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## Evaluation system of classroom teaching quality for PCA-based ideology and politics in colleges and universities

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### ABSTRACT

To reveal the relationship between the classroom teaching quality and level of Ideology and Politics in colleges and universities and their influencing factors, PCA (Principal Component Analysis) is used to conduct its quantitative analysis. In this analysis, the relationship between the factors, such as teaching quality and level, teaching objectives and methods, teaching content, teaching language, teaching bearing, blackboard-writing, teaching process, student performance and others, is studied. As a result, a quantitative relation between the teaching quality and level and their influencing factors is obtained, which provides a decision-making basis for improving the classroom teaching level and quality.

### KEYWORDS

Principal component analysis; Ideology and politics; Classroom teaching; Quantitative analysis



## INTRODUCTION

Since the reform and opening up, the classroom teaching reform of Ideology and Politics Theory is continued and enjoyed great achievements throughout Chinese colleges and universities. However, previous reforms are mostly concentrated on the teaching contents and classroom settings. Nonetheless, the reform related to the evaluation on teaching index system is quite lagging behind. Though teachers engaged in the teaching of Ideology and Politics Theory classroom also attach great importance to the research and summary of teaching experience and methods, weighty research results of classroom teaching evaluation index system are still rare. Hence, it seems extremely important and urgent to explore the new form, new method, new way and new idea of Marxist Ideology and Politics Theory education under new situation.

Based on the above analysis, the fundamentality to improve the classroom teaching quality and level of Ideology and Politics in colleges and universities is to study the classroom teaching evaluation index and its system. In the form of questionnaire and by means of drawing on others' wisdom and successful experiences, this paper obtains a quantitative relation between the classroom teaching quality of Ideology and Politics and its affecting factors through PCA, which provides a decision-making basis for improving its classroom teaching level and quality.

### PCA (PRINCIPAL COMPONENT ANALYSIS)

#### Basic thought of PCA

Principal Component Analysis is to substitute many original variables by finding out several aggregative variables through adopting a dimensionality reduction in mathematics. Therefore, these aggregative variables can replace the information amount of original variables as much as possible, and they are irreverent between each other. The statistics analysis method that changes many variables into several unrelated aggregative ones is called Principal Component Analysis.

#### Mathematical model of PCA

For the sample data,  $P$  variables,  $x_1, x_2, \dots, x_p$ , are observed. The digital data matrix of  $n$  samples is as follows:

$$X = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{pmatrix} = (x_1, x_2, \dots, x_p)$$

$$x_j = \begin{pmatrix} x_{1j} \\ x_{2j} \\ \vdots \\ x_{nj} \end{pmatrix}, \quad j = 1, 2, \dots, p$$

Wherein:

PCA is to aggregate  $P$  observed variable into  $P$  new variables (aggregative variables), namely

$$\begin{cases} F_1 = a_{11}x_1 + a_{12}x_2 + \cdots + a_{1p}x_p \\ F_2 = a_{21}x_1 + a_{22}x_2 + \cdots + a_{2p}x_p \\ \dots \\ F_p = a_{p1}x_1 + a_{p2}x_2 + \cdots + a_{pp}x_p \end{cases}$$

Namely:

$$F_j = \alpha_{j1}x_1 + \alpha_{j2}x_2 + \cdots + \alpha_{jp}x_p$$

$$j = 1, 2, \dots, p$$

The models are required to meet the following conditions:

$$F_i, F_j \text{ are unrelated } (i \neq j, i, j = 1, 2, \dots, p)$$

The variance of  $F_1$  is greater than the variance of  $F_2$ , and the latter is larger than the variance of  $F_3$ . Then we can analogize in order

$$a_{k1}^2 + a_{k2}^2 + \cdots + a_{kp}^2 = 1 \quad k = 1, 2, \dots, p.$$

Thus,  $F_1$  is called the first principal component, and  $F_2$  is the second principal component. Similarly, there are  $P$

th principal components. Principal component is also known as the main component. Here  $a_{ij}$  is called the principal component coefficient.

