and Delphi method, aiming to evaluate the quality of the whole process of industry-education integration. The evaluation system covers the three dimensions of input, process and effect of the integration of production and education, and gives corresponding weights to the indicators under each dimension, in order to provide scientific reference for relevant decision makers.

KEYWORDS

Stakeholders; Delphi Method; Hierarchical Analysis; Quality Evaluation Indicators for the integration of production and education

1 Introduction

With the advent of the 21st century, China's higher vocational education has gradually entered a new stage of connotative development. In April 2019, the Ministry of Education and the Ministry of Finance jointly issued the Opinions on the Implementation of the Plan for the Construction of High-level Higher Vocational Schools and Specialties with Chinese Characteristics (referred to as the "Double-High Plan"), which proposes to start the construction of high-level higher vocational schools and specialty groups to lead the overall improvement of the connotation of vocational education. In October 2020, the State Council issued the "Overall Program for Deepening Education Evaluation Reform in the New Era" (the "Overall Program"), proposing to empower modern education from the perspective of education evaluation reform.

In order to improve the ability of vocational education to cultivate high-quality skilled personnel, to meet the needs of social development, and to achieve the goal of modernizing vocational education. In February 2019, the General Office of the State Council issued the Implementation Plan for Accelerating the Modernization of Education (2018-2022) , which puts forward the improvement of the modern system of vocational education, the improvement of the system and mechanism for running schools with the integration of production and education, the establishment of a sound system of standards for vocational education and the deepening of the integration of production and education in vocational education[1]. In the 2020 Action Plan for Improving the Quality and

Excellence of Vocational Education (2020-2023) issued by the Ministry of Education and nine other ministries, emphasis is placed on deepening the structural reform of the supply side of vocational education, deepening the reform of the collaborative model of school-enterprise cooperation, and improving the ability of vocational education to serve society and the economy[2]. In October 2021, the General Office of the State Council issued the Opinions on Promoting the High-Quality Development of Modern Vocational Education, stating that a modern vocational education system would be basically completed by 2025, that the supply structure of vocational education should be optimized, that a diversified pattern of school-running should be perfected, and that the in-depth integration of production and education should be promoted in a coordinated manner[3]. In December 2022, the General Office of the State Council issued the Opinions on Deepening the Reform of the Construction of a Modern Vocational Education System, which clearly indicates the exploration of a new model for the construction of a modern vocational education system at the provincial level, and the creation of municipal industry-teaching consortia and industry-teaching integration communities[4].The document points out that vocational education is now a key task of the reform of modern vocational education system. In order to implement the policy of building a modernized vocational education system more quickly, in July 2023, the General Office of the Ministry of Education issued the Key Tasks on Accelerating the Construction and Reform of the Modern Vocational Education System, which points out that vocational education is now focusing on the following key development tasks: building municipal industry-teaching consortiums and industry-teaching integration communities, building open regional industry-teaching integration practice centers, continuing to build professional teaching resource libraries for vocational education, building vocational education informatization benchmark schools, and building vocational education model virtual simulation training bases[5].

As can be seen from the above-mentioned policy documents, the status of vocational education has become clearer, its role more prominent, and the modernization of vocational education has risen to the level of a national development imperative. In order to give better play to the role of vocational education in training high-quality skilled personnel and improve the ability to serve the economy, and to promote the modernization of vocational education, it is necessary to deepen the integration of production and education and to promote the quality of personnel training. The integration of production and education is an effective way to change the traditional vocational education training mode, and it is an important way to solve the shortage of highly skilled technical personnel, improve the quality of labor force and ease the pressure of employment. However, at this stage in China, the evaluation system of the integration of production and education in higher vocational colleges and universities is not perfect, and the design of indicators is insufficient. The evaluation process tends to over-emphasize the school's input and neglect the effect of industry-teaching integration in enhancing students' employability. The lack of scientific and reasonable evaluation indexes is not only unfavorable to accurately assess the effectiveness of the integration of production and education, but also unable to effectively motivate schools to further promote the integration of production and education as a mode of educating people.

