



## Strategies for Improving the Quality of Cultivating Composite Talents of Higher Vocational Business and Trade Majors in the Era of Digital Economy

Zheng Li<sup>1,\*</sup>, Mulan Luo<sup>1</sup>, Xiang Chen<sup>1</sup>, Zihao Li<sup>1</sup> and Sheng Li<sup>1</sup>

<sup>1</sup> School of Foreign Languages & Trade, Qingyuan Polytechnic, Qingyuan, Guangdong, 511510, China

**SUMMARY:** *For the evaluation indexes of the quality of cultivation of composite talents of higher vocational business and trade majors constructed, this paper utilizes the entropy weight method and the normal cloud model to calculate the objective weight of each index as well as the hierarchical degree of affiliation, and to analyze the influence of the indexes on the quality of cultivation. After that, we constructed an ordered probit model by combining the index data, and solved the best parameters of the model through the great likelihood estimation function, so as to effectively order the value of each index in improving the quality of the cultivation of complex talents of higher vocational business and trade majors. Calculation found that the second-level indicator with the highest objective weight is talent cultivation conditions (0.3409), and the third-level indicator is faculty (0.3343). 3 second-level indicators and 9 third-level indicators positively affect the quality of complex talent cultivation of higher vocational business and trade majors at the level of 0.001. According to the size of the weight and coefficient, the problems of higher vocational business and trade majors are improved in an orderly manner to provide help for students to become compound talents.*

**KEYWORDS:** *higher vocational business and trade majors; composite talents; entropy weight method; normal cloud model; ordered probit model*

### 1 Introduction

In the era of digital economy, enterprises have realized comprehensive digital transformation. Digital transformation refers to the process of using digital technology, network technology, etc. to promote the transformation and upgrading of enterprise organization form, production and operation mode, industrial structure, management mode and other aspects [1, 2]. In the process of digital transformation, many traditional industries and traditional enterprises in China are actively carrying out digital transformation and upgrading, such as machine for man in manufacturing industry, intelligent transformation of service industry, etc. This digital transformation is not only a technical upgrade, but also an update of the development concept, which represents a new direction of social and economic development [3-6]. Regarding the research on the positive impact of digital transformation on enterprises, Zhaoh and Ren [7] proved that enterprise digital transformation has a significant impact on improving capacity utilization through empirical analysis of listed companies, and pointed out that enterprise innovation and enterprise specialized production play a mediating role in the impact of digital transformation on capacity utilization. Xu et al [8] emphasized that green innovation is an

\*drleolee@163.com

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important way to promote the sustainable economic sustainable development, and examined the impact of digital transformation on corporate green innovation based on panel data of listed companies, and the results showed that digital transformation helps to promote corporate green innovation. Wang et al [9] discussed the impact of digital transformation on the performance of manufacturing enterprises, and pointed out that digital transformation of manufacturing enterprises is beneficial to improve corporate performance by analyzing the annual report data of listed manufacturing enterprises.

With the increasing degree of social digitization, enterprises are increasingly using digital tools such as the Internet, big data, blockchain, etc., which also promotes the continuous innovation of business models, resulting in a large number of new business models based on digital technology [10-12]. The demand for business professionals in this new business model is changing from “quantity” to “quality”, which brings challenges to the training of business professionals in higher vocational colleges. Under the background of digital transformation, business enterprises not only need financial and trade professional knowledge and skills, but also need students with digital technology, data analysis, data management and other capabilities of professional composite talents [13, 14]. However, at present, many higher vocational colleges and universities specializing in commerce are not accurate enough in the positioning of talent cultivation objectives, and there is no accurate positioning of talent cultivation objectives required by the enterprise job groups under the background of digital transformation, and there is a lack of digital skills in the content of the relevant modules in the curriculum, and some of the curriculum is out of touch with the enterprise job groups, resulting in a lack of relevance and practicality of the teaching content [15, 16]. This requires that higher vocational commerce majors use digital technology to systematically promote from conceptual innovation, curriculum reconstruction, industry-teaching integration, teacher construction and evaluation reform, in order to cultivate students' comprehensive ability and practical skills, so that they can adapt to the changes and demands of the market, and to improve the competitiveness of students' employment [17, 18].

In the context of the era of digital economy, the requirements of enterprises for talents have gradually increased, and vocational education is facing the problem of the disconnect between talent cultivation and enterprise demand, in order to transform this situation and improve the comprehensive ability of students, to realize the transformation of talent cultivation under the digital transformation, teaching mode innovation and other educational reform methods is the way to go. Xu et al [19] emphasized the fundamental process of promoting digital transformation to achieve digital governance of vocational education and deepen educational and pedagogical reforms, which is important for improving educational and pedagogical quality as well as promoting economic and social development. Based on a classic case study, Ma et al [20] outlined the current best practices for digital transformation of vocational education in China and made recommendations for future development. [21] pointed out that in order to adapt to the needs of enterprises in the era of digital economy, higher vocational colleges and universities need to improve the talent training system, update the concept of education, and innovate educational means to cultivate students' comprehensive management ability. Yang [22] introduced digital transformation as an inevitable trend of education reform and development, and digitalization will bring unlimited potential and a new vision for education, especially in talent development. Liu et al [23] used a literature review to discuss the cultivation of digital talents in the context of the digital economy era, and based on the results of the analysis of knowledge mapping and the current status quo, they proposed an implementation strategy for the cultivation of digital talents. Xie and Zhang [24] based on the literature review in order to analyze the characteristics of global research on digital transformation of vocational education in an observable and systematic way, and the results showed that it was emphasized that the

transformation of higher vocational colleges and digital teaching and learning was a common global concern, and that China was in the leading position of research on the integration of industry and education.

In addition, Liu and Jiao [25] combined the context of the era of digital economy, used cluster analysis to optimize the curriculum system, and emphasized the importance of practical teaching, which provided a theoretical basis and practical guidance for cultivating high-quality marketing professionals in line with market demand. Chang and Liu [26] discussed an innovative model for cultivating young talent in the context of the digital economy, addressing the disconnect between the education system and the needs of the digital economy, and proposed a talent cultivation model involving the government, higher education institutions, and enterprises. Jiang and Wang [27], in order to promote the innovation of the management model of vocational undergraduate education, proposed a study on the development strategy of undergraduate education in the context of the construction of digital China, aiming to create an innovative education model to promote a more balanced development of vocational education. Hou [28] discusses the dilemmas faced by the training of business administration talents in colleges and universities under the background of digital transformation, and puts forward the strategy of constructing a comprehensive training mode for business administration talents in colleges and universities, in order to create a talent cultivation mode that meets the needs of the market and positions. Mo [29] analyzed the necessity and feasibility of digital transformation from the top-level design and logical relationship of professional groups, and explored the effective ways of digital transformation of professions in terms of revision of professional talent cultivation programs, reform of curriculum system, and innovation of teaching mode.

