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Research on the Design of Quality Evaluation System of Vocational Education Industry-Teaching Integration Based on Hierarchical Analysis Method

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ABSTRACT

With the continuous promotion of the integration of industry and education, constructing a quality evaluation system for the integration of industry and education in vocational education has become a key issue to improve the level of vocational colleges and universities' curricula. Based on the CIPP model, the article builds a quality evaluation system of vocational education industry-teaching integration that includes 4 first-level indicators, 12 second-level indicators and 34 third-level indicators, and empirically analyzes the quality of industry-teaching integration in three higher vocational colleges, H1, H2 and H3, using the fuzzy comprehensive evaluation method through the questionnaire survey from the viewpoint of empirical application. According to the results of the fuzzy comprehensive evaluation, the quality of industry-teaching integration in H1 and H2 higher vocational colleges and universities belongs to the good level, and its comprehensive judgment value is 78.2 and 78.395 respectively.The comprehensive judgment value of the quality of industry-teaching integration in H3 higher vocational colleges and universities is 82.037, which belongs to the excellent level. The three sample higher vocational colleges have achieved outstanding results in the integration of industry and education, providing an example for the development of integration of industry and education for higher vocational colleges in the region.

Keywords: fuzzy comprehensive evaluation method, evaluation system, industry-education integration, hierarchical analysis method

1. Introduction

With the rapid development of the economy and the continuous upgrading of industrial structure, there is an increasing demand for highly skilled personnel in all walks of life in the society, which also puts forward higher requirements for vocational education. However, the traditional vocational education model has been difficult to meet the diversified and practical needs of modern society for

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talent training, and the integration of industry and education has become an important way to promote the reform and development of vocational education [1-4]. Industry-education integration is a deep combination of education field and industrial development, a market-oriented talent cultivation mode, aiming at realizing a close match between education content and industrial demand through the interaction and cooperation between education and industry, and improving the pertinence and practicality of education and cultivation [5-7]. Through school-enterprise cooperation, work-learning integration, and the construction of practical training bases, vocational colleges and universities are able to enable students to learn and practice in real or near-real working environments, so as to cultivate high-quality technical and skillful talents in line with market demand [8-10]. In order to promote the vertical and deep development of the integration of industry and education, it is particularly important to construct a scientific and reasonable quality evaluation system for the integration of industry and education [11-12]. The system is oriented to the educational objectives of the integration of industry and education, and is designed around the two dimensions of the educational process and educational results, covering the practicality of teaching content, the innovation of teaching methods, the practical improvement of students' abilities, enterprise satisfaction and social benefits [13-16]. Through the quality evaluation system of the integration of industry and education, vocational colleges and universities can not only discover the problems in the process of integration of industry and education in a timely manner, and put forward suggestions for improvement according to the actual situation, but also provide a scientific basis for the reform and development of vocational education, and further promote the improvement of the quality of education and the innovation of the education model, so as to realize the benign interaction between the development of education and the economic and social development [17-21].

The integration of industry and education is an important contributing factor to the transformation and upgrading of industrial structure and the development of regional economy as well as an inherent requirement, and it is an effective way to improve the quality of higher vocational colleges and universities. Literature [22] emphasizes that deepening school-enterprise cooperation can significantly improve the quality of higher vocational colleges and universities, promote higher vocational colleges and universities to adopt school-enterprise cooperation modes tailored to the local conditions through government promotion and top-level design, and then enhance the technical service capacity of the school and the quality of talent cultivation, so as to realize the mutual benefits of the school and the enterprise. Literature [23] shows that higher vocational colleges and universities can rely on the platform of industry-education fusion to integrate school and enterprise resources, formulate school-enterprise collaborative education training programs, and enhance students' employment competitiveness and comprehensive quality by carrying out scientific and technological innovations and technical exchanges, so as to realize the cultivation of high-quality skilled talents. Literature [24] used structural equation model to quantitatively analyze the important factors driving the integration of industry and education in higher vocational education in the era of intelligence, and explored the optimization mechanism for the in-depth development of the integration of industry and education in higher vocational education in the context of the era of intelligence.

The construction of the quality evaluation system for the integration of industry and education in vocational education has far-reaching significance for social development. Literature [25] and others designed a comprehensive evaluation system containing 11 evaluation indexes from the perspectives of teachers, teaching, research and service to assess the performance of the integration of industry and education with the higher vocational colleges and universities in the Yangtze River Delta region as the object of study, and further optimized some of the indexes' performance. Literature [26] uses the “structure-behavior-performance” analysis paradigm of industrial organization theory to construct the index system for the evaluation of the performance of the integration of industry and education, and applies the entropy weight method to assign the indexes, which can effectively analyze the degree of coupling and coordination between higher education and regional industries, and provide data support for the promotion of sustainable economic and social development. Literature [27] adopts multi-attribute group decision-making problem to evaluate the quality of industry-education integration in rural vocational education, and establishes a probabilistic linguistic hybrid aggregation method based on comprehensive normalization technique, and empirical research shows that the proposed model has a high evaluation performance for industry-education integration under the perspective of rural revitalization. Literature [28] believes that the evaluation of the quality of school-enterprise cooperation should not only consider the background and current situation between schools and enterprises, but also the subjective cognition and emotion of individual students, based on which the evaluation index system based on the CIPP model is established to achieve the evaluation goals of scientificity, applicability and feasibility. Literature [29] examined the quality evaluation system of industry-teaching integration centered on the vocational ability of artificial intelligence, designed a complete evaluation index system by mining the specific needs of enterprise positions and combining with the establishment of experts, and used intuitionistic fuzzy hierarchical analysis to assign weights to the indexes, which was able to analyze in detail the key factors that caused mismatch between the industrial demand and the supply of talents. It can be found that the quality evaluation system of industry-teaching integration in vocational education can better serve the social and economic development through the evaluation feedback mechanism on the one hand, and on the other hand, it can also promote the in-depth cooperation between schools and enterprises in the areas of resource sharing, technology research and development, etc., as well as provide support for the cultivation of comprehensive quality talents with employment competitiveness.

The article firstly proposes to construct a vocational education curriculum evaluation index system with the CIPP model as the framework, the first-level indexes include the background assessment of the integration of industry and education, input assessment, process assessment and outcome assessment, and the second-level indexes include 12 indexes including the need for course offerings and the basis of curriculum construction. Then the related calculation steps of fuzzy comprehensive evaluation model and affiliation matrix are elaborated. Subsequently, the hierarchical analysis method is used to determine the weights of the indicators, and the empirical analysis is carried out with three higher vocational colleges and universities (H1, H2, and H3) in a certain province as the object of the study, and the questionnaire research, fuzzy comprehensive evaluation method and other methods are used to evaluate the quality of the integration of industry and education in the three higher vocational colleges and universities, and finally, the SEM results are analyzed.