2 Literature review

2.1 Definition of the concept of quality assessment of the integration of production and education

The quality evaluation of industry-industry integration is the process of assessing and judging the process and results of industry-industry integration. It is a comprehensive, objective and scientific assessment of the objectives, contents and effects of the integration of production and

education through a series of indicators, methods and tools, in order to determine the quality level and improvement direction of the integration of production and education. The goal of the assessment is to check the quality of the project at all stages, so as to recognize in time which parts of the project have been carried out according to the predetermined objectives and to adjust the existing problems. For the integration of education and industry, evaluation includes the following three aspects.

(1) Pre-input evaluation. Evaluating the input stage of the integration of production and education, including setting goals, identifying partners, planning resources and so on. The evaluation of planning should consider its rationality, feasibility and fit with industrial needs to ensure that the foundation and direction of the project meet expectations.

(2) Evaluation of the implementation process. Evaluation of the implementation process of industry-education integration, including project organization, resource allocation, cooperation and communication. The evaluation of the implementation process should take into account the implementation of the project, the effect of cooperation, communication and coordination to ensure that the project is carried out smoothly according to plan and collaboration.

(3) Effectiveness evaluation. Evaluate the effect of the integration of production and education, including the employment rate of students, the competitiveness of enterprises, and the degree of matching between teaching content and industrial demand. The evaluation of the effect should take into account the actual results and impact of the program, so as to ensure that the integration of production and education can bring substantial benefits to student employment and industrial development.

Through the evaluation of these three aspects, it is possible to have a comprehensive understanding of the quality level of the industry-teaching integration project and to identify problems in a timely manner so that necessary adjustments and improvements can be made. Feedback and analysis of the evaluation results will provide strong support for the continuous improvement of the project, ensuring that the industry-teaching integration project can continuously adapt to the needs and challenges of the development process and realize the expected goals.

2.2 Research on quality evaluation of the integration of production and education

Existing literature focuses on the study of the influencing factors and different participating subjects in the evaluation of the integration of production and education. From the aspect of institutional mechanism, Sun et al. (2021) believe that the system of integration of production and education is not specific and has low constraints, which affects the development of integration of production and education[6]. From the aspect of cooperation and benefit-sharing relationship, Tang (2018) believes that the responsibility conflict, school-enterprise conflict, and lack of system in the integration of production and education affect the implementation of the integration of production and education in local universities[7].The study is based on the report of the quality of teaching in applied undergraduate colleges and universities. From the aspect of capacity building, Zhang and He(2021) summarized the main factors affecting the integration of production and education in applied colleges and universities according to the report on teaching quality of applied undergraduate colleges and universities, including the construction of applied disciplines and majors, the path of cultivating "dual-teachers" and the mechanism of interaction between schools and enterprises. It also promotes the integration of production and education in terms of the goal of running schools with the function of serving regional industries, building special applied clusters of disciplines and specialties, creating a platform of "integration of industry, academia and research" for school-enterprise cooperation, implementing the bidirectional development of teaching and

competitions, and constructing a "dual-teacher, dual-competence" teaching team[8]. Based on the survey and analysis of medical device industry in Yangtze River Delta, Liu et al. (2013) concluded that the motivation of school-enterprise cooperation is mainly affected by factors related to efficiency, incentives and competitive mechanism[9].

Different stakeholders were involved in the evaluation study. Gao and Zhao(2018) rated the quality of production and education integration in higher vocational schools in terms of five major stakeholders: government, enterprises, schools, teachers and students. In their exchanges with school administrators, they were found to be more inclined to discuss the ideal level of integration and education in higher vocational institutions and provided many useful comments on how to measure its effectiveness. Convinced that the cultivation of talents is the main goal and key factor in the evaluation of the quality of the integration of higher vocational education through an in-depth study of the quality of the integration of production and education in higher vocational education[10]. The quality concept of the integration of production and education should be constructed from the mechanism of multi-party participation. Based on the experience of developing their study, Zhang et al. (2019) advocated that the quality concept of industry-education integration should be constructed from a multi-party participation mechanism. To construct the quality concept of industry-education integration, efforts should be made in many aspects, such as legal support system and systematic quality evaluation system. This is done in order to better understand and achieve the goal of integration of production and education[11]. Xiu proposed that on the basis of the international model of triple helix innovation structure, we should learn from the useful and successful practical experience of other countries, such as the construction of a triple helix system with universities, enterprises and the government as the main body. In China, it is necessary to optimize the collaborative structure between schools and enterprises, and study in depth the distribution of their rights and responsibilities to ensure that the integration of production and education can be effectively supported and promoted; it is necessary to re-examine the content of the relevant policies, and at the same time to adapt to the needs of the current environment of the integration of production and education, so as to provide a good policy environment and economic support for the cooperation between schools and enterprises; Schools should take the initiative to actively carry out industry-teaching and research programs, and provide students with practical training opportunities and good employment channels. At the same time, we should also promote the construction of evaluation based on the theory of stakeholders, take into account the opinions and interests of stakeholders to ensure the quality and effect of the integration of production and education, and form a complete set of theoretical system, policy strategy, institutional setup and quality assurance program in the aspect of supervision and evaluation. Only in this way can we create a unique quality evaluation and research system for the integration of production and education in higher vocational schools, and make greater contributions to China's education and industrial development[12].