In the era of digital economy, the transformation and upgrading of vocational education helps to promote the modernization of the education system. And improving the comprehensive competitiveness of higher vocational students has become a necessary path for transformation and upgrading. In this paper, after analyzing the influencing factors of the cultivation quality of complex talents in higher vocational business and trade majors as a whole, an evaluation index system containing three levels is constructed. In order to clarify the degree of influence of each indicator on the cultivation quality, the entropy weight method is introduced to objectively calculate the weights occupied by each indicator. At the same time, the cloud digital eigenvalues of the indicators at all levels are calculated, and a normal cloud model is constructed to assess the level and affiliation of the indicator data and judge the current level of talent cultivation quality. Then, an ordered probit model is established to categorize and rank the influence of each indicator on the cultivation quality by solving the regression coefficient value, so as to provide a reference for the improvement direction of quality enhancement.

## **2 Selection of evaluation indicators and determination of weights based on the entropy weight-cloud model**

### **2.1 Selection of Quality Evaluation Indicators for Composite Talent Cultivation**

From the perspective of the basic level of cultivation of complex talents in higher vocational business and trade majors, the policy environment, basic support and hardware foundation are of great significance to the cultivation of talents. The number of policy documents formulated by government departments in favor of the development of schools reflects the local government's support and attention to higher vocational education. The number of reports on the network and paper media is a reflection of the teaching quality of the school. The investment

of funds in higher vocational education brings about the creation of educational equipment as well as educational environment. The increase in the area of planned land and the total amount of funding revenue can build a strong faculty to protect higher vocational education. Schools invested in the construction of training room funds, equipment and equipment purchase funds are part of the investment in education funds, increase the total amount of equipment and per capita equipment for the cultivation of talents to provide support.

From the level of higher vocational business professional complex talent training conditions, the school's professional construction, faculty, teaching conditions together build a standardized place for talent training. To improve the quality of talent cultivation in schools, the key is to improve the competitiveness of professional construction, focusing on increasing the number of majors and the number of students enrolled in majors, but also focusing on the development of advantageous majors and the number of students in advantageous majors as a proportion of the total number of majors. Teaching staff is an important guarantee for the standard of vocational education in higher vocational schools, so it is necessary to increase the proportion of teachers with senior titles and the proportion of teachers with master's degrees and above. Higher vocational education should also emphasize the practical ability of students, accelerate the construction of practice places, and increase the number of on-campus training rooms and off-campus training bases.

From the perspective of the impact level of compound talent cultivation of higher vocational business and trade majors, the competitiveness of students, teaching competitiveness, and competitiveness of graduates are the embodiment and proof of the results of the teaching work of higher vocational colleges and universities. Effective cultivation of composite talents will make the minimum score line of freshmen admission, the completion rate of enrollment and admission, and the rate of freshmen enrollment increase. The number of national-level competition awards, the number of provincial and ministerial-level competition awards, the number of high-quality courses, the employment rate of graduates, and the average monthly income of graduates also reflect the quality of the school's teaching and the development potential of students.

After finishing, in accordance with all the principles of indicator system construction, the quality of cultivation of complex talents of higher vocational business and trade majors is taken as the first-level indicator. The three major directions of talent cultivation foundation, talent cultivation conditions, and talent cultivation influence are taken as secondary indicators. The nine indicators of policy environment, basic guarantee, hardware foundation, professional construction, faculty, teaching conditions, student source competitiveness, teaching competitiveness, graduate competitiveness, etc. are taken as tertiary indicators. Table 1 is the quality evaluation index system for the cultivation of composite talents in higher vocational business and trade majors.

*Table 1: Evaluation Index System for Quality of Compound Talent Cultivation*

Primary indicator	Primary indicator number	Secondary indicator	Secondary indicator number	Third-level indicators	Third-level indicators number	
Quality of Comprehensive Talent Cultivation in Vocational Trade Specialties	A1	Personnel training foundation	B1	Policy environment	C1	
				Basic guarantee	C2	
				Hardware foundation	C3	
		Personnel training conditions	B2	Professional Construction	Teaching staff	C5
					Teaching conditions	C6
					Source competitiveness	C7
		Personnel training impact	B3	Graduate competitiveness	Teaching competitiveness	C8
					Graduate competitiveness	C9

## 2.2 Steps of Quality Evaluation of Cultivation Quality of Higher Vocational Business and Trade Composite Talents Based on Entropy Weight-Cloud Model

### 2.2.1 Determination of indicator weights

In this paper, in the evaluation of the quality of the cultivation of higher vocational business and trade complex talents, we choose to determine the weights of the evaluation indicators of the cloud model through the entropy weight method of the objective assignment method. Entropy weight method overcomes the randomness of subjective assignment method, and it is a kind of objective weights obtained by calculating the information entropy of each index relying solely on the real data of each index. Generally speaking, the lower the entropy of the indicator, the lower the degree of uncertainty, indicating that the amount of information it reflects is larger, and its weight is higher; on the contrary, the higher the entropy, the greater the uncertainty, indicating that the amount of information it contains is less, and the weight is lower. The specific calculation steps of entropy weight method are as follows:

1) Re-standardize the screened indicator data.

2) Assuming that there are  $p$  indicators and  $q$  evaluation objects, calculate the weight  $V_{ri}$  of the  $r$  sequence of evaluation objects under the  $i$  indicator in relation to that indicator:

$$V_{ri} = \frac{x_{ri}}{\sum_{r=1}^q x_{ri}} \quad (1)$$

3) Calculate the entropy value  $e_i$  for the  $i$  th indicator:

$$e_i = -k \sum_{r=1}^q v_{ri} \ln(v_{ri}) \quad (2)$$

where  $k = 1/\ln(q)$ , and  $v_{ri} \ln(v_{ri}) = 0.0$  if  $v_{ri} = 0.0$ .