2. Method

2.1. Quality Evaluation Index System of Vocational Education Industry-Teaching Integration Based on CIPP Model

Based on the four dimensions of “background-input-process-result” in the CIPP model, this paper constructs the evaluation index system of vocational education courses in the context of the integration of industry and education. The evaluation index system of vocational education courses in the context of integration of production and education is shown in Table 1. Through visiting and researching relevant enterprises, as well as interviews and questionnaires with experts in vocational education and personnel managers of enterprises, an index system was formed, which includes 4 first-level indexes, 12 second-level indexes and 34 third-level indexes.

1) "Background evaluation" index. The background evaluation is mainly an analysis of the necessity of curriculum development, which can be evaluated with the help of three secondary indicators: "curriculum development needs", "curriculum construction foundation" and "curriculum goal positioning". Among them, the "needs of curriculum development" can be divided into three levels: "the needs of social and economic development", "the needs of industry talent supply", and "the needs of students to achieve employment" [30]. At the social level, the ultimate goal of vocational education

is to promote the high-quality development of the industry, so the curriculum construction of colleges and universities should be based on the development needs of regional characteristic industries and improve the service capacity of economic and social development. At the industry level, the development of vocational education courses should first carry out systematic and in-depth demand research, and conduct research on the "needs of industry talent supply", such as the level, quantity, specification, and standard of talent demand, so as to identify the focus and direction of professional talent training, and cultivate professional talents according to the needs of the job market. At the student level, the core goal of vocational education is to cultivate "people" and implement the concept of "people-oriented", so it is necessary to pay attention to the vocational knowledge and practical ability necessary for the employment of students in this major, and formulate a scientific and reasonable curriculum system.

2) "Input Evaluation" indicator. The input evaluation is based on the background evaluation, the conditions and resources required to achieve the goal are evaluated, and its essence is the analysis of the appropriateness and utility of the curriculum program, aiming to form an optimal curriculum program, which can be investigated by using three secondary indicators of "course content", "teacher allocation" and "teaching resource allocation". Among them, the "course content" includes three third-level indicators: "selectivity of content", "completeness of structure" and "modernity of materials". With the continuous refinement of the social division of labor, the job market for vocational college students presents personalized and differentiated positions, and the content provided by the courses is required to be selective and meet the needs of students' future positions and their own development.

3) "Process evaluation" index. The process evaluation is a dynamic evaluation of the teaching process of the whole vocational education course, which can be evaluated from four secondary indicators: "teachers' teaching activities", "students' learning experience", "course assessment" and "enterprise participation". Among them, "teachers' teaching activities" can be carried out from three aspects: "teaching design", "teaching methods" and "teaching reflection". The complexity of the background of vocational education learning groups and the differences in cognitive ability put forward higher requirements for teachers' teaching design and teaching methods. Whether the teaching design follows the basic rules of learners' vocational ability training, and whether it reflects the stage, hierarchy and gradual nature of teaching. Whether teachers can make reasonable and efficient use of the resources of both schools and enterprises to provide students with learning experience activities such as experiments, operations, and drills are important observation points for the evaluation of teaching activities.

4) "Achievement evaluation" indicators. Outcome evaluation is a key part of curriculum evaluation and the final test of educational effectiveness, which can be carried out from two aspects: "student learning outcomes" and "curriculum impact". The ultimate goal of curriculum construction, implementation and evaluation is to cultivate and develop students, and students' learning outcomes are the most direct form of expression. The evaluation of learning outcomes should focus on whether students have the vocational knowledge, skills, and literacy required by their majors, and whether the results of curriculum implementation have met the expected talent training goals of the curriculum [31].

Table 1. The evaluation index system of vocational education course is built

Primary indicator	Secondary indicator	Tertiary index
Background evaluation(W1)	Curriculum need(W11)	The need for social and economic development(W111)
		The need for industry talent supplies(W112)
		The students need to realize employment(W113)
	Foundation of curriculum construction(W12)	Academic background(W121)
		Staff reserve(W122)
		Corporate engagement(W123)

	Course target positioning(W13)	Talent training target(W131)
		Curriculum organization(W132)
Input evaluation(W2)	Course content(W21)	Content selectivity(W211)
		Structural integrity(W212)
		The time of the material(W213)
	Qualified teachers(W22)	Corporate tutor(W221)
		The "double teacher" teacher team(W222)
	Teaching resource allocation(W23)	Online course platform(W231)
		Teaching equipment(W232)
		Campus training center(W233)
		Off-campus internship base(W234)
Process evaluation(W3)	Teaching activities of teachers(W31)	Teaching design(W311)
		Teaching method(W312)
		Teaching reflection(W313)
	Students' learning experience(W32)	Participation in learning activities(W321)
		Reflection on learning results(W322)
	Course assessment(W33)	Subject of examination(W331)
		Appraisal content(W332)
		Assessment mode(W333)
	Corporate engagement(W34)	Enterprise expert engagement(W341)
		Enterprise device invocation(W342)
		Enterprise site supply(W343)
Achievement evaluation(W4)	Student learning(W41)	Occupational knowledge(W411)
		Vocational skill(W412)
		professionalism(W413)
	Course impact(W42)	Demonstration leading action(W421)
		Sustainability(W422)
		Extensibility(W423)

2.2. Confirmation of indicator weights

The Delphi method and the hierarchical analysis method are used to determine the weights of the indicators. Hierarchical analysis method is through the qualitative indicators fuzzy quantitative method to calculate the hierarchical single ranking (weights) and the total ranking, in order to serve as a systematic method of the goal (multiple indicators), multi-program optimization decision-making, can be multi-dimensional, multi-level to carry out the evaluation of the basic steps of implementation are: first of all, the establishment of the problem's recursive hierarchical structure. Analyze the relationship between the basic elements in the evaluation system and the intermediate links involved in achieving the goal [32]. Second, construct a two-by-two comparison judgment matrix. In this step, the decision maker must repeatedly answer the question about the criterion, i.e., determine "which of the two elements is more important" and assign a certain value to its importance.

Constructing the judgment matrix:

$$A=(a_{ij})n\times n \tag{1}$$

$$A=\begin{bmatrix} a_{11}\cdots a_{1n} \\ \vdots\ddots\vdots \\ a_{1n}\cdots a_{nn} \end{bmatrix} \tag{2}$$

Among them: $a_{ji}=1/a_{ij}$.

