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Research Article

Research on Performance Evaluation System of College Entrepreneurship Education Level Based on CIPP Model*

Xiaoli Shi[1]
Xi'an International University

Abstract

As a brand-new educational concept and education mode, entrepreneurship education has been widely carried out in colleges and universities across the country. A systematic study on the evaluation of college entrepreneurship education is conducive to ensuring the sustainable and stable development of college entrepreneurship education. This paper first analyzes the current status of the development of entrepreneurship education in universities in China. Second, it establishes a CIPP-based evaluation indicator system for university entrepreneurship education capabilities, which includes four main indicators: environmental basis, resource allocation, process action, and result performance, and uses factor analysis to comprehensively evaluate various indicators. Finally, by taking four universities in our country as examples, the indicator weights of university entrepreneurship education ability evaluation are calculated, and then the comprehensive evaluation results of entrepreneurship education level in the four universities are calculated.

Keywords

Entrepreneurship Education • CIPP Model • Factor Analysis Method • Performance Evaluation

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[1]**Correspondence to:** Xi'an International University, Yudou Road 18, Yanta District, Xi'an 710077, China. Email: aidp654@126.com

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At present, as a brand-new educational concept and education mode, the entrepreneurship education has been widely carried out in colleges and universities nationwide (Fan *et al*. 2015). How to evaluate and enhance entrepreneurship education in colleges and universities has gradually become the focus and difficulty of education theoretical research. The reasonable evaluation of college entrepreneurship education level is a relatively complicated systematic project. So far, our country has not yet established a relatively complete evaluation system for entrepreneurship education in universities. There is even less research on how to upgrade entrepreneurship education in colleges and universities (Mosqueda *et al*., 2009). A systematic study of the evaluation of entrepreneurship education in colleges and universities has a very important practical significance and far-reaching impact on ensuring the sustainability, stability and healthy development of college entrepreneurship education (Jablonsky, 2016).

For college entrepreneurship education, a large number of scholars at home and abroad have conducted very systematic and comprehensive research, and also formed a series of research results. The United States is the first country to carry out entrepreneurship education in colleges and universities. It conducts in-depth research and discussion on curriculum setting, teaching methods, and education modes of entrepreneurship education (Liu Chen Bose Hu & Bruton, 2013); some foreign scholars have studied the evaluation indicator system of college entrepreneurship education (Prathap & Ratnavelu, 2015); domestic research mainly focuses on the quality evaluation of entrepreneurship education in colleges and universities and existing major problems (Prescott Norcini Mckinlay & Rennie, 2002). The existing literature mostly stays at the theoretical level. This paper is based on the CIPP model and uses factor analysis to establish an all-round, multi-angle performance evaluation indicator system of entrepreneurship education in colleges and universities, so as to conduct empirical research, and it's of important practical significance.

Introduction of basic theories

CIPP model

The CIPP model was first proposed by the American scholar Stufflebeam on the basis of reflection on Tyler's behavioral goal model in 1967 (Behzad Parasto & Arash 2013). The CIPP model mainly includes four evaluation elements, respectively are: background, input, process, and results. The CIPP model has a strong systemic nature and can provide information for different aspects of decision making. Therefore, the CIPP model is also called a decision-oriented model (Singh, 2004). The CIPP model considers that the purpose of evaluation is not to prove, but to improve (Neyazi Arab Farzianpour & Mahmoudi, 2016).

Factor analysis

Factor analysis was first proposed by the famous British psychologist C.E. Spearman in 1904. It is a statistical technique that studies the extraction of commonalities from variable groups (Apley & Shi, 2001). Factor analysis can be used to find representative factors among a large number of variables and classify variables of the same nature into one factor (Lorber, 1985). It determines the weight of each comprehensive

factor by the variance contribution rate, which avoids artificial subjective factors and makes the results more reasonable and objective (Trevisan Garcia Schuchardt & Poppi, 2008).