4) Calculate the indicator utility value  $d_i$ :

$$d_i = 1.0 - e_i \quad (3)$$

5) Calculate the weight  $w_i$  for each indicator:

$$w_i = \frac{d_i}{\sum_{i=1}^p d_i} \quad (4)$$

### 2.2.2 Indicator rubric set and normal cloud model construction

Evaluation index evaluation set is evaluators could have all sorts of evaluation results, according to the data evaluation objects and scope fan.if domain level theory, set up index evaluation set  $H = \{H_1, H_2, H_3 \cdots H_t\}$ , Each grade has a corresponding evaluation range. The number of evaluation grades  $t$  should not be too many, as an excessive number would make it difficult to describe the language values and increase the difficulty of determining the grade attribution. Therefore, the number of evaluation grades  $t$  is generally an odd number such as 1, 3, 5, and 7, which can generate an intermediate grade and make it easier to determine the

grade attribution. Accordingly, this study divides the hierarchical thesis domain of the evaluation index of the quality of composite talents cultivation of higher vocational business and trade majors into five levels:  $H = \{E, D, C, B, A\}$ . Among them, "E" represents A poor grade, "D" represents a relatively poor grade, "C" represents a medium grade, "B" represents a good grade, and "A" represents an excellent grade. In this paper, each evaluation index comment set and the final comprehensive evaluation results are expressed in the form of the above five grades.

After constructing the indicator comment set, it is necessary to realize the transformation of the fuzzy concept of each indicator evaluation level through the normal cloud model, reflecting the specific information of the cloud model. The construction of normal cloud model needs cloud numerical eigenvalues as its necessary parameters, which contain  $Ex$  (expectation),  $En$  (entropy),  $He$  (hyperentropy). Let the upper and lower critical values of the rank  $h$  ( $h = 1, 2, \dots, t$ ) corresponding to the indicator  $x_i$  ( $i = 1, 2, \dots, t$ ) be  $x_{ih}^a$  and  $x_{ih}^b$ , respectively, and the notion of characterization,  $h$ , of the rank corresponding to the indicator  $i$ , can be utilized to normal cloud model to transform it:

$$Ex_{ih} = (x_{ih}^a + x_{ih}^b) / 2 \quad (5)$$

Since the critical value is a transition between two adjacent levels, it is actually a fuzzy boundary which should belong to two neighboring levels each, i.e., the affiliation of the two evaluation levels corresponding to a critical value should be equal. Then:

$$\exp\left\{-\frac{(x_{ih}^a - x_{ih}^b)^2}{8(En_{ih})^2}\right\} = 0.50 \quad (6)$$

To wit:

$$En_{ih} = \frac{x_{ih}^a - x_{ih}^b}{2.50} \quad (7)$$

The superentropy  $He_{ih}$  represents the thickness of the cloud layer, which is a measure of the uncertainty of the entropy, and this paper is adjusted to select a suitable value of superentropy through many repeated experiments.

### 2.2.3 Determination of Indicator Affiliation and Comprehensive Evaluation Rating

Combining the actual data of each evaluation index of the quality of complex talent cultivation of higher vocational business and trade majors and the calculated cloud numerical eigenvalues, with the help of the  $X$  conditional cloud generator, we generate the affiliation degree of each grade corresponding to each evaluation index, and form the matching cloud model affiliation matrix. The normal cloud model affiliation degree is:

$$\mu(x_0) = \exp\left\{-\frac{(x_0 - Ex)^2}{2(En')^2}\right\} \quad (8)$$

where  $En'$  is a normal random number taking  $En$  as the expectation and  $He$  as the standard deviation,  $En' \sim N(En, He)$ , and the generated affiliation matrix is expressed as

$U = (U_{ih})_{n \times t}$ . In order to make the accuracy of the evaluation results much higher, the final evaluation index affiliation is determined by repeating  $N$  times  $X$  the comprehensive average of different affiliation values under the conditional cloud generator, i.e.:

$$U_{ih} = \frac{1}{N} \sum_{k=1}^N U_{ih}^k \quad (9)$$

The weight  $W$  of each evaluation indicator is fuzzy transformed with the affiliation matrix  $U$  of each evaluation indicator to obtain the fuzzy evaluation subset  $Z = (z_1, z_2, \dots, z_h)$  on the rubric set  $H$ :

$$Z = W \times U \quad (10)$$

where  $Z_h = \sum_{i=1}^n W_i U_{ih}$  ( $h=1, 2, \dots, t$ ), denotes the degree of affiliation corresponding to the  $h$ th evaluation grade of the evaluation object. Accordingly, in combination with the principle of maximum affiliation, the rank with the maximum affiliation is selected as the final rank of the comprehensive evaluation of regional logistics index.

## 2.3 Calculation of indicator weights and hierarchical affiliation analysis

### 2.3.1 Entropy weighting method weights and objective weight calculation

600 students of commerce majors in  $W$  higher vocational colleges and universities were selected as the research object. Set up a questionnaire to collect the evaluation data of students on the indicators of the quality of compound talents training of commerce majors, and combine the entropy weight-cloud model to determine the weight and rank affiliation degree of each indicator, and study the effect of each indicator in influencing the quality of the compound talents training of higher vocational commerce majors. A total of 600 questionnaires were distributed, 578 questionnaires were recovered, and 550 valid questionnaires were obtained after finishing. According to the aforementioned formula, the entropy value and coefficient of difference of the second-level and third-level indicators were firstly calculated respectively to obtain the objective weights of the indicators at all levels. Table 2 shows the weights of the indicators calculated by the entropy weight method. Multiplying the weights of the indicators at all levels, the cumulative weight of the third-level indicators relative to the whole is calculated as the result of objective weighting. Table 3 is the calculated objective weight of each indicator.

After calculation, the objective weights of the three second-level indicators of talent cultivation foundation, talent cultivation conditions, and talent cultivation influence are 0.3326, 0.3409, and 0.3265. The highest weight is talent cultivation conditions, and the corresponding weights of the three third-level indicators also reach 0.3338 (C4), 0.3343 (C5), and 0.3335 (C6). It can be seen that the indicator that has the greatest influence on the quality of cultivation of complex talents in higher vocational business and trade majors is the faculty in the conditions of talent cultivation, followed by professional construction and teaching conditions.

