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Xiaoying Bai, Yulong Wan

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Evaluation method of innovation and entrepreneurship education quality in colleges and universities based on entropy weight method

Xiaoying Bai*

Faculty of Automation,
Huaiyin Institute of Technology,
Huai'an, Jiangsu, 223003, China
Email: wyl669488@163.com

*Corresponding author

Yulong Wan

School of Business,
Jiangsu Vocational College of Electronics and Information,
Huai'an, Jiangsu, 223003, China
Email: WYL15951267841@163.com

Abstract: To overcome the problems of poor accuracy and long-time evaluation of innovation and entrepreneurship. This paper puts forward the quality evaluation method of innovation and entrepreneurship education in Colleges and Universities Based on entropy weight method. First, the index system of innovation and entrepreneurship is designed. Secondly, 12 innovation and entrepreneurship data such as the number of enterprise teachers and the number of entrepreneurship are obtained according to the index system. Then, the judgement matrix is constructed, the weight value is calculated by the difference, the initial weight is corrected by the correction coefficient obtained by the entropy weight method, and the comprehensive evaluation score is calculated to realise the quality evaluation of innovation and entrepreneurship. The experimental results show that the accuracy of this method is up to 99.9%, and the evaluation time is less than 6S, which can improve the evaluation effect of innovation and entrepreneurship.

Keywords: correlation function; entropy weight method; weight coefficient; judgement matrix; matter element method.

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Biographical notes: Xiaoying Bai, Lecturer, Master's degree, School of Mechanical Engineering, Nanjing University of Science and Technology, Working in Faculty of Automation, Huaiyin Institute of Technology, serve as academic secretary. His research interests are blockchain technology, teaching management, academic administration, innovation and entrepreneurship education, etc.

Yulong Wan, 2016 PhD candidate, School of Economics and Management, China University of Mining and Technology, Management Science and engineering major, Associate Professor, Working in Jiangsu Vocational College of Electronics and Information, His research interests are logistics management and blockchain technology.

1 Introduction

At present, innovation and entrepreneurship education has become an important means to deepen the comprehensive reform of colleges and universities, promote the connotation construction and improve the quality of talent training (Su and Zhang, 2020). With the in-depth development of innovation and entrepreneurship education in Colleges and universities, the atmosphere of innovation and entrepreneurship is increasingly strong, the activities of innovation and entrepreneurship are increasing, and the awareness of innovation and entrepreneurship is deeply rooted in the hearts of the people, and positive progress has been made (Shen, 2019). But at the same time, there are still some problems that cannot be ignored in the educational practice, such as inadequate implementation of innovation and entrepreneurship education policies, imperfect training mechanisms, and insufficient integration of specialised and creative talents (Wang et al., 2020). In view of this, to carry out the quality evaluation of innovation and entrepreneurship in Colleges and universities is conducive to comprehensively understand the current situation of innovation and entrepreneurship education in Colleges and universities, find out the weaknesses and shortcomings, and clear the development breakthrough. It is of great significance to deepen the reform of innovation and Entrepreneurship Education in Colleges and universities.

Many scholars have studied this problem. For example, Chen et al. (2020) proposed a CIPP based quality evaluation method for entrepreneurship education in colleges and universities. It uses data mining technology to obtain the characteristics of entrepreneurship data, uses fuzzy mathematics to grade the influencing factors of entrepreneurship indicators, calculates the subjective weight of entrepreneurship evaluation through combination weighting method, and constructs a CIPP model to achieve entrepreneurship quality evaluation. This method can improve the accuracy of evaluation, however, the evaluation efficiency is poor. Ke and Chen (2022) combine the CIPP model with AHP-FCE to improve the efficiency of entrepreneurship evaluation. The AHP method is used to layer the influencing factors of entrepreneurship education. The FCE method is used to calculate the weight of entrepreneurship evaluation indicators, analyse the allocation of entrepreneurship education resources, introduce the weight of evaluation indicators into the CIPP model, and output the fuzzy evaluation results. This method improves the accuracy of evaluation and shortens the evaluation time, but the evaluation cost is high. Zhu and He (2020) evaluates the quality of innovation and entrepreneurship education based on ‘process results’, obtains innovation and entrepreneurship effectiveness factors and influencing factors by designing innovation and entrepreneurship evaluation effect questionnaires, classifies the

effectiveness factors and influencing factors by attribute division method, constructs innovation and entrepreneurship effectiveness judgement matrix through ‘process results’ of innovation and entrepreneurship evaluation, and outputs innovation and entrepreneurship evaluation results. This method can improve the allocation of entrepreneurial education resources, but the accuracy of the evaluation results is poor.