Again, the ranking and consistency test under the single criterion is performed. To carry out hierarchical single sorting, the normalization is processed so that the sum of the elements in the vector is 1, which is recorded as W. The elements of W are the sorting weights of the elements of the same hierarchy on the relative importance of the factors of the previous hierarchy, and this process is called hierarchical single sorting. Due to the complexity of objective things will make the researcher's judgment with subjectivity and one-sidedness, completely require each time to compare the judgment of the thinking of the same standard is unlikely, so for the single-criteria sorting, are required to do a one-time test. The specific steps are as follows: first, using the sum method, the column vectors of matrix A are normalized. Second, the elements of A are summed by rows. Third, the resulting row vectors are normalized to obtain the weight vector W of each evaluation index weight ranking.

$$w_i = \frac{\overline{W_i}}{\sum_{i=1}^{n} \overline{W_i}} \tag{3}$$

$$W = \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix} \tag{4}$$

Fourth, compute $\lambda \max$ to obtain the feature vector W corresponding to the largest feature root $\lambda \max$ which is the weight vector.

$$AW = \lambda \max W \tag{5}$$

$$\lambda \max = \frac{1}{n} \sum_{i=1}^{n} \frac{(AW)_i}{W_i} \tag{6}$$

Fifth, compute the stochastic consistency ratio of the pairwise comparison matrix CR. When $CR < 0.1$, the judgment matrix has satisfactory consistency.

$$CR = \frac{CI}{RI} \tag{7}$$

$$CI = \frac{\lambda \max - n}{n-1} \tag{8}$$

2.3. Fuzzy integrated evaluation model

2.3.1. Calculation steps of the fuzzy comprehensive evaluation method:

1) Hierarchy of evaluation targets. The target level A is divided into 5 guidelines $B_i, i = 1,2,3,4,5$. Guideline B_i contains n indicators, and the exact value n is determined by the number of indicators under the i guideline layer. To wit:

$$A = (B_1, B_2, B_3, B_4, B_5) \tag{9}$$

$$B_i = (C_{i1}, C_{i2}, \cdots, C_{in}) \tag{10}$$

2) Determine the weighting values of indicators at each level. The weight value includes the weight set W_B of the criterion layer relative to the total objective layer and the weight set W_C of the indicator layer relative to the criterion layer. i.e:

$$W_B = (W_{B1}, W_{B2}, \cdots, W_{B5}) \tag{11}$$

$$W_C = (W_{Ci1}, W_{Ci2}, \cdots, W_{Cin}) \tag{12}$$

3) Determine the set of evaluation level criteria

$$V = \begin{bmatrix} V_{111} & V_{112} & \cdots & \cdots & V_{115} \\ V_{121} & V_{122} & \cdots & \cdots & V_{125} \\ V_{131} & V_{132} & \cdots & \cdots & V_{135} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ V_{551} & V_{552} & \cdots & \cdots & V_{555} \end{bmatrix} \tag{13}$$

where V_{inj} denotes the level $j(j = 1, 2, \cdots, 5)$ evaluation criteria corresponding to the n rd specific indicator under the $i(i = 1, 2, \ldots, 5)$ nd criterion level.

4) Establish the affiliation matrix

$$R = (R_1, R_2, R_3, R_4, R_5)^T \tag{14}$$

$$R_i = \begin{bmatrix} r_{i11} & r_{i12} & \cdots & \cdots & r_{i15} \\ r_{i21} & r_{i22} & \cdots & \cdots & r_{i25} \\ r_{i31} & r_{i32} & \cdots & \cdots & r_{i35} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{in1} & r_{in2} & \cdots & \cdots & r_{in5} \end{bmatrix} \tag{15}$$

where R_i is the affiliation matrix of the i nd criterion $(i = 1, 2, \cdots, 5)$.

5) Hierarchical fuzzy evaluation. The weights and affiliation matrix determined by the hierarchical analysis method are utilized for the operation.

(1) Fuzzy evaluation of indicator layer on criterion layer

$$B = (B_1, B_2, B_3, B_4, B_5)^T \tag{16}$$

$$B_i = W_{Ci} \circ R_i = (w_{ci1}, w_{ci2}, \cdots, w_{cin}) \circ \begin{bmatrix} r_{i1} & r_{i12} & \cdots & \cdots & r_{i15} \\ r_{i21} & r_{i22} & \cdots & \cdots & r_{i25} \\ r_{i31} & r_{i32} & \cdots & \cdots & r_{i35} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{in1} & r_{in2} & \cdots & \cdots & r_{in5} \end{bmatrix} \tag{17}$$

where B_i is the fuzzy evaluation of the $i(1, 2, 3, 4, 5)$ nd criterion.

(2) Fuzzy evaluation of the criterion layer on the target layer

$$S = W_B \circ B = (w_{B1}, w_{B2}, \cdots, w_{BS}) \circ \begin{bmatrix} W_{C1} \circ R_1 \\ W_{C2} \circ R_2 \\ W_{C3} \circ R_3 \\ W_{C4} \circ R_4 \\ W_{C5} \circ R_5 \end{bmatrix} = (S_1, S_2, S_3, S_4, S_5) \tag{18}$$

where S is the affiliation matrix of the five classes and operation " $\circ$ " is the fuzzy operator.

2.3.2. Computation of the Affinity Matrix:

1) Indicator categorization. The indicator set is categorized to determine the one-factor fuzzy set of different types of indicators, which is also known as the affiliation matrix [33].

2) Affiliation degree calculation method. The two types of indicator affiliation functions are calculated as follows:

(1) Positive indicators. The values of each class of positive indicators are listed in order from the largest to the smallest. The formula is as follows:

$$r_{in1}=1; r_{in2}=r_{in3}=r_{in4}=r_{in5}=0, x_{in}>V_{in1} \tag{19}$$

$$\begin{cases} r_{in(j+1)}=\dfrac{V_{inj}-x_{in}}{V_{inj}-V_{in(j+1)}} & V_{in(j+1)}\le x_{in}\le V_{inj}\,(j=1,2,3,4) \\ r_{inj}=1-r_{in(j+1)} \end{cases} \tag{20}$$

$$r_{in5}=1; r_{in1}=r_{in2}=r_{in3}=r_{in4}=0, x_{in}<V_{in5} \tag{21}$$

(2) Reverse indicators. The values of each level of the reverse indicator are listed in descending order. The formula is as follows:

$$r_{in1}=1; r_{in2}=r_{in3}=r_{in4}=r_{in5}=0, x_{in}<V_{in1} \tag{22}$$

$$\begin{cases} r_{in(j+1)}=\dfrac{x_{in}-V_{inj}}{V_{in(j+1)}-V_{inj}} & V_{in(j+1)}\le x_{in}\le V_{inj}\,(j=1,2,3,4) \\ r_{inj}=1-r_{in(j+1)} \end{cases} \tag{23}$$

$$r_{in5}=1; r_{in1}=r_{in2}=r_{in3}=r_{in4}=0, x_{in}>V_{in5} \tag{24}$$

3) Selection of fuzzy synthesis operator. When performing fuzzy conversion, it is necessary to choose the appropriate fuzzy synthesis operator, fuzzy synthesis operator can be generally categorized into the following four models:

(1) Model 1 $M(\wedge,\vee)$

$$B_j=\overset{m}{*}\vee\left(w_i\wedge r_{ij}\right)=\max_{1\le i\le m}\left\{\min(w_i,r_{ij})\right\}(j=1,2,\cdots,n) \tag{25}$$

The symbol “$\wedge$” is for small and “$\vee$” is for large. Example:

$$B=W\circ R=(0.4,0.4,0.4)\circ\begin{pmatrix}0.6 & 0.4 & 0.3\\ 0.4 & 0.5 & 0.3\\ 0.3 & 0.3 & 0.4\end{pmatrix}=(0.4\quad 0.4\quad 0.4) \tag{26}$$

In the formula:

$$\begin{aligned} B_1 &= (0.4\wedge 0.6)\vee(0.4\wedge 0.4)\vee(0.4\wedge 0.3)\\ &=(0.4\vee 0.4\vee 0.3)\\ &=0.4 \end{aligned} \tag{27}$$

Other B_j Algorithm is the same $(j=1,2,\cdots,n)$

(2) Model 2 $M(\cdot,\vee)$ Operator

$$B_j = \bigvee_{i=1}^{m} (w_i \cdot r_{ij}) = \max\nolimits_{1\le i\le m} (w_i \cdot r_{ij}), (j = 1, 2, \cdots, n) \tag{28}$$

Example:

$$B = W \circ R = (0.4, 0.4, 0.4) \circ \begin{pmatrix} 0.6 & 0.4 & 0.3 \\ 0.4 & 0.5 & 0.3 \\ 0.3 & 0.3 & 0.4 \end{pmatrix} = (0.24 \quad 0.20 \quad 0.16) \tag{29}$$

In the formula:

$$\begin{aligned} B_1 &= (0.4 \cdot 0.6) \vee (0.4 \cdot 0.4) \vee (0.4 \cdot 0.3) \\ &= (0.24 \vee 0.16 \vee 0.12) \\ &= 0.24 \end{aligned} \tag{30}$$

Other B_j Algorithm is the same $(j = 1, 2, \cdots, n)$

(3) The model 3 $M(\wedge, \oplus)$ operator

$\oplus$ is a bounded sum operation, i.e., an ordinary addition operation under a bounded restriction.

$$B_j = \min\left\{1, \sum_{j=1}^{m} \min(w_i, r_{ij})\right\}, (j = 1, 2, \cdots, n) \tag{31}$$

Example:

$$B = W \circ R = \left(0.3, 0.3, 0.3\right) \circ \begin{pmatrix} 0.5 & 0.4 & 0.3 \\ 0.4 & 0.3 & 0.2 \\ 0.3 & 0.2 & 0.1 \end{pmatrix} = \left(0.9 \quad 0.8 \quad 0.7\right) \tag{32}$$

In the formula:

$$\begin{aligned} B_1 &= (0.3 \wedge 0.5) \oplus (0.3 \wedge 0.4) \oplus (0.3 \wedge 0.3) \\ &= (0.3 \oplus 0.3 \oplus 0.3) \\ &= 0.9 \end{aligned} \tag{33}$$

Other B_j Algorithm is the same $(j = 1, 2, \cdots, n)$

(4) model 4 $M(\cdot, \oplus)$ operator

$$B_j = \min\left\{1, \sum_{j=1}^{m} w_j r_{ij}\right\}, (j = 1, 2, \cdots, n) \tag{34}$$

Example:

$$B = W \circ R = (0.3, 0.3, 0.3) \circ \begin{pmatrix} 0.5 & 0.4 & 0.3 \\ 0.4 & 0.3 & 0.2 \\ 0.3 & 0.2 & 0.1 \end{pmatrix} = \left(0.36 \quad 0.27 \quad 0.18\right) \tag{35}$$

In the formula:

$$\begin{aligned} B_1 &= (0.3 \cdot 0.5) \oplus (0.3 \cdot 0.4) \oplus (0.3 \cdot 0.3) \\ &= (0.15 \oplus 0.12 \oplus 0.09) \\ &= 0.36 \end{aligned} \tag{36}$$

Other B_j algorithms are the same $(j = 1, 2, \cdots, n)$.

When $w_i (i = 1, 2, \cdots, n)$ is a normalized vector, i.e. when:

$$\sum_{i=1}^{n} w_i = 1 \tag{37}$$

$$\sum_{i=1}^{n} w_i r_{ij} \le 1 \tag{38}$$

In this case, the arithmetic model becomes $M(\cdot,+)$. The computation is:

$$B_j = \sum_{i=1}^{n} w_i r_{ij}, (j = 1, 2, \cdots, n) \tag{39}$$

The above four models, in most cases, produce evaluation results that are consistent. However, Models 1~3 lose some important information during the calculation process, and these three models can be applied in cases where only extreme values need to be evaluated or where a major factor is to be highlighted. Model 4 incorporates the effects of all evaluation indicators on river health when performing calculations, and does not ignore the information of single-factor evaluation, using a weighted approach that emphasizes the influence of the largest contributing factor, and each participating factor is also applied, which can reflect the health of the reasonable back relatively accurately and comprehensively. Therefore, model 4 was prioritized for this study.

3. Results and discussion

3.1. Evaluation indicators and weighting analysis

The quality evaluation indexes and weights of vocational education industry-education integration are shown in Table 2. As can be seen from the table, the most crucial factor in the quality assessment system of vocational education industry-education integration is input evaluation, with a weight of 0.2777, followed by background evaluation, with a weight of 0.2751, and then process evaluation and outcome evaluation, with weights of 0.2473 and 0.1999, respectively.From the longitudinal point of view, the weight of input evaluation is the highest, which indicates that it plays a crucial role in the overall quality assessment. Vocational education institutions, industry experts and the business community attach great importance to ensuring the smooth progress of industrial education integration. In the evaluation and implementation process, educational institutions and enterprises are required to closely integrate the development trend and goals of the industry, match the characteristics of the industry, the professional settings of the educational institutions and the talent cultivation programs of the enterprises, clearly define their respective educational characteristics and expertise in products and technologies, jointly develop educational materials and curricula, and actively promote practical teaching and digital teaching through cooperation between schools and enterprises, so as to ensure that the quality of the integration of industrial education in vocational educational institutions is effectively safeguarded. The quality of industrial education integration in vocational education institutions is effectively guaranteed. From a cross-sectional perspective, the four dimensions have similar weights, indicating that the assessment of the quality of industrial education integration needs to comprehensively consider factors such as basic support, resource allocation, talent training and employment outcomes. In order to improve the quality of industrial education integration, participants such as vocational education institutions and enterprises need to make joint efforts in terms of organizational structure, resource input, talent training and employment outcomes.