Table 2: The weights of each indicator calculated by the entropy weight method

Indicators	Indicator Number	Entropy value	Coefficient of variation	Weight
Secondary indicator				
Personnel training foundation	B1	0.9548	0.0135	0.3326
Personnel training conditions	B2	0.9373	0.0130	0.3409
Personnel training impact	B3	0.9788	0.0135	0.3265
Third-level indicators				
Policy environment	C1	0.9522	0.0146	0.3333
Basic guarantee	C2	0.9543	0.0151	0.3332
Hardware foundation	C3	0.9579	0.0143	0.3329
Professional Construction	C4	0.9386	0.0137	0.3338
Teaching staff	C5	0.9343	0.0135	0.3343
Teaching conditions	C6	0.9391	0.0138	0.3335
Source competitiveness	C7	0.9784	0.0150	0.3328
Teaching competitiveness	C8	0.9793	0.0153	0.3322
Graduate competitiveness	C9	0.9788	0.0157	0.3323

Table 3: Objective weights of each indicator

Indicators	Indicator Number	Weight	Corresponding dimension	Dimension weight	Final weight
Secondary indicator					
Personnel training foundation	B1	0.3326	A1	1.0000	0.3326
Personnel training conditions	B2	0.3409			0.3409
Personnel training impact	B3	0.3265			0.3265
Third-level indicators					
Policy environment	C1	0.3333	B1	0.3326	0.1110
Basic guarantee	C2	0.3332			0.1108
Hardware foundation	C3	0.3329			0.1107
Professional Construction	C4	0.3338	B2	0.3409	0.1138
Teaching staff	C5	0.3343			0.1141
Teaching conditions	C6	0.3335			0.1137
Source competitiveness	C7	0.3328	B3	0.3265	0.1088
Teaching competitiveness	C8	0.3322			0.1085
Graduate competitiveness	C9	0.3323			0.1086

### 2.3.2 Indicator Assessment Cloud and Affiliation Calculation

After determining the objective weight of each indicator, combining the actual data of each evaluation indicator of the cultivation quality of composite talents of higher vocational business and trade majors, the cloud digital feature value of each indicator is calculated, and the corresponding rank affiliation of each indicator is generated. The evaluation standard cloud is obtained through the forward cloud generator according to the standard cloud digital features, and the output cloud drops in this paper are taken as 2850. Figure 1 shows the assessment standard cloud of the three-level indicators (taking C5 of the faculty team with the highest objective weight as an example). The score of C5 indicators mainly focuses on about 60-80

points, which is in the “good” grade.

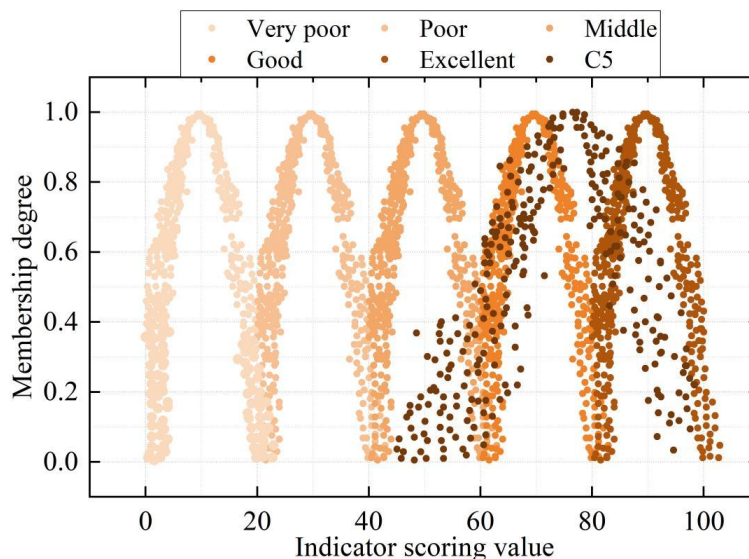
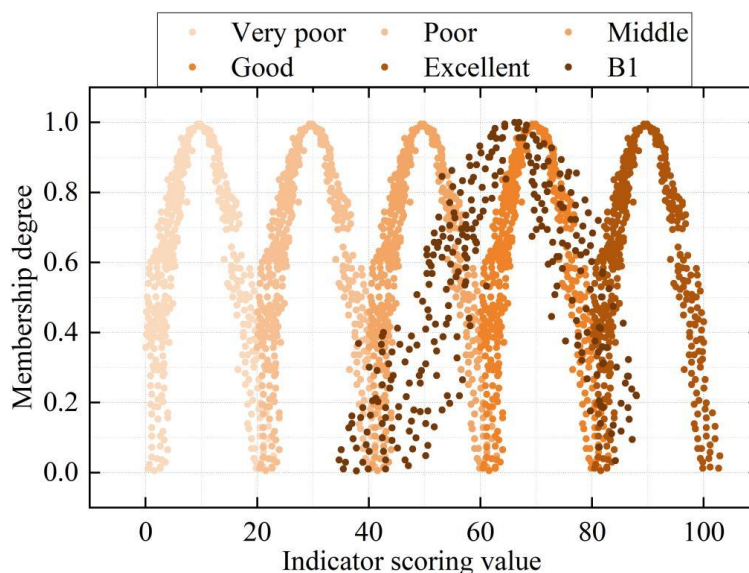
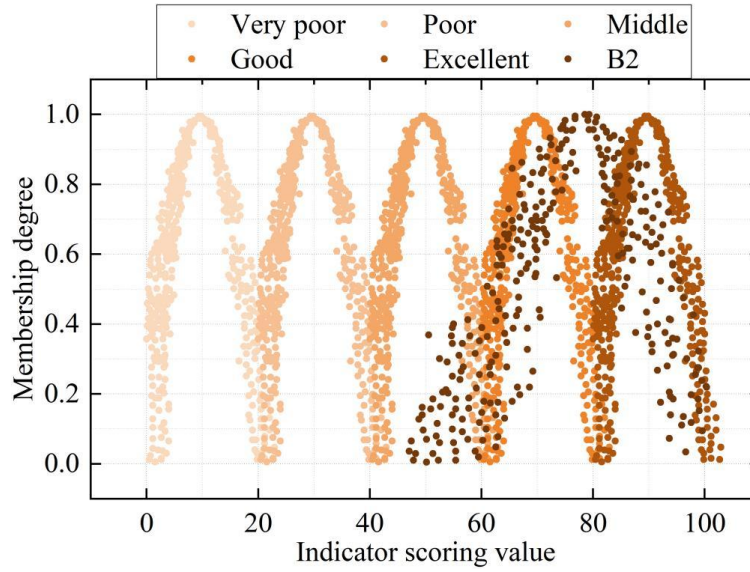