3 Research design and implementation

In order to ensure the scientificalness and accuracy of the evaluation indicators, three rounds of expert evaluation opinion collection and feedback were conducted using the Delphi expert survey method. By analyzing and comparing the results of the expert survey, the importance and relative weights of the indicators at various levels were determined, and then the weights of the indicators were determined using the hierarchical analysis method. The selection of experts is the key link to the success of the Delphi method, which determines the quality and effect of the Delphi method. In order to ensure that the opinions of the selected experts are representative and authoritative, a

series of detailed and strict criteria and processes must be followed. First, it is important to ensure that the experts have in-depth backgrounds and experiences related to the subject matter of the study. They should have many years of research or practical experience in the relevant fields and thus be able to provide depth, breadth and foresight to the study. In addition, their academic achievements, work background and influence in the industry are also important considerations. This requires experts with diverse academic backgrounds, research areas, as well as geographic locations, cultural backgrounds and work experiences. This ensures that we have a comprehensive, diverse and balanced expert opinion. Finally, the willingness of the experts to participate and their cooperative attitude are also key to the selection process. They should be willing to participate in multiple rounds of the survey, as well as have an open and positive attitude towards the research.

3.1 Screening and identification of expert groups

The degree of specialization of the Expert Group reflects the professional knowledge and practical experience of its members in the field of higher vocational education and industry-teaching integration. The experts in the group range from new teachers to senior lecturers, which means that the group has a comprehensive knowledge structure and teaching practice from basic education concepts to advanced academic research. The academic composition ranges from bachelor's degree to doctoral degree, indicating that the group not only has a solid theoretical foundation, but also has the ability to conduct advanced research. The distribution of titles shows that the members of the group are able to provide insight and assessment in their respective areas of specialization, whether they are starting out as assistant lecturers or experienced senior lecturers. The types of schools they serve, ranging from national demonstration sites to generalist institutions, ensure that the assessment results synthesize the perspectives and needs of educational institutions at different levels. Overall, the composition of this panel of experts ensures that in-depth, multi-faceted and high-quality professional advice is provided in the evaluation of the integration of production and education.

Table 1 Statistical table of basic information on experts

Classification	Options	Number of persons	Percentage/%
Age	31-40 years old	5	50
	41-50 years old	3	30
	50 and over	2	20
Years of teaching experience	1-5 years	4	40
	6-10 years	3	30
	11-20 years	1	10
	20 years or more	2	20
Highest degree	Undergraduate	2	20
	Master's Degree	4	40
	Doctor	4	40
Title	No title	4	40
	Assistant Lecturer	2	20
	Lecturer	2	20
	Associate Professor and above	2	20
The school in which it is located	National demonstrations and priorities	2	20
	Provincial demonstration or focus	5	50
	general institutions	3	30
	Other	0	0

3.1.1 Expert authority factor analysis

This study evaluates the reliability of experts by calculating the expert authority coefficient Cr. The value of Cr ranges from 0 to 1. Generally, when Cr is greater than or equal to 0.7, it is considered acceptable. The Cr coefficient is calculated based on two factors, one is the basis for expert judgment Ca, and the other is the expert's familiarity with the problem Cs. Among them, Ca is evaluated based on the expert's theoretical analysis ability, practical work experience and other factors; Cs is evaluated based on the expert's understanding of the issues being consulted. The average of the two calculation results is the Cr coefficient. The closer the Cr value is to 1, the higher the authority of the expert and the higher the reliability of the consultation results.