Table 2. The quality evaluation index and weight of the professional education

Primary Indicator	Weighting	Secondary Indicator	Weighting	Tertiary Index	Weighting
(W1)	0.2751	(W11)	0.6485	(W111)	0.6193
				(W112)	0.2037
				(W113)	0.1770
		(W12)	0.2238	(W121)	0.5313
				(W122)	0.1637
				(W123)	0.305
		(W13)	0.1277	(W131)	0.8333
				(W132)	0.1667
(W2)	0.2777	(W21)	0.6044	(W211)	0.4141
				(W212)	0.2070
				(W213)	0.3789
		(W22)	0.2476	(W221)	0.7257
				(W222)	0.2743
		(W23)	0.1480	(W231)	0.6002
				(W232)	0.1326
				(W233)	0.1830
				(W234)	0.0842
(W3)	0.2473	(W31)	0.2989	(W311)	0.2172
				(W312)	0.3264
				(W313)	0.4564
		(W32)	0.1249	(W321)	0.4141
				(W322)	0.5859
		(W33)	0.2001	(W331)	0.5375
				(W332)	0.1938
				(W333)	0.2687
		(W34)	0.3761	(W341)	0.2070
				(W342)	0.2523
				(W343)	0.5407
(W4)	0.1999	(W41)	0.5762	(W411)	0.4198
				(W412)	0.2929
				(W413)	0.2873
		(W42)	0.4238	(W421)	0.3198
				(W422)	0.4929
				(W423)	0.1873

3.2. Empirical analysis of the evaluation of the quality of industry-teaching integration in vocational education

3.2.1. Evaluation Objects and Data Sources:

1) Evaluation Objects. H1, H2 and H3 vocational education in a province with outstanding experience in industry-education integration are selected for field investigation.

2) Data sources. Based on the established indicator system, the indicator data are collected, mainly from the statistical data of the third-party platform.

3) Raw data. Based on the previously constructed indicator system, the three vocational education H1, H2 and H3 were surveyed, and teachers and administrators responsible for or engaged in the work of industry-teaching integration were interviewed, and the raw data of the three vocational education were collated.The raw data of the three-level indicators of H1, H2 and H3 institutions are shown in Table 3.

Table 3. The original data of the three levels of H1, H2, H3 institutions

Primary Indicator	Secondary Indicator	Tertiary Index	H1	H2	H3
(W1)	(W11)	(W111)	75.37%	74.59%	76.49%
		(W112)	73.39%	88.39%	70.56%
		(W113)	68.52%	78.08%	91.49%
	(W12)	(W121)	85.22%	86.87%	69.46%
		(W122)	80.52%	69.54%	82.85%
		(W123)	87.72%	81.07%	71.1%
	(W13)	(W131)	88.43%	71.27%	71.31%
		(W132)	83.88%	83.82%	77.34%
(W2)	(W21)	(W211)	85.59%	81.96%	76.24%
		(W212)	81.34%	72.22%	72.06%
		(W213)	85.47%	69.49%	80.38%
	(W22)	(W221)	77.01%	80.28%	68.89%
		(W222)	82.87%	86.55%	75.27%
	(W23)	(W231)	85.52%	77.49%	72.57%
		(W232)	78.55%	78.51%	71.52%
		(W233)	89.87%	80.09%	79.25%
		(W234)	80.94%	78.65%	71.07%
(W3)	(W31)	(W311)	90.09%	75.85%	79.37%
		(W312)	71.09%	78.53%	78.66%
		(W313)	74.02%	75.31%	83.33%
	(W32)	(W321)	88.99%	76.85%	85.12%
		(W322)	91.12%	79.16%	70.31%
	(W33)	(W331)	81.64%	82.03%	84.78%
		(W332)	89.76%	69.24%	75.44%
		(W333)	73.05%	92.29%	86.76%
	(W34)	(W341)	71.64%	83.8%	83.91%
		(W342)	77.88%	75.33%	71.72%
		(W343)	81.86%	74.54%	87.08%
(W4)	(W41)	(W411)	75.29%	76.68%	70.22%
		(W412)	74.16%	90.34%	70.95%
		(W413)	87.84%	91.7%	82.43%
	(W42)	(W421)	72.28%	90.89%	71.05%
		(W422)	75.58%	71.32%	88.31%
		(W423)	75.12%	82.5%	84.17%

3.2.2. Evaluation Process of Vocational Education Industry-Education Integration Performance:

1) Single-factor evaluation of vocational education industry-teaching integration performance. In this paper, a total of 10 expert questionnaires were sent out, and the 10 experts include leaders, researchers, professors and teachers in vocational education who are responsible for school-enterprise cooperation in industry-teaching integration. And the comment set is defined as V={V1,V2,V3,V4,V5}={excellent, good, average, qualified, unqualified}, and evaluated by experts, and

designed a single-factor evaluation questionnaire for the integration of industry and education in vocational education, the rules are, reference comment set V={V1,V2,V3,V4,V5}={excellent, good, average, qualified, unqualified}, according to the monitoring data of the third-level indicators, each second-level index is given a grade, and only one evaluation level can be selected when evaluating the second-level indicators. Finally, the univariate evaluation results of 10 experts on the second-level indicators of H1 higher vocational, H2 higher vocational and H3 higher vocational are summarized, and the univariate evaluation results of the second-level indicators of the integration of industry and education in the three colleges are shown in Table 4.