Figure 1: Evaluation criteria for the third-level indicators (C5)

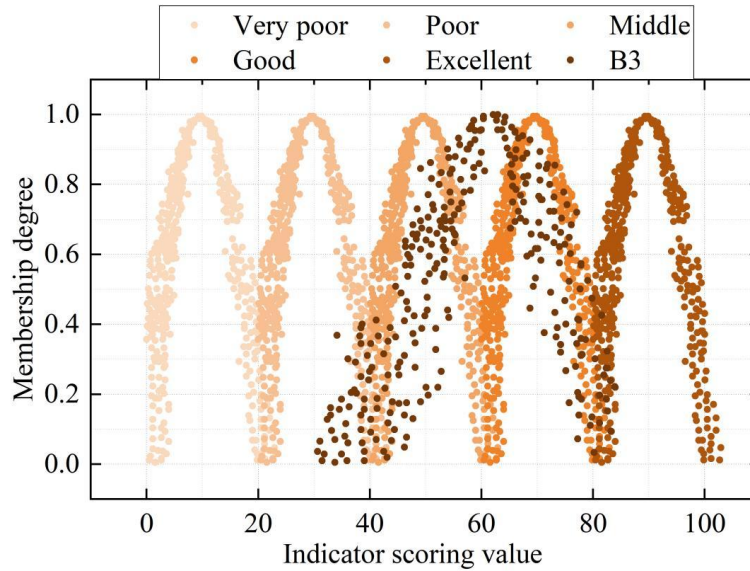
Based on the digital characteristics of the secondary index cloud, the forward cloud generator algorithm is used to convert the feature parameters into the comprehensive evaluation cloud of the secondary index. By outputting the evaluation cloud map, the three-level evaluation grades of the quality of compound talent cultivation in the higher vocational business and trade major are obtained. Figure 2 shows the evaluation standard cloud of the secondary indicators. The evaluation scores of the three secondary indicators, namely the foundation of talent cultivation B1, the conditions for talent cultivation B2, and the impact of talent cultivation B3, are mainly concentrated around 60-80, 75-95, and 55-75, which are respectively at the "good", "excellent", and "medium" levels.



(a) Evaluation of the foundation effect of talent cultivation



(b) Evaluation of the effectiveness of talent cultivation conditions



(c) Evaluation of the Impact of Talent Development Programs

Figure 2: Evaluation criteria for secondary indicators

Similarly, Figure 3 is the comprehensive assessment standard cloud of the first-level indicators. The first-level indicator A1 is the quality of cultivation of complex talents in higher vocational commerce majors, i.e., the general objective level. Comprehensively, the training quality score of 600 students of commerce majors in senior colleges and universities is around 70-90, which is in the direction of “good” grade but inclined to “excellent” grade. In order to improve the quality of the training of compound talents in commerce majors, it is necessary to improve the insufficient indicators in a targeted way.

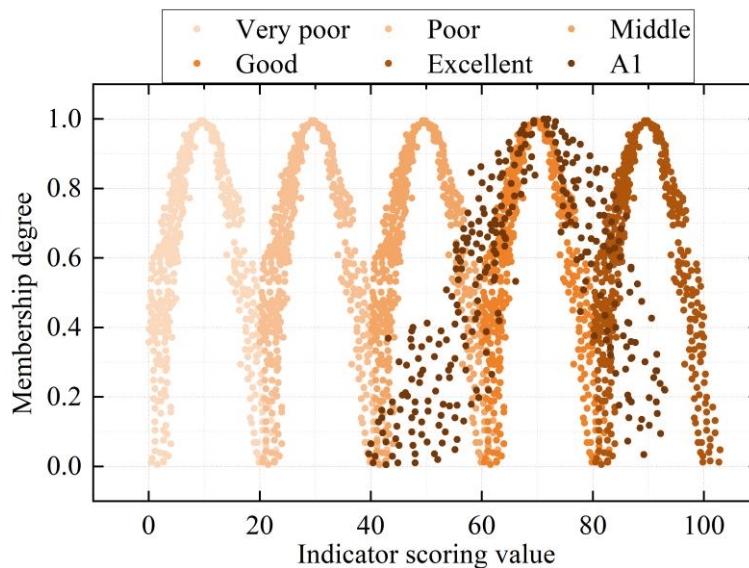


Figure 3: Evaluation criteria for the third-level indicators

### 3 Probit modeling and ranking of indicators

#### 3.1 Ordered Probit Model Construction and Great Likelihood Estimation Solution

##### 3.1.1 General Ordered Probit Models

Using the data related to the quality of talent cultivation of 600 students majoring in commerce and trade in W higher vocational colleges and universities, combined with the evaluation index system, we constructed an ordered Probit model to analyze the influence of each index on the quality of cultivation of composite talents in higher vocational commerce and trade majors, and to consider the quality improvement strategy as a whole. Ordered Probit model is commonly used in the regression model in which the explanatory variables are categorical order variables. It is assumed that the regression model is in the form of:

$$U_i = X_i\beta + \varepsilon_i, i = 1, \dots, n \tag{11}$$

where  $U_i$  is the dependent variable;  $X_i$  is the observation, i.e., the independent variable, as a  $1 \times d$ -dimensional row vector;  $\beta$  is the regression coefficient, as a  $d \times 1$ -dimensional column vector; and  $\varepsilon_i$  is the residual term, and it needs to be assumed that it is independently and identically distributed, which might as well be assumed here as  $\varepsilon_i \sim iid N(0, \sigma_\varepsilon^2)$ .

When  $U_i$  is the observable numerical quantity, the above model is the most common linear regression model, and the regression coefficient  $\beta$  can be fitted using least squares estimation without any distributional assumptions on  $\varepsilon_i$ . However, sometimes the true value of  $U_i$  is often not directly available, and instead we are left with a series of nominal ordinal variables  $y_i, i = 1, \dots, n$  representing the categorical values that satisfy  $1 \leq y_i \leq C$ , with  $y_i$  being an integer, and  $C$  being the number of categoricals. And  $U_i$  is related to  $y_i$  as follows:

$$y_i = j \text{ if } \gamma_{j-1} < U_i \leq \gamma_j \quad (12)$$

where  $\gamma = (\gamma_0, \gamma_1, \dots, \gamma_C)'$  is the demarcation variable and  $\gamma_0 \leq \dots \leq \gamma_C$ ,  $\gamma_j$  denotes the demarcation between the classification  $j$  and  $j+1$ ,  $1 \leq j \leq C$ , and the classification is counted starting at 1 to start counting.