Table 2 Assignment of coefficients for expert judgment

Basis of judgment	Degree of influence on expert judgment (Ca)		
	High impact	General impact	Low impact
Practical experience	0.5	0.4	0.3
Theoretical analysis	0.3	0.2	0.2
Peer understanding	0.1	0.1	0.1
Intuition	0.1	0.1	0.1

Table 3 Assignment of coefficients of experts' familiarity with the indicators

Familiarity	Coefficient(Cs)
Familiar	1.0
More familiar	0.75
General familiarity	0.50
Not too familiar	0.25
Very unfamiliar	0.00

The formula for calculating the degree of authority of an expert is

$$Ca = (1\times2+0.9\times4+0.8\times4)/10=0.88 \quad (1)$$

$$Cs = (0.9\times1+0.7\times4+0.5\times5)/10=0.62 \quad (2)$$

$$Cr = (Ca + Cs)/2=0.75 \quad (3)$$

Among them, Cr represents the degree of expert authority; Ca represents the judgment coefficient; Cs represents the degree of familiarity. According to the calculation results, the average value (Cs) of the experts' problem familiarity is 0.62, indicating that they have a fairly high understanding of the problem, which makes their judgments more authoritative. In addition, according to the data in the table above, the average value (Ca) of the experts' judgment basis coefficient is 0.88, which indicates that they can use accurate and effective basis to judge the problem. The final authority coefficient is 0.75, exceeding the threshold of 0.7. This value indicates that the above-mentioned expert team has good authority, thus making the consultation results quite credible and persuasive.

3.1.2 Expert judgment reliability analysis

The reliability of an expert's judgment is assessed by weighting the degree of credibility of the basis used by the expert. The weight of each expert's basis of judgment can be calculated by summing the corresponding values. The self-assessment weights of all experts are then added together to obtain the overall weights.

Table 4 Expert interpretation based on self-assessment results

Score(q)	1	0.9	0.8
Number of people(m)	2	4	4

3.1.3 Expert familiarity analysis

The experts' issue familiarity weights reflect their specific familiarity with the issue. The results of the survey showed that one was very familiar, four were familiar and five were more familiar.

Table 5 Analysis of the results of the expert familiarity

Familiarity	Number of persons	Proportion/%
Very familiar	1	10
Familiarity	4	40
More familiar	5	50

3.2 Indicator revision, deletion and identification

Through the first round of expert feedback and revision, we have finalized a preliminary indicator system. Among them, the input of teachers was further refined into the matching of teacher quality with industry. The revision of this indicator is to solve the problem that the original indicator over-emphasized quantity and neglected quality. The new indicator focuses on assessing teachers' industrial background, modernization of teaching methods, and cooperation with the industry, so as to reflect more comprehensively the degree of matching between teachers' teams and the needs of industry-teaching integration. This includes teachers' participation in industry training and professional development activities, as well as their involvement in industrial practices.

Collaborative education has been amended to read "Effectiveness of integration of production and education in education". The purpose of this change is to make the indicator more operational and clearer, so that it can accurately measure the actual effectiveness of the integration of production and education in education. The revised indicator focuses on the performance of students in internships and project learning, as well as the substance of cooperation between schools and enterprises, such as the durability, innovation and depth of cooperation.

In the second round of consultations, experts will be invited to participate again. They will receive a list of opinions and suggestions collected by the first round of Delphi and will be asked to evaluate and vote on each of them. Experts can rate each recommendation based on their own judgment and understanding to reflect their level of support for the recommendation. These scores will be summarized and analyzed to determine the relative importance and consistency level of each recommendation. In this round of consultation, the focus is on revising the formulation of the first-level indicators, and refining the indicator of "the number and proportion of enterprise teachers" to reflect more clearly the actual contribution of enterprise teachers in curriculum development and teaching. The refinement of the indicator can further clarify the roles and contributions of enterprise teachers, and focus on whether or not they have integrated enterprise experience into the teaching process.

In the evaluation of the effect of education-industry integration, the indicator of the number of internship students is adjusted to the comprehensive evaluation of the quality of internship students, which completes the change from the survey of the number of internship students to the comprehensive evaluation of internship students, in order to comprehensively assess the internship experience and obtain the students' real feelings about the internship work. Finally, the experts refined the evaluation of student satisfaction, focusing on student satisfaction with the integration of production and education internships or programs, and changed the term "satisfaction with enterprises" to "student satisfaction with the integration of production and education internships/programs".