Table 4. The results of the evaluation of the secondary index

Academy	Index Name	Excellence		Good		General		Qualify		Out Of Line	
		Number	Score	Number	Score	Number	Score	Number	Score	Number	Score
H1	(W11)	5	0.5	2	0.2	2	0.2	1	0.1	0	0.0
	(W12)	6	0.6	2	0.2	1	0.1	1	0.1	0	0.0
	(W13)	5	0.5	3	0.3	0	0.0	2	0.2	0	0.0
	(W21)	5	0.5	2	0.2	0	0.0	3	0.3	0	0.0
	(W22)	6	0.6	2	0.2	1	0.1	1	0.1	0	0.0
	(W23)	6	0.6	4	0.4	0	0.0	0	0.0	0	0.0
	(W31)	4	0.4	2	0.2	2	0.2	2	0.2	0	0.0
	(W32)	7	0.7	2	0.2	1	0.1	0	0.0	0	0.0
	(W33)	6	0.6	3	0.3	1	0.1	0	0.0	0	0.0
	(W34)	4	0.4	4	0.4	1	0.1	1	0.1	0	0.0
	(W41)	6	0.6	3	0.3	0	0.0	1	0.1	0	0.0
	(W42)	3	0.3	2	0.2	4	0.4	1	0.1	0	0.0
H2	(W11)	4	0.4	3	0.3	3	0.3	0	0.0	0	0.0
	(W12)	1	0.1	4	0.4	5	0.5	0	0.0	0	0.0
	(W13)	5	0.5	2	0.2	2	0.2	1	0.1	0	0.0
	(W21)	6	0.6	2	0.2	1	0.1	1	0.1	0	0.0
	(W22)	5	0.5	1	0.1	3	0.3	1	0.1	0	0.0
	(W23)	4	0.4	4	0.4	1	0.1	1	0.1	0	0.0
	(W31)	6	0.6	2	0.2	1	0.1	1	0.1	0	0.0
	(W32)	5	0.5	3	0.3	1	0.1	1	0.1	0	0.0
	(W33)	7	0.7	0	0.0	2	0.2	1	0.1	0	0.0
	(W34)	8	0.8	0	0.0	1	0.1	1	0.1	0	0.0
	(W41)	4	0.4	4	0.4	2	0.2	0	0.0	0	0.0
	(W42)	5	0.5	3	0.3	1	0.1	1	0.1	0	0.0
H3	(W11)	7	0.7	2	0.2	0	0.0	1	0.1	0	0.0
	(W12)	4	0.4	5	0.5	1	0.1	0	0.0	0	0.0
	(W13)	7	0.7	2	0.2	1	0.1	0	0.0	0	0.0
	(W21)	9	0.9	1	0.1	0	0.0	0	0.0	0	0.0
	(W22)	7	0.7	0	0.0	2	0.2	1	0.1	0	0.0
	(W23)	5	0.5	3	0.3	2	0.2	0	0.0	0	0.0
	(W31)	6	0.6	4	0.4	0	0.0	0	0.0	0	0.0
	(W32)	8	0.8	1	0.1	1	0.1	0	0.0	0	0.0
	(W33)	4	0.4	5	0.5	1	0.1	0	0.0	0	0.0
	(W34)	6	0.6	1	0.1	2	0.2	1	0.1	0	0.0
	(W41)	6	0.6	2	0.2	1	0.1	1	0.1	0	0.0
	(W42)	4	0.4	4	0.4	1	0.1	1	0.1	0	0.0

2) Fuzzy comprehensive evaluation of vocational education industry-teaching integration performance:

(1) Evaluation set. Evaluation set V ={V1,V2,V3,V4,V5} ={Excellent, Good, Average, Qualified, Unqualified}, Evaluation set corresponding to the set of values N = {N1, N2, N3, N4, N5}, Evaluation set V corresponding to the set of values N, the quantitative value of Evaluation set V is shown in Table 5.

Table 5. The quantifiable value of the comment set V

Comment set v	Excellence	Good	General	Qualify	Out Of Line
Range of values	100.00~80.00	79.90~65.00	64.90~60.00	59.90~55.00	V<54.90
Group median	90	72.45	62.45	57.45	27.5

(2) Calculation results of fuzzy comprehensive evaluation model. The fuzzy comprehensive evaluation model is utilized to calculate the fuzzy comprehensive evaluation results for the performance of industry-education integration of H1, H2 and H3 vocational education. According to the theory of fuzzy comprehensive evaluation, the second-level indicator weight vector W_i of the factor set is multiplied by the corresponding fuzzy matrix of the second-level indicators to find the second-level evaluation vector.

a) Calculation of fuzzy comprehensive evaluation for H1 vocational education. Firstly, H1 vocational education is analyzed, and the fuzzy relationship matrix of A1 industry-education integration input can be obtained as p_1 from the single-factor fuzzy evaluation results, and the calculation results are shown below:

$$A_1 = w_1 * p_1 = (0.6485, 0.2238, 0.1277) * \begin{bmatrix} 0.5 & 0.2 & 0.2 & 0.1 & 0 \\ 0.6 & 0.2 & 0.1 & 0.1 & 0 \\ 0.5 & 0.3 & 0 & 0.2 & 0 \end{bmatrix} = (0.522, 0.213, 0.152, 0.113, 0)$$

From the results of single-factor fuzzy evaluation, we can get the fuzzy relationship matrix of A2 industry-education integration process is p_2, and the calculation results are shown below:

$$A_2 = w_2 * p_2 = (0.6044, 0.2476, 0.1480) * \begin{bmatrix} 0.5 & 0.2 & 0 & 0.3 & 0 \\ 0.6 & 0.2 & 0.1 & 0.1 & 0 \\ 0.6 & 0.4 & 0 & 0 & 0 \end{bmatrix} = (0.540, 0.23, 0.025, 0.206, 0)$$

From the results of single-factor fuzzy evaluation, we can get the fuzzy relationship matrix of A3 industry-education integration effect as p_3, and the calculation results are shown below:

$$A_3 = w_3 * p_3 = (0.2989, 0.1249, 0.2001, 0.3761) * \begin{bmatrix} 0.4 & 0.2 & 0.2 & 0.2 & 0 \\ 0.7 & 0.2 & 0.1 & 0 & 0 \\ 0.6 & 0.3 & 0.1 & 0 & 0 \\ 0.4 & 0.4 & 0.1 & 0.1 & 0 \end{bmatrix} = (0.477, 0.295, 0.13, 0.097, 0)$$

From the results of single-factor fuzzy evaluation, we can get the fuzzy relationship matrix of A4 industry-education integration effect as p_4, and the calculation results are shown below:

$$A_4 = w_4 * p_4 = (0.5762, 0.4238) * \begin{bmatrix} 0.6 & 0.3 & 0 & 0.1 & 0 \\ 0.3 & 0.2 & 0.4 & 0.1 & 0 \end{bmatrix} = (0.473, 0.258, 0.17, 0.1, 0)$$

To summarize what we know, the results of the comprehensive evaluation of the performance of industry-teaching integration in H1 vocational education are:

$$A = w * p = (0.2751, 0.2777, 0.2473, 0.1999) * \begin{bmatrix} 0.522 & 0.213 & 0.152 & 0.113 & 0 \\ 0.54 & 0.23 & 0.025 & 0.206 & 0 \\ 0.477 & 0.295 & 0.13 & 0.097 & 0 \\ 0.473 & 0.258 & 0.17 & 0.1 & 0 \end{bmatrix} = (0.506, 0.247, 0.115, 0.132, 0)$$

We take the set of ratings V = {V1,V2,V3,V4,V5} = {Excellent, Good, Fair, Pass, Fail} as the mid-value of the set, V = {90,72.45,62.45,57.45,27.5} respectively. The initial "S" in "Score" is used to represent the score for calculating the dimension scores and the composite performance score. Calculated results of H1 vocational education industry-education integration performance evaluation.The calculated results of H1 vocational education industry-education integration performance evaluation are shown in Table 6. This shows that H1 vocational education industry-industry integration is good, excellent and outstanding in terms of input, process and effect respectively, and the comprehensive judgment value of industry-industry integration performance is 78.2, which belongs to the grade of "good", and it can be regarded that the performance of industry-industry integration in this school has reached a good level.

