

# Comprehensive Evaluation Model of Ideological and Political Classroom Teaching Combining the Fuzzy Hierarchical Statistical Model

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## Abstract:

The ideological and political education of college students is the lifeline of higher education work. In this paper, an evaluation indicator system for the effectiveness of ideological and political education in college students is established. In addition, the AHP method is used to determine the weight of indicators at various levels. Based on the fuzzy hierarchical statistical model, the effectiveness level of ideological and political education in college students is divided into five evaluation levels, that is, excellent, good, medium, qualified and failed, and an evaluation team is set up to grade the indicators of the evaluation objects and determine the degree of membership for the indicators at each level accordingly. A multi-level fuzzy comprehensive evaluation model for the effectiveness of ideological and political education in college students is established, which has implemented the quantitative treatment of a qualitative problem. To verify the evaluation effect of the evaluation model, the student of the Department of Social Sciences in grade 2018 with the student number 20180143 is selected to carry out the evaluation, and the evaluation results are compared with the those of the existing methods. The evaluation results are consistent, which suggest that the model can be used for the effectiveness evaluation of the ideological and political education in college students.

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## I. INTRODUCTION

The ideological and political education of college students is the lifeline of higher education work<sup>[1-2]</sup>. As the main front of the ideological and political education in college students, colleges and universities should increase investment in the ideological and political education of college students, strengthen the building of ideological and political teaching and research teams, and enrich the forms of ideological and political education for college students. On the other

hand, they should carry out a comprehensive evaluation of the effectiveness of the ideological and political education in college students, accurately grasp the ideological and political education status in college students and conduct targeted educational activities<sup>[3-6]</sup>. In order to carry out the effectiveness evaluation of ideological and political education in college students effectively, many experts and scholars have conducted a series of fruitful research work and achieved some results<sup>[7]</sup>. Some scholars in China have

started their studies from five aspects: educators, educational objects, educational contents, educational methods and educational situations<sup>[8]</sup> to establish an indicator system for the effectiveness evaluation of the ideological and political education in college students. However, the system is complicated, and no quantitative weights are provided<sup>[9]</sup>. Some other scholars<sup>[9-10]</sup> take the postgraduate network ideological and political education as the research object and establish an evaluation indicator system in a targeted manner. They have also established an evaluation indicator system based on the overall effectiveness of the ideological and political education in colleges and universities to evaluate and guide the ideological and political education in the colleges and universities<sup>[11-13]</sup>.

In this paper, based on the fuzzy hierarchical statistical model, through the full consideration of the ideological quality, political quality, moral quality, legal quality, and psychological quality of college students, a fuzzy comprehensive evaluation model for the effectiveness of the ideological and political quality education in college students is established. In addition, practical examples are combined to verify the evaluation effect of the model, so as to improve the effectiveness evaluation system for the ideological and political education in college students.

## II. ESTABLISHMENT OF FUZZY COMPREHENSIVE EVALUATION MODEL FOR THE EFFECTIVENESS OF IDEOLOGICAL AND POLITICAL EDUCATION IN COLLEGE STUDENTS

Under the condition of multi-factor constraints, the comprehensive evaluation of the effectiveness of ideological and political education in college students has the characteristics that the relationship between the evaluation indicators and the evaluation results is not clear, the evaluation domain is difficult to quantify and non-deterministic, and so on. Hence, the establishment of a fuzzy comprehensive evaluation model by

using the fuzzy comprehensive evaluation method can be considered to quantify the comprehensive non-linear evaluation domain, perform quantitative treatment on the qualitative problems, and finally obtain clear evaluation results. Based on the AHP method and fuzzy hierarchical statistical model, the construction steps of the effectiveness evaluation model for the ideological and political education in college students are as the following:

### *A. Establishment of a Comprehensive Indicator System for the Effectiveness Evaluation of Ideological and Political Education in College Students*

The theoretical connotation of the effectiveness evaluation of the ideological and political education in college students is taken as the starting point, the research results and the actual work of previous scholars are combined to establish a three-level comprehensive indicator system for the effectiveness evaluation of the ideological and political education in college students. The first-level indicators (target layer) in the evaluation indicator system are set as the effectiveness of ideological and political education in college students. The first-level indicators have five subordinated second-level indicators, and the second-level indicators are further broken down into 17 three-level indicators. The detailed structure of the indicator evaluation system is shown in Table 1 as the following. According to Table 1, the set of factors at each level of indicators can be summarized. For example, the set of the first-level indicators can be summarized as the following:  
 $I = \{I_1, I_2, I_3, I_4, I_5\} = \{\text{Ideological quality, political quality, moral quality, legal quality, psychological quality}\}.$