In the third round of the Delphi method, experts will again receive feedback on the results of the second round of the Delphi method and will be asked to reassess and vote on the key

recommendations contained therein. The purpose of this round is to further consolidate the views of the experts and try to reach consensus.

The experts were able to re-rate and discuss the key recommendations in order to determine the final changes and deletions. In the secondary indicator "Teacher Quality and Industry Interface", for the tertiary indicator "Educational Background and Industry Experience of Dual-Teacher Teachers", experts discussed the use of a quantitative scoring system to accurately evaluate the dual-teacher attributes of the teachers and the extent to which they are connected to the industry. The experts discussed the use of a quantitative scoring system to accurately evaluate the dual-teacher attributes of teachers and the extent of their connection with industry. As for the third-level indicator of "professional group construction", which is "the construction of professional groups for industry-teaching integration (curriculum standards, teaching materials, talent cultivation programs, etc.)", it was suggested that the descriptions were too mixed, and that the three professional construction documents mentioned in the indicator should be listed as separate items, and be divided into "professional group teaching resources" and "professional group teaching resources". Through the third round of expert consultation, it is expected that the refinement of the indicator system will be realized, and it is expected that this round of consultation will make each indicator more precise, clear, and easy to understand and apply; improve consistency and reliability, and make the evaluation system more consistent and reliable on the whole through further discussion and the formation of a consensus; and enhance the practicality of the operation, so that the indicator system will be more in line with the needs of the actual operation, and be easy to be applied in practice. In order to better demonstrate the results of the third round of expert consultation, the details are shown in Table 6, including the latest definitions of each indicator, the reasons for adjustments, and their measurement methods.

Table 6 Evaluation index system for integration of production and education in higher education institutions

Tier 1 indicators	Secondary indicators	Tertiary indicators
Inputs for the integration of production and education	Financial inputs	Inputs to the construction of professional clusters
		The status of funding for cooperative enterprises
	Faculty quality aligned with industry	The educational background and industrial experience of dual instructors, the
		Examples of the involvement of business faculty in curriculum development and teaching
	Construction of training bases	Number of on- and off-campus training rooms (number on campus, number off campus)
		Configuration of on- and off-campus training rooms (site setup, financial investment, staffing, etc.)
		The alignment of practical training programs with the needs of industry
		Modernization of practical training facilities
The process of integration of production and education	Organizational and institutional support	Number of relevant national policy documents
		Number of management systems for building professional clusters
		implementation and effectiveness of the system
	Industrial Environmental Assessment	The demand for talent in regional industries
		Assessment of the impact of the integration of production and education on industrial development

Table 6 Evaluation index system for integration of production and education in higher education institutions(Continued).

Tier 1 indicators	Secondary indicators	Tertiary indicators
	Construction of professional clusters	Number of cooperative enterprises
		Degree of match between professional cluster settings and regional industries (%)
		The construction of teaching resources for professional groups
		The status of the reform of the teaching model
		The development of talent training programs for professional clusters
		The quality and depth of the integration of production and education
Effectiveness of integration of production and education	The effect of the integration of production and education in educating people	Comprehensive evaluation of top-up students
		The actual effectiveness of school-enterprise project cooperation
		Acceptance of graduates by enterprises
	student satisfaction	Student satisfaction with industry-teaching internships/ programs
		Satisfaction with courses in specialty clusters that
		overall satisfaction of graduates with the quality of education
	social impact	The situation of specialized clusters serving the regional economy
		the contribution of graduates to the local society and economy
		The role of industry-education integration in regional educational development

4 Use AHP analytic hierarchy process to determine indicator weights

4.1 The use of hierarchical analysis

The Analytical Hierarchy Process is a multi-criteria decision-making analysis method that aims to help decision-makers make weight allocations and decision-making choices among factors at multiple levels. In the 1970s, American mathematician Thomas L. Saaty proposed the Analytic Hierarchy Process (AHP). Since its inception, this method has been widely used in research in many fields, helping managers make scientific decisions under the influence of multiple factors. It is also often used in the calculation process of indicator weights. The AHP method decomposes decision-making problems under the influence of multiple factors into multiple levels, and each level is

decomposed into several criteria or factors. In the same level of analysis, a judgment matrix is established to determine the weight of this level by conducting pairwise comparisons between various factors. Then, the relative importance of the weights between factors is determined by calculating eigenvectors and eigenvalues.