Entropy weight method is an objective weighting method. In information theory, entropy value is used to measure the degree of disorder of the system. The measurement comes from abstract uncertain information. In this process, the order index in the system is information. Although the directions of the two are opposite, the absolute values are the same (Cheng, 2021). Entropy weight is used to represent the relative intensity of each indicator in the evaluation system of the target system. As the name implies, entropy weight method is to use entropy value to obtain the weight. When using, the entropy weight of each indicator can be calculated by combining the information entropy value with the relative variation degree of each indicator that needs to be considered. In order to effectively solve the problems of the method, this paper designs an evaluation method of innovation and entrepreneurship education quality in Colleges and Universities Based on entropy weight method, which can effectively improve the evaluation effect of innovation and entrepreneurship education quality in Colleges and universities. Specific research ideas are as follows:

First, design the index system of innovation and entrepreneurship quality evaluation. According to the actual situation of a university in L City,

Secondly, the standardised processing of innovation and entrepreneurship quality evaluation data. According to the index system, 12 university innovation and entrepreneurship data such as the number of enterprise teachers, the average score, and the number of entrepreneurship were obtained. The original data were linearly transformed by the dispersion method to complete the data standardisation processing.

Then, the quality evaluation of innovation and entrepreneurship education in Colleges and universities. The information entropy method is used to construct the judgement matrix of innovation and entrepreneurship education quality. The weight value of innovation and entrepreneurship education quality is obtained through the difference calculation, and the scale of the importance of innovation and entrepreneurship evaluation in Colleges and universities is determined. The correction coefficient is obtained by the entropy weight method to correct the initial weight, and the final weight is obtained. The comprehensive evaluation score of innovation and entrepreneurship education quality in Colleges and universities is calculated to realise the quality evaluation of innovation and entrepreneurship education.

Finally, taking the evaluation efficiency, evaluation accuracy and investment cost as indicators to verify the quality evaluation effect of innovation and entrepreneurship education, and draw a conclusion.

2 Construction and standardisation of innovation and entrepreneurship index system

2.1 Construction of innovation and entrepreneurship index system

According to the actual situation of a university in L City, the index system of innovation and entrepreneurship quality evaluation is designed, as shown in Table 1.

- 1 Teaching quality is mainly used to evaluate the teaching quality of colleges and universities for innovation and entrepreneurship, including the number of enterprise professionals (i.e., senior innovation and entrepreneurship personnel with rich experience in enterprises). The average score is used to represent the learning of students' innovation and entrepreneurship.
- 2 Innovation quality is mainly used to evaluate the innovation level of colleges and universities, including the total number of patents, including invention patents, utility model patents, copyrights, appearance patents, etc.
- 3 Entrepreneurship quality is mainly used to evaluate the achievements of innovation and entrepreneurship, including the number of incubated enterprises and their registered capital, among which the number of high-tech enterprises is used to represent the high-quality entrepreneurial achievements; The average value of attracting employment and the average value of profit are used to represent the entrepreneurial effect, that is, how many social jobs and wealth have been created.