Noting that  $c_i$  denotes a category to which an individual  $y_i$  belongs, the model is said to be an ordered probit model if any  $y_i$  belonging to the category  $c_i$  is smaller than any  $y_j$  belonging to the category  $c_j$ , if and only if  $c_i \leq c_j$ . More intuitively, an ordered probit model is one in which the explanatory variables are categorical variables in a logical order.

### 3.1.2 Great Likelihood Estimation for Ordered Probit Models

Before introducing the ordered Probit model, we first make a necessary clarification. The estimation methods we will discuss below are applicable both for the Probit models used in earlier Probit methods and for the one-dimensional Probit model (the ordered Probit model with  $M = 2$ ).

Let  $Q = M + K - 1$ , and the model asks for a solution to the problem of estimating the  $Q$  parameters  $\mu_2, \mu_3, \dots, \mu_{M-1}, \beta_0, \beta_1, \dots, \beta_K$ . Following the usual treatment of the Probit model, the parameters of this model are also estimated using the great likelihood method. For convenience, noting  $Z_{ij} = \mu_j - X_i' \beta$ ,  $\Phi_{i,j} = \Phi(Z_{ij})$ , then  $Pr(Y_{ij} = 1) = \Phi_{i,j} - \Phi_{i,j-1}$ .

To obtain the great likelihood function

$$L = L(Y | \beta_0, \dots, \beta_K, \mu_2, \dots, \mu_{M-1}) \propto \prod_{i=1}^n \prod_{j=1}^M (\Phi_{i,j} - \Phi_{i,j-1})^{Y_{ij}} \quad (13)$$

log-likelihood function

$$l = \log L \propto \sum_{i=1}^n \sum_{j=1}^M Y_{ij} \log(\Phi_{i,j} - \Phi_{i,j-1}) \quad (14)$$

Derivation of the parameters yields the likelihood equation

$$\begin{cases} \frac{\partial l}{\partial \beta_u} = \sum_{i=1}^n \sum_{j=1}^M Y_{ij} \left( \frac{N_{i,j-1} - N_{i,j}}{\Phi_{i,j} - \Phi_{i,j-1}} \right) x_{ui} = 0 \\ \frac{\partial l}{\partial \mu_s} = \sum_{i=1}^n \sum_{j=1}^M Y_{ij} \left( \frac{N_{i,j} \delta_{s,j} - N_{i,j-1} \delta_{s,j-1}}{\Phi_{i,j} - \Phi_{i,j-1}} \right) = 0 \end{cases} \quad (15)$$

where  $0 \leq u \leq K$ ,  $2 \leq s \leq M - 1$ .

where,  $N_{i,j} = \frac{1}{\sqrt{2\pi}} \exp\left\{-\frac{Z_{ij}^2}{2}\right\}$ ,  $1 \leq i \leq n, 0 \leq j \leq M$ ,  $\delta_{i,j} = \begin{cases} 1 & i = j \\ 0 & i \neq j \end{cases}$ ,  $0 \leq i \leq M, 0 \leq j \leq M$ .

The Newton Raphson (N-R) method is used to solve the likelihood equation of the Probit model. Since this method has the advantages of computational simplicity and better convergence properties, it has become a popular method for solving the great likelihood solution of the Probit model nowadays. However, a few caveats need to be mentioned here.

First, although the  $N - R$  method usually has a good convergence speed, it cannot guarantee 100% convergence. Second, in the case of multiple solutions to the likelihood equation, the  $N - R$  method does not guarantee convergence to the global optimal solution.

## 3.2 Analysis of metrics based on ordered probit

### 3.2.1 Basic Characteristics of the Sample Data

Table 4 shows the basic characteristics of the sample data of the study. The basic characteristics of the 600 students majoring in business and trade in W Higher Education Institutions include 3 categories of domicile, gender, and grades. The proportion of each sample data for each of the 2 types of basic characteristics of household registration and gender is around 50%; the proportion of the 5 types of grades is in the range of 11.67%-33.33%. There are no extremes in the sample data, so the indicator data collected through 600 students are usable, and the next step can be to continue to construct the ordered probit model.

*Table 4: Basic characteristics of the research sample data*

Basic characteristics	Type	Number of people	Percentage (%)
Residence registration	Town	308	51.33
	Rural	292	48.67
Gender	Female	301	50.17
	Male	299	49.83
Grade	<60	85	14.17
	60-75	102	17.00
	76-85	143	23.83
	86-90	200	33.33
	91-100	70	11.67

### 3.2.2 Statistical analysis of impact factors

The constructed Probit model was analyzed. Table 5 shows the regression coefficients and estimation results of Probit model. According to Table 5, the nine influencing factors in three levels of sub-cultivation foundation, talent cultivation conditions and talent cultivation influences are significantly correlated with the quality of composite talent cultivation of higher vocational business and trade majors at the 0.001 level. The mean and coefficient size of the influencing factors are ranked:  $C5 > C4 > C3 > C1 > C2 > C3 > C7 > C9 > C8$ . That is to say, if we want to further improve the quality of complex talent cultivation of senior business and trade majors, we have to consider comprehensively improving the faculty, professional construction, etc. represented by these 9 indexes, and in particular, we have to think of the ways to improve the level of the existing teachers of senior business and trade majors, and at the same time, to introduce the excellent talents Teaching.

Table 5: Regression coefficients and estimation results of the Probit model

Variable	Mean value	Variance	Coefficient	P	
A1	4.086	0.229	-	-	
B1	C1	4.141	0.169	1.217	0.001
	C2	4.082	0.237	1.153	0.001
	C3	4.050	0.204	1.085	0.001
B2	C4	4.375	0.273	1.662	0.001
	C5	4.532	0.254	1.712	0.001
	C6	4.294	0.362	1.634	0.001
B3	C7	3.861	0.311	1.098	0.001
	C8	3.700	0.152	1.039	0.001
	C9	3.742	0.103	1.058	0.001

### 3.2.3 Robustness Tests

In order to test the regression effect of the constructed ordered Probit model, the robustness test is conducted by changing the estimation method to ordinary least squares/excluding part of the sample/modifying part of the sample, etc., and the heterogeneity test is conducted by dividing the graduation year. Table 6 shows the results of the robustness test. According to the test results, although the coefficients of B1-B3 and C1-C9 are different in different models, they always positively affect the quality of cultivating compound talents in senior business and trade majors at the 0.001 level. This indicates that the core conclusions remain consistent after using different estimation methods, verifying the important role of multiple indicator factors in promoting the quality of composite talent cultivation of higher vocational business and trade majors.