Assuming that the total sample size is N, each sample has k original evaluation indicators, which are X_1, X_2..., X_k. The j-th indicator of the i-th sample is expressed as X_{ij}= (i=1, 2..., N; j=1, 2..., K), and the evaluation indicator is processed as follows:

Standardized the data. In general, many selected indicators are not comparable, and the indicators need to be standardized in order to perform comparisons (Hopke, 1988). Using dimensionless method to process the raw data can both ensure the consistency of directions and eliminate the influence of dimensions (Stommel Wang Given & Given, 1992). At present, the Z-score method is commonly used in the world and the conversion formula is:

$$X'_{ij} = X_{ij} - \frac{\overline{X_j}}{s_j} \tag{1}$$

Where:

$$\overline{X_j} = \sum_{i=1}^{n} \frac{x_{ij}}{n} \tag{2}$$

$$S_j^2 = \sum_{i=1}^{n} \frac{(X_{ij} - \overline{X_j})^2}{n-1} \tag{3}$$

After the data is standardized, it needs to satisfy:

$$\mathrm{E}\left(X'_{ij}\right) = 0, \mathrm{Var}\left(X'_{ij}\right) = 1 \tag{4}$$

Calculate the eigenvalues and eigenvectors of the correlation coefficient matrix R. By the characteristic equation $|R-\lambda E|=0$, we can get the characteristic value λ_m (m=1, 2..., k; m<k). Then by the equation set $(R-\lambda E)F_m = 0$,we can get corresponding eigenvectors F_m of the eigenvalues λ_m. F_m is a linear combination of X_1, X_2..., X_k and represents factors that play a dominant role in comprehensive performance evaluation (Birnbaum Benfey & Shasha 2001).

Rotate the factor load matrix. Rotation of the initial factor load matrix usually uses the Varimax method to redefine the common factors by several indicators with larger weights in the linear combination, thereby achieving effective simplification (Miyazaki, *et al*. 1993).

Establish a comprehensive evaluation model to calculate factor scores. Express the indicator variable as a linear combination of common factors:

$$X_i = a_{i1}F_1 + a_{i2}F_2 + \cdots + a_{im}F_m \ \ (\mathrm{i} = 1,2,\cdots,\mathrm{m},\ \ \mathrm{m} < \mathrm{k}) \tag{5}$$

In general, the common factor can be expressed as a linear combination of variables, that is:

$$F_j = \beta_{j1}X_1 + \beta_{j2}X_2 + \cdots + \beta_{jm}X_m \ \ (\mathrm{j} = 1,2,\cdots,\mathrm{m},\ \ \mathrm{m} < \mathrm{k}) \tag{6}$$

β_{jm} is the factor score of the common factor F_j on the indicator variable X_n. The weighted sum is calculated with the contribution of each common factor as the weight, and finally the comprehensive factor score is obtained:

$$F = \sum_{i=1}^{m} \alpha_i F_i \quad (7)$$

Where:

$$\alpha_i = \frac{\lambda_i}{\sum_{i=1}^{m} \lambda_i} \quad (8)$$

λ_i is the variance contribution rate, $\frac{\lambda_i}{\sum_{i=1}^{m} \lambda_i}$ is the cumulative variance contribution rate.

Factor analysis of the performance evaluation of college entrepreneurship education based on CIPP