Table 1 Comprehensive indicator system and weight for the effectiveness evaluation of the ideological and political education in college students

First-level indicator	Coding	Second-level indicator	Weight	Coding	Third-level indicator	Single weight	Total weight
Ideological and political quality of college students I	I <sub>1</sub>	Ideological quality	0.389	I <sub>1,1</sub>	Ideal and faith	0.125	0.049
				I <sub>1,2</sub>	View of life and values	0.260	0.101
				I <sub>1,3</sub>	Patriotism and national spirit	0.547	0.213
				I <sub>1,4</sub>	Learning attitude	0.068	0.026
	I <sub>2</sub>	Political quality	0.389	I <sub>2,1</sub>	Marxist theoretical quality	0.105	0.041
				I <sub>2,2</sub>	Political behavior	0.636	0.247
				I <sub>2,3</sub>	Political practice ability	0.259	0.101
				I <sub>2,4</sub>	Collectivism	0.649	0.034
	I <sub>3</sub>	Moral quality	0.053	I <sub>3,1</sub>	Social morality	0.279	0.015
				I <sub>3,2</sub>	Family morality	0.072	0.004
				I <sub>3,3</sub>	Legal knowledge	0.105	0.012
				I <sub>3,4</sub>	Legal concept	0.259	0.030
	I <sub>4</sub>	Legal quality	0.116	I <sub>4,1</sub>	Legal conduct	0.636	0.074
				I <sub>4,2</sub>	Self-awareness of emotional personality	0.055	0.003
				I <sub>4,3</sub>	Consciousness quality	0.262	0.014
				I <sub>4,4</sub>	and psychology of love	0.565	0.034
	I <sub>5</sub>	Psychological quality	0.053	I <sub>5,1</sub>	Mental health	0.034	0.006
				I <sub>5,2</sub>	Mental outlook	0.118	0.006

Where  $\lambda_{\max} = 5.136$ ,  $CI = 0.034$ ,  $RI = 1.12$ ,  
 $CR = 0.0303$

Table 3: Judgment matrix, weight and consistency test of indicator I<sub>1</sub> items

Name	I <sub>1,1</sub>	I <sub>1,2</sub>	I <sub>1,3</sub>	I <sub>1,4</sub>	Weight (eigenvector)
I <sub>1,1</sub>	1	1/3	1/5	3	0.125
I <sub>1,2</sub>	3	1	1/3	4	0.260
I <sub>1,3</sub>	5	3	1	5	0.547
I <sub>1,4</sub>	1/3	1/4	1/5	1	0.068

Where  $\lambda_{\max} = 4.189$ ,  $CI = 0.063$ ,  $RI = 0.89$ ,  
 $CR = 0.0708$

Table 4: Judgment matrix, weight and consistency test of indicator I<sub>2</sub> items

Name	I <sub>2,1</sub>	I <sub>2,2</sub>	I <sub>2,3</sub>	Weight (eigenvector)
I <sub>2,1</sub>	1	1/5	1/3	0.105
I <sub>2,2</sub>	5	1	3	0.636
I <sub>2,3</sub>	3	1/3	1	0.259

Where  $\lambda_{\max} = 3.039$ ,  $CI = 0.020$ ,  $RI = 0.52$ ,  
 $CR = 0.0375$

Table 5: Judgment matrix, weight and consistency test of indicator I<sub>3</sub> items

Name	I <sub>3,1</sub>	I <sub>3,2</sub>	I <sub>3,3</sub>	Weight (eigenvector)
I <sub>3,1</sub>	1	3	7	0.649
I <sub>3,2</sub>	1/3	1	5	0.279
I <sub>3,3</sub>	1/7	1/5	1	0.072

Where  $\lambda_{\max} = 3.065$ ,  $CI = 0.033$ ,  $RI = 0.52$ ,  
 $CR = 0.0625$

### B. Establishment of the Effectiveness Evaluation Set of Ideological and Political Education in College Students

The effectiveness level of ideological and political education in college students is set to five levels, that is, the evaluation set is determined as the following:  
 $V = \{V_1, V_2, V_3, V_4, V_5\} = \{\text{excellent, good, medium, qualified, failed}\}$ . If the percentage system is used to indicate the evaluation level, the 5-level score interval can be determined as the following: Excellent  $\in [90, 100]$ , good  $\in [80, 90)$ , medium  $\in [70, 80)$ , qualified  $\in [60, 70)$ , and failed  $\in [0, 60)$ .

