International Journal of Innovation in Science and Mathematics
Volume 7, Issue 2, ISSN (Online): 2347–9051

Comprehensive Evaluation of Undergraduate Education Quality in Jiangsu Province, China

Jian Zhang[1], Ning Wang[1] and Hui Xu[1]*
Department of Mathematics, Yanbian University, Yanji, China.
*Corresponding author email id: 1968895572@qq.com

Date of publication (dd/mm/yyyy): 11/04/2019

Abstract **– With China's increasing comprehensive national strength, China's higher education development has entered the world's top level. As a major education province in China, Jiangsu Province's undergraduate education quality development in 13 prefecture-level cities is not balanced. Firstly, this paper carries out R-type cluster analysis on general education indicators through SPSS, so as to screen out the indicators affecting the quality of undergraduate education in Jiangsu Province. Secondly, TOPSIS method is applied to evaluate and rank the educational level of 13 cities in Jiangsu Province. The multi-index comprehensive evaluation system in this paper is suitable for undergraduate education quality evaluation all over the world, and can also be applied to other evaluation problems.**

Keywords **– Comprehensive Evaluation, Correlation Analysis, R-type Clustering Analysis, TOPISI Method.**

I. INTRODUCTION

As China's comprehensive national strength continues to increase, China's higher education development has entered the upper-middle level of the world and Jiangsu Province, as a major education province in China, has a certain level of education. There are thirteen prefecture-level cities in Jiangsu Province and the quality of undergraduate education between different cities is not balanced. The purpose of this paper is to establish a suitable multi-index comprehensive evaluation system to quantitatively explain the specific imbalance of undergraduate education quality in 13 prefecture-level cities in Jiangsu Province.

Through the reference [1], we can screen out nine important and comprehensive quality evaluation indicators for undergraduate education. The evaluation indexes of education generally include the number of undergraduate colleges, the number of enrolled students, the faculty and structure, the ratio of students to teachers, the conditions and utilization of teaching, the construction of professional construction and teaching, the employment of students, the input and output of scientific research, and the construction of dual-class disciplines. This paper is based on collecting relevant index data of thirteen prefecture-level cities in Jiangsu Province and correspondingly standardizing the data. Ref [2] provides some basic data for some indicators in 13 prefecture-level cities in Jiangsu Province. On this basis, a comprehensive evaluation system for the quality of undergraduate education in Jiangsu Province was established.

II. MODEL INTRODUCTION

Considering that the correlation between the indicators is large, the information will overlap, so the index is reduced by the R-type cluster analysis. After the dimension reduction process, the new six indicators are obtained. Finally, the TOPSIS method was used to comprehensively evaluate the quality of undergraduate education in 13 prefecture-level cities in Jiangsu Province.

A. *Introduction to R-type Clustering Analysis:*

Cluster analysis is an ideal multivariate statistical technique. There are different similarities between the sam-

-ples or indicators studied. According to multiple observation indicators, the statistics that can measure the similarity between the indicators are found, and the statistics are the basis for classifying the types [3]. The indicators with greater similarity (samples) are divided into one group, and the other samples with greater similarity (indicators) are aggregated into one group until all the samples (indicators) are aggregated. Q-type clustering analysis classifies samples and R-type clustering analysis classifies variables. This study used cluster analysis to classify provinces.

B. *Introduction to TOPSIS Method:*

The TOPSIS method is an effective hybrid multi-indicator decision-making method. The TOPSIS method is a method based on the closeness of a limited number of evaluation objects and idealized targets, and is a relatively good evaluation of the existing objects [4]. Because this question is to comprehensively evaluate 13 prefecture-level cities in Jiangsu Province, there are relatively many types of evaluation indicators in different cities. Therefore, the TOPSIS method is used to comprehensively evaluate the multiple indicators of this topic. By constructing the positive ideal solution and the negative ideal solution for evaluating the quality of undergraduate education, and calculating the relative closeness of each prefecture-level city plan to the ideal program, the comprehensive evaluation of the quality of undergraduate education is carried out.

III. Model Building and Solving

Let x_1 be the number of undergraduate colleges. Let x_2 be the number of enrolled students. Let x_3 be the faculty and structure. Let x_4 be the ratio of students to teachers. Let x_5 be the conditions and utilization of teaching. Let x_6 be the construction of professional construction and teaching. Let x_7 be the employment of students. Let x_8 be the input and output of scientific research. Let x_9 be the construction of dual-class disciplines. Ref [5] gives different quantitative methods for different indicators, and Ref [6] gives specific methods for data normalization. After the quantitative processing of each indicator and the data normalization processing, the following model is established and solved.