Analysis of the status of entrepreneurship education in Chinese universities

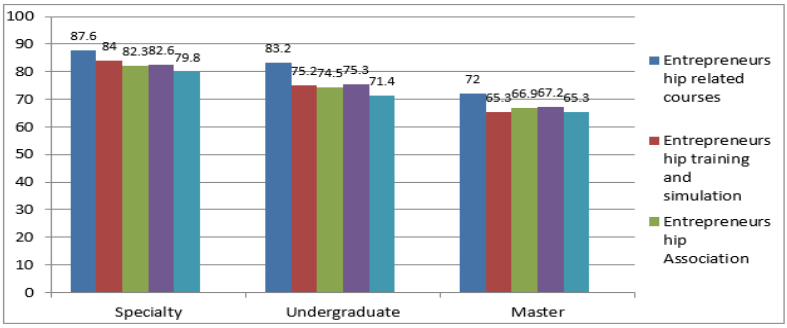

Figure 1. Participation in entrepreneurship education activities

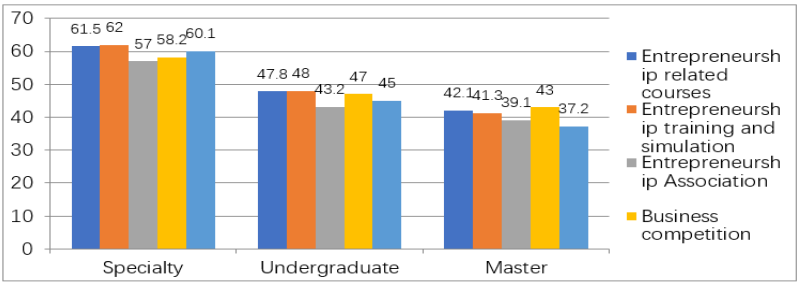

Figure 2. The satisfaction of entrepreneurship education activities

Entrepreneurship education in Chinese universities started in the late 1990s. In April 2002, the pilot work on entrepreneurship education started. At present, many colleges and universities in China have already carried out entrepreneurship education through various means. Students have a relatively high degree of participation,

as shown in Figure 1. However, overall student satisfaction is not high, as shown in Figure 2. This shows that colleges and universities still need to increase their efforts to promote the sustainable development of college entrepreneurship education.

Establishment of evaluation indicator system for college entrepreneurship education

According to the research results of domestic and foreign experts, and according to the relevant theories of the CIPP model, this paper establishes an evaluation indicator system for college entrepreneurship education based on the CIPP model. The system mainly includes four major indicators, as shown in Figure 3.

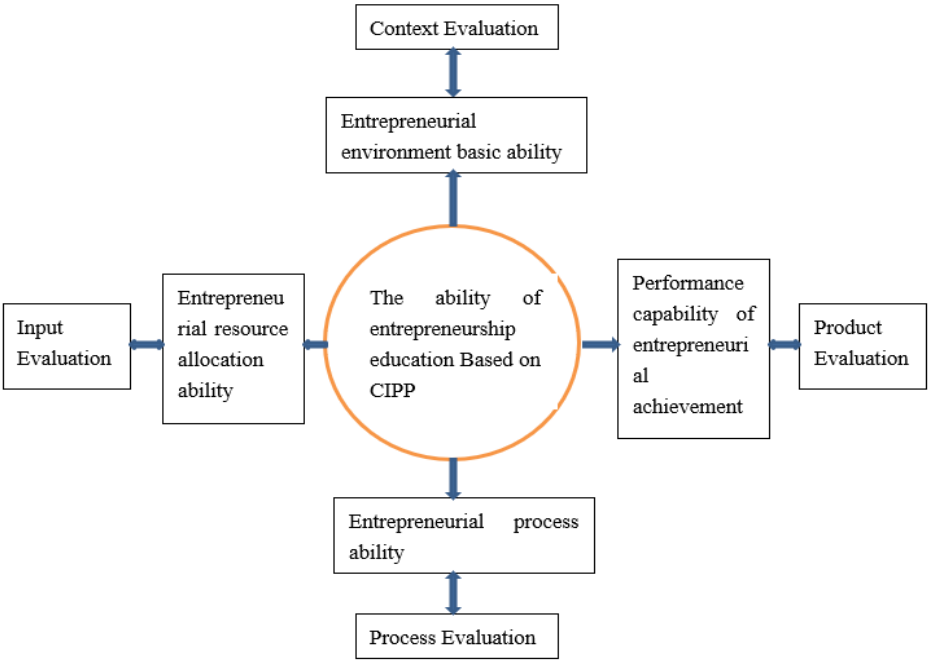

Figure 3. Evaluation model of entrepreneurship education level in Colleges and Universities

The evaluation indicator system of college entrepreneurship education level mainly includes four main indicators: environment basic ability, resource allocation ability, process action ability and result performance ability. Each primary indicator includes several secondary indicators and tertiary indicators. See Table 1 for details.

Factor analysis of performance evaluation

This paper mainly uses software SPSS 18.0 for factor analysis, and evaluates the level of entrepreneurship education in four universities in China, which are Renmin University of China, Tsinghua University, Wuhan University, and Heilongjiang University.