Table 1 Innovation and entrepreneurship evaluation index system

<i>Target layer</i>	<i>Level I indicator</i>	<i>Secondary indicators</i>	<i>Company</i>
Quality evaluation of innovation and Entrepreneurship Education	Teaching quality	Number of enterprise teachers	People
		Average score	Fraction
		Number of awards	Piece
		Number of maker spaces	Individual
	Innovation quality	Total patents	Piece
		Number of invention patents	Piece
		Average value of achievement conversion	10,000 yuan
	Entrepreneurial quality	Number of startups	Individual
		Average registered capital	10,000 yuan
		Number of high-tech enterprises	Individual
		Average employment attraction	People
		Average profit	10,000 yuan

2.2 Acquisition of innovation and entrepreneurship data in universities

According to the established innovation and entrepreneurship evaluation index system, 12 types of university innovation and entrepreneurship data, including the number of enterprise teachers, the average score, the number of competition awards, the number of maker spaces, the number of invention patents, and the number of entrepreneurship, were obtained. The research obtained the innovation and entrepreneurship data of a university in L City, with a time span from 2017 to 2021.

Since the original data obtained have different statistical standards, it is necessary to standardise these data first. In this study, the deviation method is used to perform linear transformation on the original data (Dang et al., 2020), so that the results after standard

processing fall within the interval of [0,1]. Let X be the sequence of n indicators, and the normalisation formula is as follows.

$$y_i = \frac{x_i - \min_{1 \leq i \leq n} \{x_i\}}{\max_{1 \leq i \leq n} \{x_i\} - \min_{1 \leq i \leq n} \{x_i\}} \quad (1)$$

In the above formula, x_i represents the original data of item, y_i represents the result after the normalisation process, and min and max represent obtaining the minimum and maximum values, respectively.

Complete the quality evaluation of innovation and entrepreneurship education in Colleges and universities according to the obtained innovation and entrepreneurship data.

3 Quality evaluation of innovation and entrepreneurship education in colleges and universities based on entropy weight method

To evaluate the quality of innovation and entrepreneurship in this study, we need to calculate the weight of the evaluation index system of innovation and entrepreneurship Road, and mainly complete the weight calculation of three steps: information entropy calculation, weight value calculation, and comprehensive evaluation score of innovation and entrepreneurship education quality in Colleges and universities. Because the entropy weight method has a wide range of application and is not affected by subjective factors, the index weight calculated by this method has high accuracy. At the same time, the entropy weight method can make full use of its own advantages of strong objectivity when jointly calculating the weight with other subjective weight methods, and exert good correction characteristics. Therefore, this paper uses the entropy weight method to calculate the correction coefficient, then corrects the initial weight, and finally obtains the combined weight (Xu, 2020). The specific calculation process is as follows:

- 1 For information entropy calculation, entropy weight method is a relatively objective method to determine the weight value according to information entropy. This method is realised by calculating the probability of each data item (Liang et al., 2021; Yz and Hz, 2022; Zhong, 2021). Construction of judgement matrix X : set a judgement matrix composed of m evaluation schemes and n indicators:

$$X = (x_{ij})_{m \times n}, i = 1, 2, \dots, m; j = 1, 2, \dots, n \quad (2)$$

Standardise the data of each indicator to eliminate the incommensurability among indicators (Grembowski et al., 2021).

$$P_{ij} = x_{ij} / \sum_{i=1}^m x_{ij} \quad (3)$$

The entropy E_j of each evaluation index is calculated. When $P_{ij} = 0$, let $P_{ij} \ln P_{ij} = 0$.

$$E_j = \sum_{i=1}^m P_{ij} \ln P_{ij} / \ln m \quad (4)$$

- 2 *Weight value calculation*: calculate the weight value of each indicator according to the information entropy of each indicator, where w represents the weight value of the indicator (Jing et al., 2022; Guo et al., 2022), E_i represents the information entropy of the i indicator, and n represents the total amount of indicators, as shown below.

$$w = \frac{1 - E_i}{n - \sum_{i=1}^n E_i} \tag{5}$$

Using the entropy E_j of each index, find the deviation degree d_j of index j :

$$d_j = 1 - E_j \tag{6}$$

The correction coefficient μ_j is determined by the deviation degree d_j of each index:

$$\mu_j = d_j / \sum_{j=1}^n d_j \tag{7}$$

Use each correction coefficient μ_j to correct the initial weight W_j obtained by the information entropy method, and calculate the weight θ_j after the correction by the entropy weight method:

$$\theta_j = \mu_j W_j / \sum_{j=1}^n \mu_j W_j \tag{8}$$

The initial weight W_j obtained and the weight θ_j corrected by the entropy weight method are calculated according to formula (8) to obtain the final weight ω_j comprehensively obtained by the entropy weight method.