A. *R-type Cluster Analysis:*

Ref [7] gives a correlation analysis that determines whether the indicators of the multi-index evaluation system have strong correlation. Correlation analysis was carried out on each index by SPSS, and the correlation coefficient matrix between the nine indicators was calculated as follows:

Table 1. Correlation coefficient matrix.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
X_1	1	0.92	0.91	0.31	-0.60	0.94	-0.35	0.69	0.92
X_2	0.92	1	0.99	0.34	-0.53	0.99	-0.06	0.73	0.99
X_3	0.91	0.99	1	0.39	-0.45	0.98	-0.02	0.72	0.99
X_4	0.31	0.34	0.39	1	0.21	0.33	-0.12	0.34	0.37
X_5	-0.60	-0.53	-0.45	0.21	1	-0.55	0.56	-0.41	-0.47
X_6	0.94	0.99	0.98	0.33	-0.55	1	-0.10	0.75	0.98
X_7	-0.35	-0.06	-0.02	-0.12	0.56	-0.10	1	-0.19	-0.03
X_8	0.69	0.73	0.72	0.34	-0.41	0.75	-0.19	1	0.71
X_9	0.92	0.99	0.99	0.37	-0.47	0.98	-0.03	0.71	1

From Table 1, we can see that there is a strong correlation and information overlap between some indicators. Therefore, the R-type clustering analysis of these indicators and the R-type clustering analysis of SPSS are carried out to obtain the clustering result pedigree chart as follows:

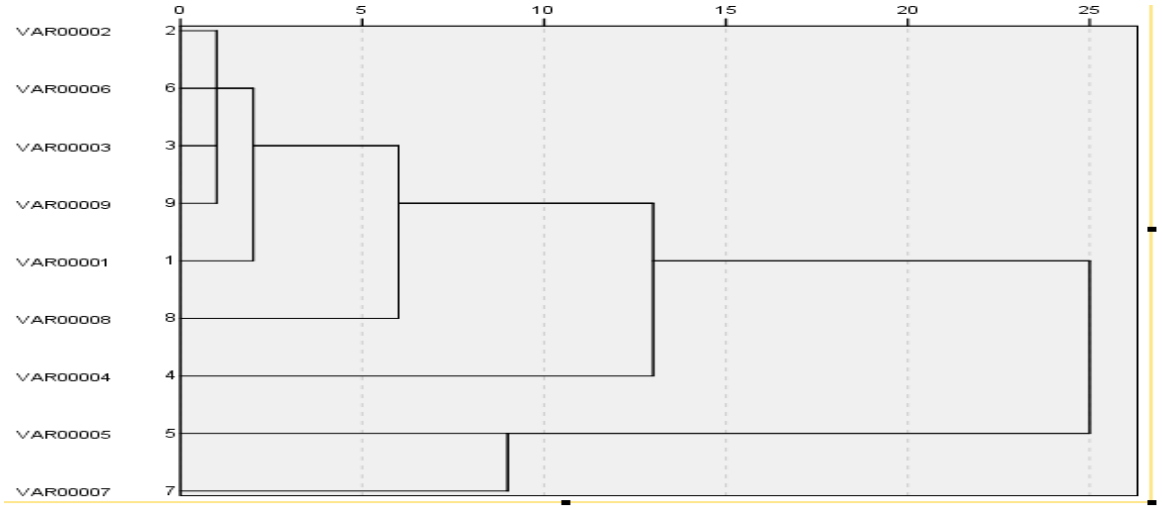


Fig. 1. Clustering result pedigree.

It can be seen from Figure 1 that there is a great correlation between the number of enrolled students, the faculty and structure of the undergraduate colleges in Jiangsu Province, the professional construction and teaching reform, and the dual-level discipline construction, which are the first to be brought together. If the indicators are divided into 6 categories, it is worthwhile to eliminate the three indicators of the faculty and structure x3, professional construction and teaching reform x6 and dual-class discipline construction x9.

B. *Comprehensive Evaluation by TOPSIS Method:*

Ref [8] gives the specific steps of TOPSIS method. The steps and results of solving this paper by TOPSIS method are given below.

Step1: Determine the weight vector of each indicator.

Assuming that the weights of the indicators are the same, the obtained weighted vector normalized attribute matrix is the same as the normalized matrix of each indicator.

Step2: Determine the positive ideal solution C* and the negative ideal solution C^0.

Positive ideal solution: . $C^* = [0.8148, 0.975, 0.4302, 0.4605, 0.2827, 0.7045,]$

Negative ideal solution:

$$C^0 = [0.0905, 0.004, 0.1104, 0.0155, 0.2568, 0] \quad (1)$$

Step3: Calculate the distance from each scheme to positive ideal s_i^* and negative ideal s_i^0.

$$s_i^* = \sqrt{\sum_{j=1}^{n}(c_{ij} - c_j^*)^2}, s_i^0 = \sqrt{\sum_{j=1}^{n}(c_{ij} - c_j^0)^2} \quad (2)$$

$i = 1, 2, \ldots, 13$; j = 1, 2 ... 6

Step 4 calculates the ranking index value (comprehensive evaluation index) of each scheme.