Table 1
An Indicator System for Evaluating the Level of Entrepreneurship Education in Colleges and Universities

Primary indicators	Secondary indicators	Tertiary indicators
Entrepreneurial environment basic ability	Regional environment(A1)	The degree of entrepreneurial activity in the cities of colleges and Universities(B1)
	Knowledge base(A2)	The number of papers published in CNKI entrepreneurship education(B2)
		CNKI entrepreneurship education paper citation(B3)
	Technical basis(A3)	The amount of authorization of the invention patent(B4)
		Number of contracts signed by technology transfer(B5)
Entrepreneurial resource allocation ability	Teacher input(A4)	The number of teaching teachers in Entrepreneurship Education(B6)
		Proportion of Senior Professional Title Teachers in Entrepreneurship Education(B7)
		Proportion of teachers with high degree of education and Entrepreneurship Education(B8)
	Funds input(A5)	Financial allocation of national Entrepreneurship Program(B9)
		The number of University appropriations for national Entrepreneurship Program(B10)
	Organizational guarantee(A6)	The number of business consulting service centers(B11)
Entrepreneurial process action ability	Entrepreneurship course(A7)	The number of entrepreneurship education courses(B12)
		Entrepreneurship education lecture / Sharon's diversity(B13)
	Entrepreneurship Project(A8)	The national business plan project number(B14)
		Student participation in national Entrepreneurship Program(B15)
	Practice platform(A9)	The number of Science Park, Pioneer Park, incubator (B16)
	Literacy promotion(A10)	Award-winning scores in the national competition program of College Students' Entrepreneurship Program(B17)
		The improvement of the psychological characteristics of College Students' entrepreneurial personality(B18)
Entrepreneurial result performance ability	Entrepreneurial effect(A11)	The number of incubating enterprises in the University Science Park(B19)
		The number of accumulative graduation enterprises in University Science and Technology Park(B20)
	Social results(A12)	The ratio of entrepreneurial rate and employment rate(B21)
		Number of outstanding entrepreneurs(B22)

Entrepreneurial environment basic ability evaluation

Table 2
Test Results of KMO and Bartlett for Entrepreneurial Environment Basic Ability Evaluation

KMO Value		0.54
Bartlett sphericity test	Approximate chi square	32.794
	Freedom	5
	Saliency	0.001

Table 2 shows that the KMO statistic for each indicator of the basic ability of the entrepreneurial environment is 0.54, and the P value is 0.001. Therefore, it is suitable for factor analysis. The results of the eigenvalue and variance contribution of each indicator are shown in Table 3.

Table 3
Eigenvalue and Variance Contribution Rate of Entrepreneurial Environment Basic Ability Evaluation Indicators

Principal component	Characteristic value	Contribution rate	Cumulative contribution value
1	2.375	45.382%	45.382%
2	1.984	36.729%	82.111%
3	1.153	12.821%	94.932%
4	0.248	4.152%	99.084%
5	0.067	0.916%	100.000%

According to Table 3, the cumulative contribution rate of the first three factors is 94.932%, far exceeding 85%, indicating that the first three factors can fully explain the indicator of entrepreneurial environment basic ability. See Table 4 for the rotation load matrix.

Table 4
Rotation Load Matrix of Factor Analysis for Entrepreneurial Environment Basic Ability Evaluation Indicators

Index	Factor		
	F_1	F_2	F_3
B1	-0.005	0.327	0.904
B2	0.987	-0.046	-0.004
B3	0.985	-0.017	0.003
B4	0.059	0.939	0.296
B5	-0.123	0.934	0.172

As can be seen from Table 4, the two indicators included in the knowledge base contribute the most to the basic capabilities of the college's entrepreneurial environment, followed by the technical infrastructure and the regional environment. The score coefficient matrix for the three factors is shown in Table 4.

Table 5
Component Score Coefficient Matrix of Entrepreneurial Environment Basic Ability Evaluation

Index	F_1	F_2	F_3
B1	-0.028	-0.314	1.294
B2	0.492	0.023	-0.014
B3	0.527	0.029	-0.018
B4	0.071	0.547	-0.121
B5	-0.026	0.651	-0.317

According to Table 5, it can be concluded that the linear combinations between the evaluation indicators are:

$$F_1 = -0.028\mathrm{B}_1 + 0.492\mathrm{B}_2 + 0.527\mathrm{B}_3 + 0.071\mathrm{B}_4 - 0.026\mathrm{B}_5$$

$$F_2 = -0.314\mathrm{B}_1 + 0.023\mathrm{B}_2 + 0.029\mathrm{B}_3 + 0.547\mathrm{B}_4 + 0.651\mathrm{B}_5$$

$$F_3 = 1.294\mathrm{B}_1 - 0.014\mathrm{B}_2 - 0.018\mathrm{B}_3 - 0.121\mathrm{B}_4 - 0.317\mathrm{B}_5$$