$$\omega_j = \rho W_j + (1 - \rho) \theta_j \tag{9}$$

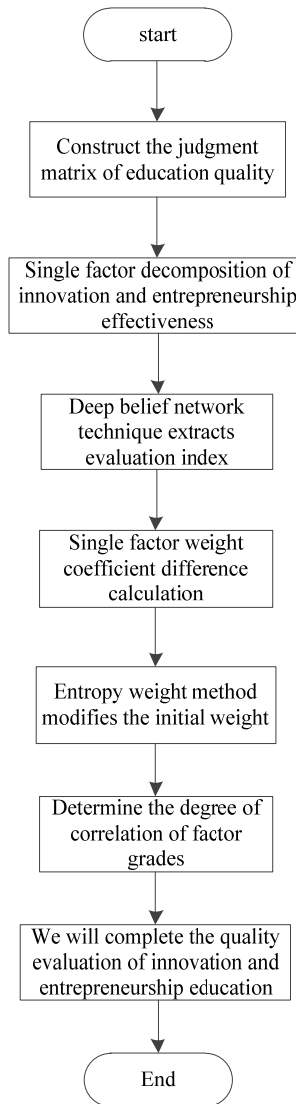
In formula (10): ρ – resolution coefficient (Mao and Zhang, 2021), usually 0.5.

- 3 *Comprehensive evaluation score calculation*: in the same decision-making unit, the value of each indicator is multiplied by its corresponding weight value and accumulated to obtain comprehensive evaluation score. Where, Z is the comprehensive evaluation score, n is the total number of indicators, x_i and w_i are the values and weight values of the fifth indicator, as shown below.

$$Z = \sum_{i=1}^n w_i * x_i \tag{10}$$

By calculating the comprehensive evaluation scores, the quality evaluation of innovation and entrepreneurship education in Colleges and universities can be effectively realised. The specific innovation and entrepreneurship evaluation process of colleges and universities is shown in Figure 1.

Figure 1 Evaluation process of innovation and entrepreneurship in colleges and universities



4 Experiment

4.1 Experimental design

In order to verify the comprehensive effectiveness of the proposed evaluation method of innovation and entrepreneurship education, experimental tests were conducted under the Windows 7 operating system and the program running software: MATLAB 2016b.

In this study, 50 universities in L city were selected as sample universities, and questionnaires were distributed to the innovation and entrepreneurship management teachers, college students who have been innovative entrepreneurs, college students who have received entrepreneurship education and other groups in the sample universities. There are 12 three-level indicators in the indicator system. In order to ensure the scientificity and accuracy of the survey results, the number of samples should be five times the number of indicators. Each school collects 500 online questionnaires and 23400 public 25000 effective questionnaires, with an effective rate of 93.6%. There are 10100 boys and 1330 girls. 5100 freshmen, 8550 sophomores, 6150 juniors and 3600 seniors. According to this result, the innovation and entrepreneurship effect of colleges and universities is tested.

4.2 Experimental index

In the quality evaluation of innovation and entrepreneurship education in this study, the higher the value of TP and TN , the better the effect of model prediction. The lower the value of FP and FN , the better. The reasons are: too high FN may lead to misjudgement of the results of the classification model. For example, the evaluation of innovation and entrepreneurship caused by non-human factors is misjudged as an accident caused by human factors, so wrong protection measures are taken for the prevention of innovation and entrepreneurship evaluation; FN is a problem caused by misjudging the quality evaluation of innovation and entrepreneurship education in Colleges and universities caused by human factors into non-human factors.