$$f_i^* = s_i^0/(s_i^0 + s_i^*), i = 1,2,\dots 13 \quad (3)$$

Step 5: The order of 13 prefecture-level cities in Jiangsu Province from superiority to inferiority can be determined by the size of the values as follows:

Table 2. Evaluation results.

s_i^*	s_i^0	f_i^*	City	Rank
1.4293	0.4467	0.7619	Nan Jing	1
0.2903	1.2894	0.1838	Wu Xi	9
0.2306	1.2882	0.1518	Xu Zhou	10
0.1909	1.3459	0.1242	Chang Zhou	13
0.4644	1.1349	0.2904	Su Zhou	3
0.5077	1.347	0.2737	Nan Tong	5
0.3594	1.3828	0.2063	Lian Yun Gang	8
0.21	1.3658	0.1333	Huai An	12
0.2192	1.3843	0.1367	Yan Cheng	11
0.6888	1.205	0.3637	Yang Zhou	2
0.352	1.3006	0.213	Zhen Jiang	7
0.5485	1.4014	0.2813	Tai Zhou	4
0.3883	1.4082	0.2162	Su Qian	6

IV. Research Conclusion

Studies have shown that among the thirteen prefecture-level cities in Jiangsu Province, the quality of undergraduate education in Nanjing, Yangzhou and Suzhou is the best. The relatively poor quality of undergraduate education is Changzhou. Judging from the economic development level of various cities in Jiangsu Province, the city with good quality of undergraduate education is more developed. This verifies the reliability of the evaluation results of the multi-index comprehensive evaluation system. Ref [9] gives the urban development status of thirteen prefecture-level cities in Jiangsu Province. According to the conclusions of this paper, we can conclude that local development has a positive correlation with the quality of undergraduate education. On the one hand, the multi-index comprehensive evaluation system cuts off redundant and useless indicators, and on the other hand makes the relative merits of the evaluation objects stand out. Therefore, the multi-index evaluation system has its advantages and can be applied to other evaluation questions.

In this paper, the multi-index comprehensive evaluation system not only deletes the redundant and useless indicators, but also makes the relative merits and demerits of the evaluation object prominent. Therefore, the multi-index evaluation system has its advantages and can be applied to other evaluation problems.

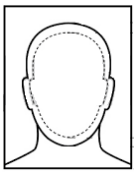
However, the data collected in this paper is manual, and there may be errors. And there are only nine initial evaluation indicators. If we can collect more comprehensive indicators and more sufficient data, we can further improve the evaluation system.

REFERENCES

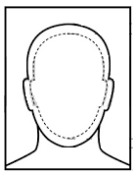
[1] Dong Haiyan. Internationalization of Undergraduate Teaching Quality Evaluation Indicators and Security System in China [D]. Nanjing University of Science and Technology, 2004.
[2] 《Report on Undergraduate Teaching Quality of Jiangsu Universities in 2014 》http://www.ec.js.edu.cn/col/col14161/index.html，2018-8-22
[3] Bo Yin. A new method for determining the number of principal components [J]. Statistics and decision-making, 2010 (19): 8-10.
[4] Xia Yongqi, Wu Qizong. A TOPSIS Method for Hybrid Multi-attribute Decision Problems [J]. Journal of Systems Engineering, 2004, 19(6): 630-634.
[5] Li Shaozhu. Reflections on the "Indicator-Quantification" Model of Educational Evaluation [J]. Journal of Nanjing Normal University: Social Science Edition, 1993(4): 45-49.
[6] Cao Jiayue, Wang Yongxing, Zhou Xiaolan, et al. Data processing of quantitative indicators and its application in nursing quality evaluation [J].Journal of Nursing Management, 2004, 4(8): 24-26.
[7] Du Jian, Zhang Wei. Correlation Analysis of Academic Influence Evaluation Indicators——Based on the Perspective of a Subdivision Subject in Medical Field [J]. Evaluation and Management, 2010(4): 68-76.
[8] Si Shoukui, Sun Zhaoliang. Mathematical Modeling Algorithm and Application [M]. Beijing: National Defense Industry Press 2016.380~384.
[9] Bai Xianchun, Ling Wei, Guo Cunzhi. Comprehensive Evaluation of Urban Development Quality——Taking 13 Provincial Cities in Jiangsu Province as an Example [J]. China Population Resources and Environment, 2004, 14(6): 91-95.

AUTHORS PROFILE'

First A. Author
Jian Zhang 1998
Student study in the department of mathematics in Yanbian University (Yanji, China).
email id: 1968895572@qq.com



Second B. Author
Ning Wang 1997
Student study in the department of mathematics in Sichuan Normal University (Cheng Du, China)



Hui Xu:
Associate Professor and master tutor of mathematics department, School of science, Yanbian University. Main research directions:
Mathematics education technology, mathematical modeling, intelligent algorithm