According to the factor score coefficient matrix, a comprehensive scoring model can be established:

$$\mathrm{F} = \sum_{i=1}^{m} \alpha_i F_i = 0.47328 \times F_1 + 0.39382 \times F_2 + 0.11396 \times F_3 \quad (9)$$

Evaluation of entrepreneurial resources allocation ability

Table 6
Test results of KMO and Bartlett for entrepreneurial resource allocation ability evaluation

KMO Value		0.561
Bartlett sphericity test	Approximate chi square	25.195
	Freedom	10
	Saliency	0.039

Table 6 shows that the KMO statistic for each indicator of the entrepreneurial resource allocation ability is 0.561, and the P value is 0.051. It is suitable for factor analysis. Table 7 shows the eigenvalues and variance contribution results of each indicator.

Table 7
Eigenvalue and variance contribution rate of entrepreneurial resource allocation ability evaluation indicators

Principal component	Characteristic value	Contribution rate	Cumulative contribution value
1	2.398	40.538%	40.538%
2	1.963	31.296%	71.834%
3	1.054	16.215%	88.049%
4	0.315	6.723%	94.772%
5	0.162	4.683%	99.455%
6	0.027	0.545	100.000%

From Table 7, we can see that the cumulative contribution rate of the first three factors is 88.048%, which is higher than 85%. This shows that the first three factors can fully explain the indicator of entrepreneurial resource allocation ability. See Table 8 for the rotation load matrix.

Table 8
Rotation Load Matrix of Entrepreneurial Resource Allocation Ability Evaluation Indicators

Index	Factor		
	F_1	F_2	F_3
B6	-0.579	0.792	-0.391
B7	0.035	0.896	0.247
B8	0.114	0.924	-0.028
B9	0.941	0.147	-0.249
B10	0.953	0.106	-0.215
B11	-0.286	0.194	0.873

As can be seen from Table 8, the three indicators included in the funding input contribute the most to the college's ability to allocate entrepreneurial resources, followed by teacher input. The score coefficient matrix for the three factors is shown in Table 9.

Table 9
Component Score Coefficient Matrix of Entrepreneurial Resource Allocation Ability Evaluation

Index	F_1	F_2	F_3
B6	-0.368	0.279	-0.546
B7	0.071	0.457	0.226
B8	0.052	0.481	-0.041
B9	0.405	0.072	-0.087
B10	0.412	0.059	-0.039
B11	0.015	0.063	0.792

According to Table 9, it can be concluded that the linear combination between each evaluation indicator is:

$$F_1 = -0.368\mathrm{B}_6 + 0.071\mathrm{B}_7 + 0.052\mathrm{B}_8 + 0.405\mathrm{B}_9 + 0.412\mathrm{B}_{10} + 0.015\mathrm{B}_{11}$$

$$F_2 = 0.279\mathrm{B}_6 + 0.457\mathrm{B}_7 + 0.481\mathrm{B}_8 + 0.072\mathrm{B}_9 + 0.059\mathrm{B}_{10} + 0.063\mathrm{B}_{11}$$

$$F_3 = -0.546\mathrm{B}_6 + 0.226\mathrm{B}_7 - 0.041\mathrm{B}_8 - 0.087\mathrm{B}_9 - 0.039\mathrm{B}_{10} + 0.792\mathrm{B}_{11}$$

According to the factor score coefficient matrix, a comprehensive scoring model can be established:

$$\mathrm{F} = \sum_{i=1}^{m} \alpha_i F_i = 0.41286 \times F_1 + 0.32745 \times F_2 + 0.15548 \times F_3 \quad (10)$$

Entrepreneurial process action ability evaluation.