Table 6: The results of the robustness test

Variable	Dependent variable: Quality of comprehensive talent cultivation in higher vocational commercial programs		
	Change the estimation method	Exclude some of the samples	Modify some sample parts
B1	1.170*** (1.152)	1.273*** (1.152)	1.174*** (1.152)
B2	1.661*** (1.670)	1.764*** (1.670)	1.670*** (1.670)
B3	1.093*** (1.065)	1.181*** (1.065)	1.084*** (1.065)
C1	1.205*** (1.217)	1.309*** (1.217)	1.216*** (1.217)
C2	1.183*** (1.153)	1.276*** (1.153)	1.182*** (1.153)
C3	1.121*** (1.085)	1.234*** (1.085)	1.124*** (1.085)
C4	1.609*** (1.662)	1.711*** (1.662)	1.617*** (1.662)
C5	1.714*** (1.712)	1.817*** (1.712)	1.723*** (1.712)
C6	1.662*** (1.634)	1.765*** (1.634)	1.671*** (1.634)
C7	1.128*** (1.098)	1.231*** (1.098)	1.127*** (1.098)
C8	1.067*** (1.039)	1.127*** (1.039)	1.033*** (1.039)
C9	1.085*** (1.058)	1.185*** (1.058)	1.091*** (1.058)
Pseudo R <sup>2</sup>	0.1068	0.1102	0.1126
R <sup>2</sup>	0.1033	0.1054	0.1071
Observation value	600	528	600

Note: \*\*\* indicates a significant correlation at the 0.001 level

### 3.2.4 Heterogeneity test

Table 7 shows the results of the heterogeneity test. Similar to the results of the robustness test, although the coefficient values of the indicators are different, they also positively affect the quality of the cultivation of composite talents in higher vocational business and trade majors at the 0.001 level. The obtained conclusions are still applicable in the tests of different years. That is, it is necessary to improve the resources and environment related to senior business and trade majors in an orderly manner in accordance with the order of talent cultivation conditions-talent cultivation foundation-talent cultivation influence, starting from each three-level indicator, to realize the overall improvement of the quality of complex talent cultivation in senior business and trade majors.

Table 7: Heterogeneity test results

Variable	Dependent variable: Quality of comprehensive talent cultivation in higher vocational commercial programs				
	2021	2022	2023	2024	2025
B1	1.124*** (1.152)	1.145*** (1.152)	1.153*** (1.152)	1.134*** (1.152)	1.55*** (1.152)
B2	1.631*** (1.670)	1.623*** (1.670)	1.627*** (1.670)	1.662*** (1.670)	1.639*** (1.670)
B3	1.073*** (1.065)	1.109*** (1.065)	1.062*** (1.065)	1.061*** (1.065)	1.101*** (1.065)
C1	1.212*** (1.217)	1.201*** (1.217)	1.212*** (1.217)	1.220*** (1.217)	1.208*** (1.217)
C2	1.145*** (1.153)	1.235*** (1.153)	1.142*** (1.153)	1.146*** (1.153)	1.142*** (1.153)
C3	1.046*** (1.085)	1.207*** (1.085)	1.074*** (1.085)	1.081*** (1.085)	1.057*** (1.085)
C4	1.631*** (1.662)	1.641*** (1.662)	1.621*** (1.662)	1.645*** (1.662)	1.456*** (1.662)
C5	1.706*** (1.712)	1.651*** (1.712)	1.720*** (1.712)	1.704*** (1.712)	1.721*** (1.712)
C6	1.621*** (1.634)	1.621*** (1.634)	1.631*** (1.634)	1.621*** (1.634)	1.613*** (1.634)
C7	1.027*** (1.098)	1.073*** (1.098)	1.073*** (1.098)	1.089*** (1.098)	1.091*** (1.098)
C8	1.017*** (1.039)	1.028*** (1.039)	1.023*** (1.039)	1.045*** (1.039)	1.028*** (1.039)
C9	1.032*** (1.058)	1.041*** (1.058)	1.051*** (1.058)	1.051*** (1.058)	1.041*** (1.058)
Pseudo R <sup>2</sup>	0.1228	0.1293	0.1204	0.1245	0.1271
R <sup>2</sup>	0.1131	0.1167	0.1129	0.1103	0.1136
Observation value	600	600	600	600	600

## 4 Conclusion

This paper combines entropy power method, normal cloud model, and ordered probit model to analyze the influence of each index on the quality of complex talent cultivation of higher

vocational business and trade majors, and to explore the most suitable path of quality enhancement. The most effective order of quality enhancement among the 3 secondary indexes is as follows: Talent Cultivation Condition>Talent Cultivation Basis>Talent Cultivation Influence. The most appropriate order of quality improvement among the nine tertiary indicators is: faculty > professional construction > teaching conditions > policy environment > basic protection > hardware foundation > competitiveness of student sources > competitiveness of graduates > competitiveness of teaching. This reveals that if we want to comply with the development requirements of the digital economy era and improve the quality of the cultivation of composite talents in commerce majors, higher vocational colleges and universities need to focus on improving the teaching-related soft strengths, followed by the hard strengths such as the environment, and lastly the propaganda and other dissemination channels.

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## About the Author

Zheng Li was born in Qingyuan, Guangdong, P.R. China, in 1981. He has obtained a doctor's degree from South China Normal University in China. Now he works as an associate professor and Dean of School of Foreign Languages & Trade, Qingyuan Polytechnic. His main research directions are vocational education and personnel training

Mulan Luo was born in Yingde, Guangdong, P.R. China, in 1981. She has obtained a master's degree from Xi'an University in China. Currently, she works as the Head of E-commerce Major in School of Foreign Languages & Trade, Qingyuan Polytechnic. Her main research direction is Cross-Boarder E-Commerce.

Xiang Chen, was born in Xiaogan, Hubei, P.R. China, in 1985. She has obtained a master's degree from Yangtze University in China. Currently, she works as an associate professor and the Head of Marketing Major in School of Foreign Languages & Trade, Qingyuan Polytechnic. Her main research directions are digital rural construction and the integration of industry and education.