- 1 The accuracy rate A_c represents the ratio of the number of samples mined by traffic accidents to the total number of samples, and the expression is:

$$A_c = \frac{TP + TN}{TP + FP + TN + FN} \quad (11)$$

- 2 Evaluation efficiency: the evaluation efficiency indicates the sum of the running time on different datasets.
- 3 Evaluation cost m_s :

The evaluation cost is the most intuitive indicator to compare the operation efficiency of algorithms, including the operation cost of classification algorithms on datasets of different scales m_y , the evaluation cost of the same dataset in different environments m_h , and the evaluation cost of different iterations m_i . The specific calculation formula is:

$$m_s = m_y + m_h + m_i \quad (12)$$

According to the experimental scheme set above, the test is conducted by comparison, mainly comparing the accuracy of sample data integrity detection and the time cost of detection.

4.3 Experimental result

4.3.1 Accuracy of quality evaluation of innovation and entrepreneurship education in colleges and universities

The accuracy of the quality evaluation of innovation and entrepreneurship education in Colleges and universities is taken as the test index. The specific experimental comparison results are shown in Table 2.

Table 2 Accuracy of quality evaluation of innovation and entrepreneurship education in colleges and universities

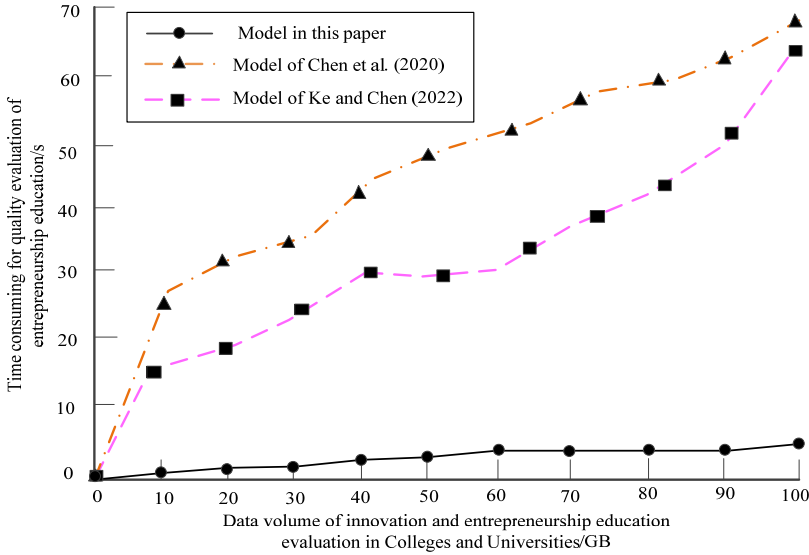
Number of test samples/(PCS)	Accuracy of quality evaluation of innovation and entrepreneurship education in universities / (%)		
	Proposed method	Methods in Chen et al. (2020)	Methods in Ke and Chen (2022)
300	98.2	89.2	79.2
350	99.2	78.6	81.5
400	99.9	83.1	87.3
450	98.2	88.5	82.8
500	97.0	80.5	86.0

According to the experimental data in Table 2, the increase in the number of test samples will have a certain impact on the accuracy of the quality evaluation of innovation and entrepreneurship education in Colleges and universities. The accuracy of innovation and entrepreneurship evaluation of the proposed method is up to 99.9%. However, since the proposed method extracts evaluation indicators through the deep belief network in the early stage of evaluation, and classifies different evaluation indicators in combination with classification specifications, the evaluation accuracy of the proposed method is significantly higher than that of the other two methods, and more accurate evaluation results can be obtained. This is because the method in this paper constructs the judgement matrix of education quality, and uses the entropy weight method to modify the initial weight, which effectively improves the accuracy of the evaluation results.