The steps of the AHP method are as follows: (1) Determine the decision-making goals and related factors: clarify the goals that require decision-making, and determine the various influencing factors related to the goals. (2) Build a hierarchical structure: Construct the goals and related factors into a reasonable, clearly divided hierarchical structure with clearly defined relationships. (3) Pairwise comparison judgment matrix: In the same level, the relative importance between each factor is judged by comparing each factor pairwise, and its relative importance is expressed numerically. (4) Calculate eigenvectors and eigenvalues: Calculate eigenvectors and eigenvalues according to the judgment matrix, and perform normalization processing to obtain the weight of each factor relative to other factors. (5) Step by step recursion to solve the final weight: compare the feature vector obtained at the previous level with the current level, and calculate the weight of each element in the new level relative to the previous level. (6) Comprehensive weights and decision-making results: Comprehensive weights at all levels are combined to obtain the final weight of the overall decision as the final decision-making result.

4.2 Build a hierarchical structure model

This article attempts to construct a high-level technician college employment quality evaluation index system from the aspects of hierarchical structure, pairwise comparison, matrix judgment and visualization. One is hierarchical structure. Using the AHP method to decompose a decision-making problem under the influence of multiple factors into multiple levels is beneficial to analyzing and understanding the structure and relationship of the problem. The second is to make pairwise comparisons of each evaluation factor. The AHP method compares the importance of each factor pairwise and assigns scores to each factor, which is conducive to the quantification and analysis of decision-making factors. The third is to construct a judgment matrix and find the weight of each factor. By calculating the eigenvectors and eigenvalues, the weight of each factor is calculated, which is beneficial to weight allocation and decision selection of decision factors. The fourth is to use visual structure diagrams to present results.

Using visualizations such as hierarchical structure diagrams and judgment matrix diagrams to directly present and analyze each element is helpful to help decision-makers intuitively understand and analyze problems. Through preliminary questionnaire surveys, field surveys and expert consultations, the influencing factors of the integration of production and education in higher vocational colleges were basically determined, and on this basis, a hierarchical structure model for professional effectiveness evaluation was established.

Constructing a two-by-two comparison matrix. In order to reduce the difficulty of comparison between indicators and the uncertainty of the scoring process, according to the importance of the indicators, the indicators at the same level are compared two by two, and the 1-9 scale method is applied to assign values to the indicators for scoring. For example, in the pairwise comparison of the first-level indicators, the three first-level indicators of the integration of production and education, the integration process of industry and education, and the integration effect of industry and education are compared in pairs, and the second-level indicators and the third-level indicators are similar.

Calculate indicator weights. The calculation of the judgment matrix was completed independently by an expert group. 12 experts, including teachers from high-level technical colleges and enterprise experts, compared each element index in pairs, assigned relative

importance to each index, and then calculated them separately using SPSS software. The weight of each indicator relative to the indicator of the previous layer. In order to verify whether there are contradictions in the judgment matrices of different indicators, a consistency test is conducted on the judgment matrices of the evaluation index system. Check whether the judgment matrix passes the consistency test according to the consistency ratio CR. If CR < 0.1, it means that the judgment matrix passes the consistency test. If CR > 0.1, it means that the judgment matrix test fails and the judgment matrix needs to be corrected.

After calculation and combined with the experts' modification opinions, the judgment matrix was further revised, and the final consistency ratio of the judgment matrix was 0.062. The test result is less than 0.1, indicating that the judgment matrix has passed the consistency test. According to the revised judgment matrix, the weights of the three first-level indicators of industry-education integration investment, industry-education integration process, and industry-education integration effect relative to the overall goal were determined to be 28.26%, 41.79%, and 29.95% respectively. At the same time, when the consistency test was performed on the judgment matrix under these three indicators, each CR value was less than 0.1, indicating that each indicator passed the consistency test. On this basis, the total ranking weight of the judgment matrix level was calculated and passed the consistency test. Therefore, the weights of each indicator are derived. As shown in Table 7.