Zihao Li was born in Shaoguan, Guangdong, P.R. China, in 1988. He has obtained a master's degree from Jiangxi University of Finance and Economics in China. Currently, he works as an associate professor and the Head of Management Major in School of Foreign Languages & Trade, Qingyuan Polytechnic. His main research directions are public management, as well as regional economy and industrial development research.

Sheng Li was born in Shaoguan, Guangdong, P.R. China, in 1988. He has obtained a master's degree from Jiangxi University of Finance and Economics in China. Currently, he works as the Head of Logistics Management Major in School of Foreign Languages & Trade, Qingyuan Polytechnic. His main research directions are logistics analysis and cost control management.

## References

- [1] Lv, K., Zhao, Y., Zhu, S., & Zhu, L. (2025). Enterprise digital transformation and labor

- structure evolution: evidence from China. *Chinese Management Studies*, 19(3), 702-733.
- [2] Zhang, C., & Wang, Y. (2024). Is enterprise digital transformation beneficial to shareholders? Insights from the cost of equity capital. *International Review of Financial Analysis*, 92, 103104.
- [3] Wang, S., Lai, Y., & Zhang, S. (2024). Greening by digitization? Exploring the effect of enterprise digital transformation on greenwashing. *Business Strategy and the Environment*, 33(7), 6616-6639.
- [4] Ai, Y., Chi, Z., Sun, G., Zhou, H., & Kong, T. (2023). The research on non-linear relationship between enterprise digital transformation and stock price crash risk. *The North American Journal of Economics and Finance*, 68, 101984.
- [5] Wang, T., Zhao, X., & Li, X. (2025). Geographical influences, media attention and enterprise digital transformation. *Technological Forecasting and Social Change*, 210, 123853.
- [6] Huang, X., Zhu, L., Yang, Q., & Xiong, X. (2024). Enterprise digital transformation and employee treatment: Evidence from China. *International Review of Economics & Finance*, 96, 103738.
- [7] Zhao, N., & Ren, J. (2023). Impact of enterprise digital transformation on capacity utilization: Evidence from China. *PloS one*, 18(3), e0283249.
- [8] Xu, C., Sun, G., & Kong, T. (2024). The impact of digital transformation on enterprise green innovation. *International Review of Economics & Finance*, 90, 1-12.
- [9] Wang, D., Shao, X., Song, Y., Shao, H., & Wang, L. (2023). The effect of digital transformation on manufacturing enterprise performance. *Amfiteatru Economic*, 25(63), 593-608.
- [10] Böttcher, T. P., Empelmann, S., Weking, J., Hein, A., & Krcmar, H. (2024). Digital sustainable business models: Using digital technology to integrate ecological sustainability into the core of business models. *Information Systems Journal*, 34(3), 736-761.
- [11] Schiavi, G. S., & Behr, A. (2018). Emerging technologies and new business models: a review on disruptive business models. *Innovation & Management Review*, 15(4), 338-355.
- [12] Ansong, E., & Boateng, R. (2019). Surviving in the digital era—business models of digital enterprises in a developing economy. *Digital Policy, Regulation and Governance*, 21(2), 164-178.
- [13] Bradač Hojnik, B., & Hudek, I. (2023). Small and medium-sized enterprises in the digital age: Understanding characteristics and essential demands. *Information*, 14(11), 606.
- [14] Zhao, Y. (2019). The rise of the useless: The case for talent diversity. *Journal of Science Education and Technology*, 28(1), 62-68.

- [15] Gallardo-Gallardo, E. (2018). The meaning of talent in the world of work. *Global talent management*, 33-58.
- [16] Zhang, Y. (2023). A Comparative Study on the Cultivation of Applied Undergraduates and Vocational Undergraduates. *World Scientific Research Journal*, 9(11), 1-10.
- [17] Pan, Y. (2023). Research on the Versatile Talent Training Mode of International Trade in Vocational University. *The Educational Review, USA*, 7(7).
- [18] LANG, N. (2024). RESEARCH ON THE PATH TO IMPROVING THE QUALITY OF TALENT CULTIVATION IN HIGHER EDUCATION INSTITUTIONS AGAINST THE BACKGROUND OF EDUCATIONAL REFORM. *INNOVATION*, 20, 134-139.
- [19] Xu, J., Jiang, T., Wei, M., & Qing, Z. (2024). The digital transformation of vocational education: Experience and reflections of Shenzhen Polytechnic University. *Vocation, Technology & Education*, 1(1).
- [20] Ma, X., Chen, M., & Diao, J. (2025). Pathways and outcomes of digital transformation in Chinese vocational colleges. *Vocation, Technology & Education*, 2(1).
- [21] Chen, Z. (2025). Innovation of the Talent Cultivation System for Management Majors in Higher Vocational Colleges in the Digital Economy Era. *Lecture Notes in Education, Arts, Management and Social Science*, 3(5), 70-74.
- [22] Yang, Z. (2022). Digital transformation to advance high-quality development of Higher Education. *Journal of Educational Technology Development and Exchange (JETDE)*, 15(2), 15-23.
- [23] Liu, G., Zhao, S., & Sumbal, M. S. (2025). Bibliometric analysis on digital talent cultivation in China. *International Journal of Crowd Science*, 9(3), 190-198.
- [24] Xie, L., & Zhang, H. (2025). Research Hotspots and Trends in the Digital Transformation of Global Vocational Education. *Journal of Educational Theory and Practice*, 2(4).
- [25] Liu, Z., & Jiao, L. (2025, November). Digital Transformation of Education in the Era of Digital Economy: Path Design and Empirical Study of New Marketing Talent Training. In *2025 International Conference on Digital Technology and Educational Psychology (DTEP 2025)* (pp. 76-89). Atlantis Press.
- [26] Chang, Q., & Liu, Z. (2024). Research on Innovative Models for Cultivating Young Talent in the Context of the Digital Economy. *Higher education*, 6(3), 123-128.
- [27] Jiang, J., & Wang, X. (2024). Research on the Development Strategy of Vocational Undergraduate Education in the Context of Digital China Construction. *Frontiers in Educational Research*, 7(5).
- [28] Hou, Y. (2025). Research on the Integrated Training Mode of Business Administration Talents in Universities under the Background of Digital Transformation. *Lecture Notes in Education, Arts, Management and Social Science*, 3(5), 14-19.
- [29] Mo, Q. (2022). Research on the integration of Innovation Elements into the Digital

Transformation of Higher Vocational Specialty under the background of Digital Economy.  
International Journal of Education and Humanities, 3(2), 131-135.