4.3.2 Quality evaluation efficiency of innovation and entrepreneurship education in colleges and universities

In order to further verify the superiority of the proposed method, the experiment takes the quality evaluation efficiency of innovation and entrepreneurship education in Colleges and universities as the test index. The higher the evaluation efficiency, the faster the evaluation speed is; On the contrary, it indicates that the evaluation speed is slow. Figure 2 shows the comparison results of the quality evaluation efficiency of innovation and entrepreneurship education in Colleges and universities with three different methods:

Figure 2 Time consuming for quality evaluation of innovation and entrepreneurship education in colleges and universities (see online version for colours)



According to the analysis of Table 2, when the amount of evaluation data is 10GB, the evaluation efficiency of innovation and Entrepreneurship of the method of (Chen et al., 2020) is 25s, the evaluation time of innovation and Entrepreneurship of the method of (Ke and Chen, 2022) is 14 s, and the evaluation time of innovation and Entrepreneurship of this method is 2S; When the amount of evaluation data is 50GB, the evaluation time of innovation and entrepreneurship in the method of Chen et al. (2020) is 48S, the evaluation time of innovation and entrepreneurship in the method of Ke and Chen (2022) is 28 s, and the evaluation time of innovation and entrepreneurship in this method is 4S. When the amount of evaluation data is 90gb, the innovation and entrepreneurship evaluation time of Chen et al. (2020) method is 65 s, the innovation and entrepreneurship evaluation time of Ke and Chen (2022) method is 47 s, and the innovation and entrepreneurship evaluation time of this method is 6S. This method can effectively improve the efficiency of innovation and entrepreneurship evaluation. This is because the method in this paper uses the deviation method to linearly transform the original data, complete the data standardisation, obtain the weight value of innovation and entrepreneurship education quality through the difference calculation, obtain the effect of different factors, and improve the evaluation efficiency.

4.3.3 Quality evaluation cost of innovation and entrepreneurship education in colleges and universities

In the following experimental tests, 50 different colleges and universities are selected as the test objects. They are divided into 5 groups according to 1–10, 11–20, 21–30, 31–40 and 41–50. The average investment cost of education quality of these 5 groups of colleges and universities is calculated. The specific experimental comparison results are shown in Table 3.

Table 3 Investment cost of education quality

Test serial number	Average investment cost / (yuan)		
	Proposed method	Methods in Wang et al. (2020)	Methods in Chen et al. (2020)
1	6850	56990	28050
2	5820	33900	27300
3	6282	31600	18300
4	5138	22507	98500
5	5600	69504	52160

According to the analysis of Table 3, when the test number is 1, the average investment cost of colleges and universities in the method of Wang et al. (2020) is 56990 yuan, the average investment cost of colleges and universities in the method of Chen et al. (2020) is 28050 yuan, and the average investment cost of colleges and Universities in the proposed method is 6850 yuan; When the test number is 3, the average investment cost of colleges and universities in the method of Wang et al. (2020) is 31600 yuan, the average investment cost of colleges and universities in the method of Chen et al. (2020) is 18,300 yuan, and the average investment cost of colleges and universities in the proposed method is 6282 yuan; The highest average cost of education quality investment in this method is 6850 yuan, and the economic benefit of education quality investment is high. This is because the proposed method extracts and classifies the evaluation indicators, which reduces the evaluation cost of the whole method.

5 Conclusion

This paper puts forward a quality evaluation method of innovation and entrepreneurship education in Colleges and Universities Based on entropy weight method. Design the index system of innovation and entrepreneurship quality evaluation. According to the index system, obtain 12 university innovation and entrepreneurship data, such as the number of enterprise teachers, the average score, and the number of entrepreneurship. Construct the judgement matrix of innovation and entrepreneurship education quality through the information entropy method, obtain the weight value of innovation and entrepreneurship education quality through the difference calculation, and use the entropy weight method to calculate the correction coefficient to correct the initial weight and obtain the final weight, Calculate the comprehensive evaluation score of the quality of innovation and entrepreneurship education in Colleges and universities, and realise the quality evaluation of innovation and entrepreneurship education. The experimental results show that:

- 1 The accuracy of innovation and entrepreneurship evaluation of this method is up to 99.9%, and the accuracy of innovation and entrepreneurship education quality evaluation is high.
- 2 The average cost of education quality investment in this method is 6850 yuan, and the economic benefit of education quality investment is high.
- 3 The evaluation takes no more than 6S under a large amount of data, which can effectively improve the efficiency of innovation and entrepreneurship evaluation.

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