The above-described model can be represented as a matrix:

$F = AX$ , wherein:

$$F = \begin{pmatrix} F_1 \\ F_2 \\ \vdots \\ F_p \end{pmatrix} \quad X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_p \end{pmatrix}$$

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1p} \\ a_{21} & a_{22} & \cdots & a_{2p} \\ \vdots & \vdots & \vdots & \vdots \\ a_{p1} & a_{p2} & \cdots & a_{pp} \end{pmatrix} = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_p \end{pmatrix}$$

$A$  is called the matrix of the principal component coefficient.

### RESEARCH OBJECTS AND DATA SOURCES

To reveal the relationship between the classroom teaching quality and level of Ideology and Politics in colleges and universities and their influencing factors, the analytical data in the paper is acquired by questionnaire, whose objects include both students and teachers.

#### Basic situation of students

There are 60.7% boys and 39.3% girls; 2.4% college students, 25% freshmen in universities, 17.3% fresh graduates, 47% undergraduates in other grades, and 8.3% graduates and doctors; 38.4% students in Humanities and Social Sciences and Management Department, 52.7% students in Engineering, Agriculture and Medicine Department, 0.9% in Arts and Sports, and 8% in other majors; 22.3% communists, 73% Youth League members, 1.4% members of democratic parties, and 3.2% of the mass; 14.5% from big cities, 14.5% students from medium cities, 16.7% from small cities, 15.3% from villages and towns, and 39% in rural areas; 87.3% atheists, 6.7% Buddhists, 1.6% Taoists, 1.2% Muslims, 1.9% Christians, 0.6% Catholics, 0.8% in other religions. More than 200 people participate in the discussion and interview (28).

#### Basic situation of teachers

Seen from the professional structure, teachers in the Humanities and Social Sciences and Management Department and teachers in Engineering, Agriculture and Medicine Department account for 45.9% and 46.1%, respectively; from the age structure, teachers between 25-30, 31-40, 41-50 and over 50 are 27.9%, 35.5%, 23.7% and 12.9%, respectively; from the title structure, there are 19.9%, 29.8%, 32.6% and 17.7% teachers in primary, intermediate, deputy senior, senior titles, respectively; from the political aspect, the communists take up 67.8%, Youth League members are 7.1%, members of democratic parties make up 3.3%, and the mass accounts for 21.8%; from the national property, the Han is 95.2% while 4.8% are minority teachers; from the religious perspective, 6% teachers are religious, wherein 2.5% is Buddhists (29).

One thousand papers are extracted as the sample questionnaires here, including 200 copies of teachers engaged in Ideology and Politics, and 800 students in colleges and universities.

### PCA

#### Statistical test

Set the significance level as 0.05. The selected data is made KMO and Bartlett's Test of Sphericity, whose results are shown in Figure 1:

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.604
Bartlett's Test of Sphericity	Approx. Chi-Square	56.843
	df	28
	Sig.	.001

Figure 1 KMO and Bartlett's Test of Sphericity

As known from Figure 1, the statistics of KMO is  $0.604 > 0.5$ , the statistics of Bartlett's Test of Sphericity is 56.843, and the significance probability equals to  $0.001 < 0.05$ . Therefore, the null hypothesis of Bartlett Test of Sphericity is rejected. Hence, the index data affecting the translation capacity are more suitable for PCA.