Table 10
Test Results of KMO and Bartlett for Entrepreneurial Process Action Ability Evaluation

KMO Value	0.629	
Bartlett sphericity test	Approximate chi square	21.962
	Freedom	10
	Saliency	0.017

As shown in Table 10, the KMO statistic of each indicator of the entrepreneurial process action ability is 0.629, and the P value is 0.017. It is suitable for factor analysis. The specific feature value and variance contribution rate result of each indicator are shown in Table 11.

Table 11
Eigenvalue and Variance Contribution Rate of Entrepreneurial Process Action Ability Evaluation Indicators

Principal component	Characteristic value	Contribution rate	Cumulative contribution value
1	2.896	60.318%	60.318%
2	1.296	20.693%	81.011%
3	1.014	11.926%	92.937%
4	0.325	5.728%	98.665%
5	0.168	1.335%	100.000%

From Table 11, we can see that the cumulative contribution rate of the first three factors is 92.937%, which is higher than 85%. This shows that the first three factors can fully explain the indicator of the entrepreneurial process action ability. See Table 12 for the rotation load matrix.

Table 12
Rotation Load Matrix of Entrepreneurial Process Action Ability Evaluation Indicators

Index	Factor		
	F_1	F_2	F_3
B12	-0.318	0.887	-0.216
B13	-0.194	0.921	0.063
B14	0.926	-0.318	0.061
B15	0.948	-0.228	0.267
B16	0.315	-0.058	0.947

From Table 12, it can be seen that the two indicators included in the entrepreneurial project have the highest contribution to the college's entrepreneurial process action ability, followed by the entrepreneurial curriculum. The score coefficient matrix of the three factors is shown in Table 13.

Table 13
Component Score Coefficient Matrix of Entrepreneurial Process Action Ability Evaluation

Index	F_1	F_2	F_3
B12	0.227	0.583	-0.192
B13	0.131	0.646	0.153
B14	0.628	0.114	-0.189
B15	0.679	0.158	-0.225
B16	-0.314	0.016	1.137

According to Table 13, it can be concluded that the linear combination between each evaluation indicator is:

$$F_1 = 0.227\mathrm{B}_{12} + 0.131\mathrm{B}_{13} + 0.628\mathrm{B}_{14} + 0.679\mathrm{B}_{15} - 0.314\mathrm{B}_{16}$$

$$F_2 = 0.583B_{12} + 0.646B_{13} + 0.114B_{14} + 0.158B_{15} + 0.016B_{16}$$

$$F_3 = -0.192B_{12} + 0.153B_{13} - 0.189B_{14} - 0.225B_{15} + 1.137B_{16}$$

According to the factor score coefficient matrix, a comprehensive scoring model can be established:

$$F = \sum_{i=1}^{m} \alpha_i F_i = 0.58752 \times F_1 + 0.24296 \times F_2 + 0.10763 \times F_3 \quad (11)$$

Entrepreneurial result performance evaluation.

Table 14
Test results of KMO and Bartlett for Entrepreneurial Result Performance Ability Evaluation

KMO Value	0.538	
Bartlett sphericity test	Approximate chi square	24.092
	Freedom	16
	Saliency	0.025

As shown in Table 14, the KMO statistic for each indicator of entrepreneurial result performance ability is 0.538, and the P value is 0.025. It is suitable for factor analysis. See Table 15 for details of the eigenvalues and variance contribution rates of each indicator.

Table 15
Eigenvalue and Variance Contribution Rate of Entrepreneurial Result Performance Ability Evaluation Indicator

Principal component	Characteristic value	Contribution rate	Cumulative contribution value
1	3.528	51.257%	51.257%
2	1.629	19.319%	70.576%
3	1.015	17.027%	87.603%
4	0.625	9.296%	96.899%
5	0.528	2.274%	99.173%
6	0.091	0.827%	100.000%

From Table 15, we can see that the cumulative contribution rate of the first three factors is 88.048%, which is higher than 85%. This shows that the first three factors can fully explain the indicator of entrepreneurial result performance ability. See Table 16 for the rotation load matrix.