Table 7 Weighting table of indicators for evaluating the quality of industry-teaching integration in higher education institutions

Tier 1 indicators	Secondary indicators	Tertiary indicators	Indicator weights/%
Industry-education integration inputs (28.26)	Financial inputs (7.24)	Inputs to the construction of professional clusters	3.3
		The status of funding for cooperative enterprises	3.94
	Faculty quality and industry alignment (7.67)	The educational background and industrial experience of dual instructors, the	3.7
		Examples of the involvement of business faculty in curriculum development and teaching	3.97
	Construction of training bases (13.35)	Number of on- and off-campus training rooms (number on campus, number off campus)	3.27
		Configuration of on- and off-campus training rooms (site setup, financial investment, staffing, etc.)	3.1
		The alignment of practical training programs with the needs of industry	3.54
		Modernization of practical training facilities	3.44

Table 7 Weighting table of indicators for evaluating the quality of industry-teaching integration in higher education institutions(Continued)

Tier 1 indicators	Secondary indicators	Tertiary indicators	Indicator weights/%
	Professional construction (22.03)	Number of cooperative enterprises	3.57
		Degree of match between professional cluster settings and regional industries (%)	3.3
		The construction of teaching resources for professional groups	3.74
		The status of the reform of the teaching model	3.57
		The development of talent training programs for professional clusters	3.81
		The quality and depth of the integration of production and education	4.04
Effectiveness of Industry-Education Integration (29.95)	The effect of the integration of production and education in people (9.72)	Comprehensive evaluation of top-up students	3.11
		The actual effectiveness of school-enterprise project cooperation	3.21
		Acceptance of graduates by enterprises	3.4
	Student satisfaction (10.08)	Student satisfaction with industry-teaching internships/programs	3.5
		Satisfaction with courses in specialty clusters that	3.24
		overall satisfaction of graduates with the quality of education	3.34
	Social impact (10.15)	The situation of specialized clusters serving the regional economy	3.64
		the contribution of graduates to the local society and economy	3.27
		The role of industry-education integration in regional educational development Use it	3.24

5 Concluding remarks

5.1 Analysis and evaluation of the indicator system

Based on the stakeholder theory and the principle of whole process evaluation, this study designs a set of quality evaluation system for the integration of production and education. Through the analysis of the evaluation results, we find that the process of industry-education integration occupies the core position in the improvement of the quality of industry-education integration in higher vocational colleges, and its weight is 41.79%. This shows that when promoting the integration of production and education, higher vocational colleges should focus on professional construction, training base construction and organizational and institutional support to ensure the quality and effect of the integration of production and education. At the same time, the evaluation

results also reveal the problems existing in the implementation of the integration of production and education, such as the allocation of training rooms inside and outside the school, the comprehensive evaluation of students in post practice, and the construction of professional group courses. The solution of these problems is very important to improve the overall quality of the integration of production and education.

5.2 Application and refinement of the indicator system

In the application of this evaluation system, because the quality of the integration of production and education is affected by the cooperation cycle, the economic development of various regions, the demand for different talents in the industrial upgrading of cooperative enterprises, and the participation of students and other related factors, we also need to pay attention to the following two aspects : First, the comprehensiveness of the evaluation indicators in the quality evaluation system of the integration of production and education, the scientificalness of the weight of the evaluation indicators, and the universality of the evaluation results need to be tested by long-term practice. Secondly, when determining the evaluation index and weight, this evaluation system comprehensively considers the demands of multiple participants. However, the quality of industry-education integration is affected by multiple participants such as government, industry, enterprise and students, which will inevitably lead to the differentiation of the demands of each participant. Therefore, how to reflect the differentiation of each participant in the evaluation process needs further research. In the follow-up application process, it should be combined with the actual situation and improved from the following two aspects: First, further improve the content of evaluation indicators. Design a more scientific evaluation index weight determination method. In addition, we can also try to construct a four-level index system or a more multi-level index layer according to the actual needs, in order to achieve the comprehensiveness, scientificalness and universality of the evaluation results. The second is to build a differentiated evaluation system. According to the development status of local governments, enterprises and industries in different school regions, we constantly explore the differentiated evaluation system and formulate more accurate evaluation indicators, so as to realize the differentiation of evaluation results and meet the demands of different participants.

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