Table **6** The results of the evaluation of the performance evaluation of the education

Academy	Primary indicator	Primary index evaluation	Membership grade	The comprehensive evaluation of the fusion performance of the generation	Membership grade
H1	(W1)	78.396	Good	78.2	Good
	(W2)	78.659	Good		
	(W3)	77.994	Good		
	(W4)	77.624	Good		

b) Calculation of fuzzy comprehensive evaluation for H2 vocational education. Next, H2 vocational education is analyzed, and the fuzzy relationship matrix of A1 industry-education integration input can be obtained from the single-factor fuzzy evaluation results as p_1. The calculation results are shown below:

$$A_1 = w_1 * p_1 = (0.6485, 0.2238, 0.1277) * \begin{bmatrix} 0.4 & 0.3 & 0.3 & 0 & 0 \\ 0.1 & 0.4 & 0.5 & 0 & 0 \\ 0.5 & 0.2 & 0.2 & 0.1 & 0 \end{bmatrix} = (0.346, 0.310, 0.332, 0.013, 0)$$

A2 The fuzzy relationship matrix for the process of industry-education integration is p_2, and the results of the calculation are shown below:

$$A_2 = w_2 * p_2 = (0.6044, 0.2476, 0.1480) * \begin{bmatrix} 0.6 & 0.2 & 0.1 & 0.1 & 0 \\ 0.5 & 0.1 & 0.3 & 0.1 & 0 \\ 0.4 & 0.4 & 0.1 & 0.1 & 0 \end{bmatrix} = (0.546, 0.205, 0.15, 0.1, 0)$$

A3 The fuzzy relationship matrix for the effect of industry-education integration is p_3, and the calculation results are shown below:

$$A_3 = w_3 * p_3 = (0.2989, 0.1249, 0.2001, 0.3761) * \begin{bmatrix} 0.6 & 0.2 & 0.1 & 0.1 & 0 \\ 0.5 & 0.3 & 0.1 & 0.1 & 0 \\ 0.7 & 0 & 0.2 & 0.1 & 0 \\ 0.8 & 0 & 0.1 & 0.1 & 0 \end{bmatrix} = (0.683, 0.097, 0.12, 0.1, 0)$$

The fuzzy relationship matrix for the effect of A4 industry-education integration is p_4, and the calculation results are shown below:

$$A_4 = w_4 * p_4 = (0.5762, 0.4238) * \begin{bmatrix} 0.4 & 0.4 & 0.2 & 0 & 0 \\ 0.5 & 0.3 & 0.1 & 0.1 & 0 \end{bmatrix} = (0.442, 0.358, 0.158, 0.042, 0)$$

To summarize what we know, the results of the comprehensive evaluation of the performance of the integration of industry and education in H2 vocational education are:

$$A = w * p = (0.2751, 0.2777, 0.2473, 0.1999) * \begin{bmatrix} 0.346 & 0.310 & 0.332 & 0.013 & 0 \\ 0.546 & 0.205 & 0.15 & 0.1 & 0 \\ 0.683 & 0.097 & 0.12 & 0.1 & 0 \\ 0.442 & 0.358 & 0.158 & 0.042 & 0 \end{bmatrix} = (0.504, 0.238, 0.194, 0.064, 0)$$

According to the principle of maximum affiliation, H2 Vocational Education Industry-Teaching Integration Performance Rating of 0.238 corresponds to the rating of “good”. H2 Vocational Education Industry-Education Integration Performance Evaluation Calculation Results, H2 Vocational Education Industry-Education Integration Performance Evaluation Calculation Results are shown in Table 7. This shows that H2 vocational education industry-teaching integration is good, fair and good in terms of input, process and effect respectively, and the comprehensive judgment value of industry-teaching integration performance is 78.395, which is “good”, and it can be regarded that the performance of industry-teaching integration in this school has reached a good level.

Table 7. The results of the evaluation of the performance evaluation of the education

Academy	Primary indicator	Primary index evaluation	Membership grade	The comprehensive evaluation of the fusion performance of the generation	Membership grade
H2	(A1)	75.08	Good	78.395	Good
	(A2)	79.105	Good		
	(A3)	81.737	Excellence		
	(A4)	77.997	Good		

c) Calculation of fuzzy comprehensive evaluation for H3 vocational education. Finally, H3 vocational education is analyzed and the fuzzy relationship matrix of A1 industry-education integration input is p_1. The calculation results are shown below:

$$A_1 = w_1 * p_1 = (0.6485, 0.2238, 0.1277) * \begin{bmatrix} 0.7 & 0.2 & 0 & 0.1 & 0 \\ 0.4 & 0.5 & 0.1 & 0 & 0 \\ 0.7 & 0.2 & 0.1 & 0.1 & 0 \end{bmatrix} = (0.633, 0.267, 0.035, 0.065, 0)$$

A2 The fuzzy relationship matrix for the process of industry-education integration is p_2, and the results of the calculation are shown below:

$$A_2 = w_2 * p_2 = (0.6044, 0.2476, 0.1480) * \begin{bmatrix} 0.9 & 0.1 & 0 & 0 & 0 \\ 0.7 & 0 & 0.2 & 0.1 & 0 \\ 0.5 & 0.3 & 0.2 & 0 & 0 \end{bmatrix} = (0.791, 0.105, 0.079, 0.025, 0)$$

A3 The fuzzy relationship matrix for the effect of industry-education integration is p_3, and the calculation results are shown below:

$$A_3 = w_3 * p_3 = (0.2989, 0.1249, 0.2001, 0.3761) * \begin{bmatrix} 0.6 & 0.4 & 0 & 0 & 0 \\ 0.8 & 0.1 & 0.1 & 0 & 0 \\ 0.4 & 0.5 & 0.1 & 0 & 0 \\ 0.6 & 0.1 & 0.2 & 0.1 & 0 \end{bmatrix} = (0.585, 0.27, 0.108, 0.038, 0)$$

The fuzzy relationship matrix for the effect of A4 industry-education integration is p_4, and the calculation results are shown below:

$$A_4 = w_4 * p_4 = (0.5762, 0.4238) * \begin{bmatrix} 0.6 & 0.2 & 0.1 & 0.1 & 0 \\ 0.4 & 0.4 & 0.1 & 0.1 & 0 \end{bmatrix} = (0.515, 0.285, 0.1, 0.1, 0)$$

To summarize what we know, the results of the comprehensive evaluation of the performance of the integration of industry and education in H3 vocational education are:

$$A = w * p = (0.2751, 0.2777, 0.2473, 0.1999) * \begin{bmatrix} 0.633 & 0.267 & 0.035 & 0.065 & 0 \\ 0.791 & 0.105 & 0.079 & 0.025 & 0 \\ 0.585 & 0.27 & 0.108 & 0.038 & 0 \\ 0.515 & 0.285 & 0.1 & 0.1 & 0 \end{bmatrix} = (0.641, 0.226, 0.078, 0.054, 0)$$

H3 vocational education industry-teaching integration performance evaluation calculation results, H3 vocational education industry-teaching integration performance evaluation calculation results are shown in Table 8. It shows that H3 vocational education industry-teaching integration is good, good, good in terms of input, process and effect respectively, and the comprehensive judgment value of industry-teaching integration performance is 82.037, which is “excellent”, and it can be regarded that the performance of industry-teaching integration of this school has reached the excellent level.