Table 16
Rotation Load Matrix of Entrepreneurial Result Performance Ability Evaluation Indicators

Index	Factor		
	F_1	F_2	F_3
B17	0.147	0.921	0.282
B18	0.139	0.895	0.168
B19	0.962	0.269	0.082
B20	0.116	0.378	0.883
B21	0.498	0.264	0.821
B22	0.892	0.047	0.491

Table 17
Component Score Coefficient Matrix of Entrepreneurial Result Performance Ability Evaluation

Index	F_1	F_2	F_3
B17	-0.069	0.593	-0.096
B18	-0.038	0.647	-0.225
B19	0.651	0.112	-0.412
B20	-0.302	-0.048	0.763
B21	0.053	-0.195	0.528
B22	0.471	-0.199	0.084

From Table 16, we can see that the two indicators included in social benefits have the highest contribution to the entrepreneurial result performance ability of colleges and universities, followed by the promotion of literacy. See Table 17 for details of the score coefficient matrix for the three factors.

According to Table 17, it can be concluded that the linear combination between each evaluation indicator is:

$$F_1 = -0.069\mathrm{B}_{17} - 0.038\mathrm{B}_{18} + 0.651\mathrm{B}_{19} - 0.302\mathrm{B}_{20} + 0.053\mathrm{B}_{21} + 0.471\mathrm{B}_{22}$$

$$F_2 = 0.593\mathrm{B}_{17} + 0.647\mathrm{B}_{18} + 0.112\mathrm{B}_{19} - 0.048\mathrm{B}_{20} - 0.195\mathrm{B}_{21} - 0.199\mathrm{B}_{22}$$

$$F_3 = -0.096\mathrm{B}_{17} - 0.225\mathrm{B}_{18} - 0.412\mathrm{B}_{19} + 0.763\mathrm{B}_{20} + 0.528\mathrm{B}_{21} + 0.084\mathrm{B}_{22}$$

According to the factor score coefficient matrix, a comprehensive scoring model can be established:

$$\mathrm{F} = \sum_{i=1}^{m} \alpha_i F_i = 0.56382 \times F_1 + 0.19274 \times F_2 + 0.11092 \times F_3 \quad (12)$$

Comprehensive evaluation. Based on the above analysis and combined with the actual data of the four universities of Renmin University of China, Tsinghua University, Wuhan University, and Heilongjiang University, the weights of the four major indicators can be calculated. See Table 18 for details.

Table 18
The Indicator Weight of The Evaluation of the Level of Entrepreneurship Education in 4 Colleges and Universities

The evaluation result of the level of entrepreneurship education	Entrepreneurial environment basic ability	Entrepreneurial resource allocation ability	Entrepreneurial process ability	Performance capability of entrepreneurial achievement
Indicator weight	0.2736	0.2248	0.2169	0.2847

The formula for comprehensive evaluation is:

$$Z_j = \omega_1 Y_{1j} + \omega_2 Y_{2j} + \cdots + \omega_m Y_{mj} = \sum_{i=1}^{m} \omega_i Y_{ij} \quad \mathrm{j}=1, 2, ..., \mathrm{n} \quad (13)$$

According to formula (13), the comprehensive evaluation results of entrepreneurship education levels in four universities can be obtained. See Table 19 for details.

Table 19
The Results Of Comprehensive Evaluation of The Level of Entrepreneurship Education in 4 Colleges and Universities

	Renmin University of China	Tsinghua University	Wuhan University	Heilongjiang University
The results of comprehensive evaluation on the level of entrepreneurship education	68.79	92.93	82.16	71.23

Conclusion

4.1 The start-up of entrepreneurship education in Chinese universities is relatively late compared to foreign countries. At present, many domestic universities and colleges have carried out entrepreneurship education

through various means. The degree of student participation is relatively high, but the overall satisfaction of students is not high. This shows that colleges and universities still need to make great efforts to promote the sustainable development of entrepreneurship education in colleges and universities.

4.2 Based on the research results of domestic and foreign experts, and according to the relevant theories of the CIPP model, this paper establishes an evaluation indicator system of college entrepreneurship education level based on the CIPP model, which mainly includes the four basic principles of environmental basis, resource allocation, process actions, and results performance, all 4 primary indicators.

4.3 Through factor analysis, the weights of indicators in the evaluation indicator system of college entrepreneurship education levels can be calculated, and the entrepreneurial education level of Renmin University of China, Tsinghua University, Wuhan University, and Heilongjiang University can be calculated based on the actual data of the four universities. The overall evaluation results were 69.79, 92.93, 82.16, and 71.23, respectively.

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