**Determination of common factors**

According to the standards that the eigenvalue is greater than 1 and the cumulative contribution rate is more than 80%, the extraction result of PCA is shown as Figure 2:

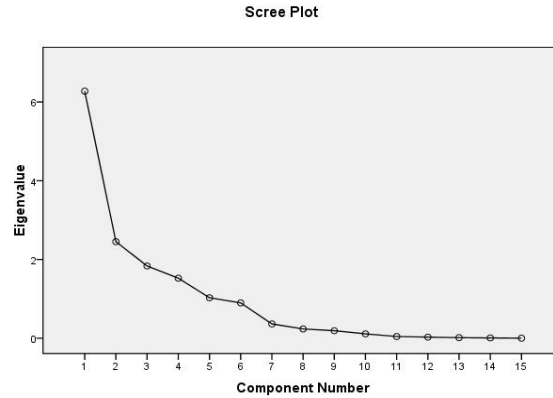


Figure 2 Scree Plot

As known from Figure 2, the eigenvalue curve in Scree Plot Figure appears the turning point at Factor 5. Therefore, the common factor is extracted from the first 5 factors. As seen from Figure 1, among 5 factors with the eigenvalue greater than 1, the first 4 factors have the cumulative contribution rate of  $80.571\% > 80\%$ . Hence, these 4 factors can reflect the affecting factors of classroom teaching quality of Ideology and Politics well.

Table 1 Eigenvalues of the Related Matrix R

	Initial Eigenvalues			Eigenvalues after extracting 4 factors and rotating orthogonally		
	Eigenvalue	Proportion	Cumulation	Eigenvalue	Proportion	Cumulation
1	6.274	41.829	41.829	5.278	35.189	35.189
2	2.453	16.352	58.181	2.477	16.511	51.700
3	1.834	12.227	70.408	2.462	16.413	68.112
4	1.525	10.164	80.571	1.869	12.459	80.571
5	1.028	6.853	87.424			
6	0.897	5.977	93.402			
7	0.362	4.415	97.816			
8	0.235	2.184	100			

**Establishment of factor loading matrix**

The factor loading matrix is calculated by means of varimax rotation, whose result is shown as Table 2 below:

Table 2 Factor Loading Matrix

	Component			
	1	2	3	4
Teaching objectives and methods x1	.926	-.084	.058	-.183
Teaching content x2	.914	-.197	.187	.204
Teaching language x3	.906	.142	.227	.059
Teaching bearing x4	.901	-.129	.220	.270
Blackboard-writing x5	.881	.359	.171	.002
Teaching process x6	.215	.888	.184	.060
Student performance x7	-.437	.758	-.060	.375
Teaching result x8	.358	.562	-.277	-.210

### Calculation of factor score

Table 3 Factor Score Matrix

	Component			
	1	2	3	4
Teaching objectives and methods x1	.170	-.039	-.018	.120
Teaching content x2	.047	-.052	-.470	.087
Teaching language x3	.180	.150	-.021	-.019
Teaching bearing x4	.212	-.031	-.114	-.121
Blackboard-writing x5	.090	-.031	.094	-.327
Teaching process x6	-.017	-.023	.020	.252
Student performance x7	.145	-.118	-.295	.356
Teaching result x8	-.101	.298	.063	.216

According to the factor score matrix in Table 3, the linear computational score model of each factor can be constructed, which is shown as the following formula specifically:

$$F_1 = 0.170x_1 + 0.047x_2 + \dots - 0.101x_8$$

$$F_2 = -0.039x_1 - 0.052x_2 + \dots + 0.298x_8$$

$$F_3 = -0.018x_1 - 0.470x_2 + \dots + 0.063x_8$$

$$F_4 = 0.120x_1 + 0.087x_2 + \dots + 0.216x_8$$

Combined with the contribution rate of each common factor in the variable variance (Table 1), it can be inferred that the mathematical evaluation model of classroom teaching quality of Ideology and Politics is as follows:

$$F = 0.35189F_1 + 0.16511F_2 + 0.16413F_3 + 0.12459F_4$$

### CONCLUSION

The relationship between the classroom teaching quality and level of Ideology and Politics in colleges and universities and their influencing factors is revealed in this paper by PCA. By means of factor extraction, calculation of factor score and other methods, a quantitative relation between the teaching quality and level and their influencing factors is obtained, which achieves its quantitative calculation and evaluation and provides a decision-making basis for improving the its classroom teaching level and quality.

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