Table 8. The results of the evaluation of the performance evaluation of the education

Academy	Primary indicator	Primary index evaluation	Membership grade	The comprehensive evaluation of the fusion performance of the generation	Membership grade
H3	(A1)	82.234	Excellence	82.037	Excellence
	(A2)	85.167	Excellence		
	(A3)	81.139	Excellence		
	(A4)	78.988	Good		

3.3. Analysis of factors affecting the quality of industry-teaching integration in vocational education

3.3.1. Description of conditioning variables. There is an interactive relationship between the quality of vocational education industry-teaching integration and each potential factor respectively. Background evaluation, input evaluation, process evaluation and outcome evaluation have a certain influence on the quality of vocational education industry-education integration.

3.3.2. Analysis of model fitness indicators. The main model fitness index is shown in Table 9. As can be seen from the table, the results of this model fitness analysis are: the model fitness index (GFI) is 0.952, which is greater than the standard requirement of 0.9. The value of model asymptotic residual mean square and square root (RMSEA) is 0.069, which meets the basic criterion of less than 0.08. And the value of SRMR is 0.0487, which also meets the criterion of less than 0.05. The value of Amended Goodness-of-Fit Index (AGFI) is 0.869, which has not yet reached the criterion of 0.9 but is greater than 0.86, so it is still an acceptable level, and all other indicators of fitness have reached the corresponding standard level.

Table 9. The main fitness index of the model

	CMIN/DF	RMSEA	SRMR	GFI	PGFI	CFI	PNFI	NFI	TLI
Judgment standard	<2.8	<0.09	<0.052	>0.85	>0.53	>0.95	>0.55	>0.92	>0.92
Model index	1.725	0.069	0.0487	0.952	0.720	0.932	0.762	0.923	0.956

3.3.3. Factor Correction Models and Path Coefficient Estimation. From the results of the validation factor analysis above and then the further modification of the model, we finally get the standardized estimation of the vocational education industry-teaching integration quality evaluation factor modification model path, vocational education industry-teaching integration quality evaluation factor modification model path diagram is shown in Figure 1. From the results of the validation factor analysis, the P-value of the association between the latent variables is equal to 0.000, less than 0.001, and the significance levels are all less than 1%, indicating that the model is set up in a more satisfactory way.

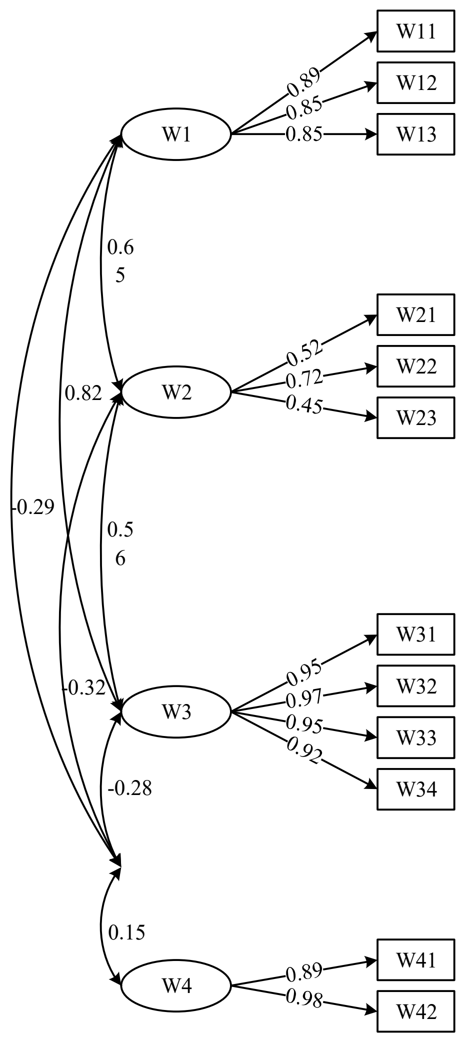

Fig. 1. The evaluation factor modifies the model path diagram

The path coefficients of the structural equation model are shown in Table 10. From the analysis of the path coefficients of the structural equation model in the table, it can be seen that there is a mutually positive influence relationship between the background evaluation and the process evaluation and input evaluation, and the influence coefficients are all above 0.5. Background evaluation, input evaluation, process evaluation and outcome evaluation all have a significant positive influence on the quality of vocational education integration.

Table 10. The model path coefficient of the structural equation

	Std.	S.E.	t	P
W1<--> W3	0.796	0.045	8.216	***
W1<-->W2	0.605	0.035	5.074	***
W3<-->W2	0.545	0.039	4.922	***
W4<-->W	0.157	0.047	2.352	0.022
W2<-->W	0.361	0.03	-3.835	***
W3<-->W	0.289	0.035	-3.921	***
W1<-->W	0.286	0.028	-3.911	***

4. Conclusion

In order to promote the deep integration of education and industry, this paper uses hierarchical analysis to construct the evaluation system of the quality of integration of industry and education in vocational education, and conducts empirical analysis, and the conclusions are mainly as follows:

Hierarchical analysis method is used to calculate the results of expert judgment on the degree of importance of the quality of integration of industry and education in higher vocational colleges and universities, and obtain the indicator system with weights. In the first-level indicators, the weight values are in the following order from high to low: input evaluation (0.2777) > background evaluation (0.2751) > process evaluation (0.2473) > outcome evaluation (0.1999). Among the secondary indicators, the need for course offerings (0.6485) has a very high degree of importance and holds a very high weight in the performance indicator system of industry-teaching integration, and it is the first and foremost consideration for monitoring the performance evaluation of industry-teaching integration in higher vocational colleges and universities.

By evaluating the quality evaluation level of the integration of industry and education in the three higher vocational colleges, the following evaluation results were obtained: on the whole, the comprehensive evaluation values of the quality of the integration of industry and education in the three higher vocational colleges were 78.2, 78.395 and 82.037, respectively, and the evaluation grades were "good", "good" and "excellent" respectively. The three sample institutions have made relatively outstanding achievements in the integration of industry and education, which have been praised by experts and provide good reference and learning value for the development of integration of industry and education in the local region.

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