### C. Application of AHP Method to Determine the Set of Indicator Weights at Various Levels

In this paper, the AHP method is used to determine the weights of indicators at all levels and implement the quantitative treatment of qualitative problems. The specific implementation steps are as the following: expert evaluation, the establishment of evaluation matrix, hierarchical order arrangement, consistency test and so on. Table 2 - Table 7 set out the evaluation matrix of the evaluation indicators at all levels as well as the consistency test results. The relative importance of each indicator in the evaluation matrix is determined by using the scale method of 1-9.

Table 2 Judgment matrix, weight and consistency test of Indicator I

Table 6: Judgment matrix, weight and consistency test of indicator  $I_4$  items

Name	$I_{4,1}$	$I_{4,2}$	$I_{4,3}$	Weight (eigenvector)
$I_{4,1}$	1	1/3	1/5	0.105
$I_{4,2}$	3	1	1/3	0.259
$I_{4,3}$	5	3	1	0.636

Where  $\lambda_{\max} = 3.039$ ,  $CI = 0.020$ ,  $RI = 0.52$ ,  
 $CR = 0.0375$

Table 7: Judgment matrix, weight and consistency test of indicator  $I_5$  items

Name	$I_{5,1}$	$I_{5,2}$	$I_{5,3}$	$I_{5,4}$	Weight (eigenvector)
$I_{5,1}$	1	1/5	1/7	1/3	0.055
$I_{5,2}$	5	1	1/3	3	0.262
$I_{5,3}$	7	3	1	5	0.565
$I_{5,4}$	3	1/3	1/5	1	0.118

Where  $\lambda_{\max} = 4.117$ ,  $CI = 0.039$ ,  $RI = 0.89$ ,  
 $CR = 0.0438$

The results of the combined consistency test of the third-level indicator item to the first-level indicator item are as the following:  $CI = 0.068$ ,  $RI = 1.21$ , and  $CR = 0.0865$ . From the above analysis, it can be seen that the GR values of the consistency test indicators for the indicator items at all levels are less than 0.10. Hence, the weights of the indicators determined thereby can meet the consistency requirement.

## 2.4 Determination of Fuzzy Comprehensive Evaluation Set at Various Levels

The fuzzy comprehensive evaluation model for the effectiveness of ideological and political education in college students includes multi-level evaluation indicators. The determination of the evaluation set should be processed from the low level to the high level, and the final effectiveness evaluation result can be obtained at the highest level. The specific implementation steps are as the following:

(1) The subset  $R_{ik}$  of the three-level indicator item k subordinate to the second-level indicator item i is obtained as shown in formula 1:

$$R_{ik} = \{r_{ik1}, r_{ik2}, r_{ik3}, r_{ik4}, r_{ik5}\}, \sum_{m=1}^5 r_{ikm} = 1$$

(1)

In the above equation (1): I - the i-th second-level indicator item; k - a third-level indicator item that falls in i; m - a certain evaluation level,  $m \in V$ ;  $r_{ikm}$  - k indicator's degree of membership to the m evaluation level, and its value is equal to the ratio of the number of assessment team member that determines the k factor falling in m level to the total number of assessment team members;  $R_{ik}$  - k indicator evaluation subset.

2) All the single factor evaluation subsets  $R_{ik}$  that fall in the second level indicator item i are arranged in turn to obtain the fuzzy evaluation matrix  $R_i$  of the second level indicator item i. For example, the fuzzy evaluation subset  $R_2$  corresponding to the indicator item  $I_2 = \{\text{political quality}\}$  is as shown in equation (2):

$$R_2 = \begin{bmatrix} r_{211} & r_{212} & r_{213} & r_{214} & r_{215} \\ r_{221} & r_{222} & r_{223} & r_{224} & r_{225} \\ r_{231} & r_{232} & r_{233} & r_{234} & r_{235} \end{bmatrix}$$

(2)

3) From the above analysis, the fuzzy comprehensive evaluation matrix of the evaluation target  $I_i$  indicator can be obtained as the following:  $B_i = I_i R_i$  ( $i = 1, 2, 3, 4, 5$ ). Subsequently, the fuzzy comprehensive evaluation set B of the evaluation model for the indicators in the first level can be further obtained as shown in equation (3):

$$B = I \cdot R = I \cdot \begin{bmatrix} I_1 \cdot R_1 \\ I_2 \cdot R_2 \\ I_3 \cdot R_3 \\ I_4 \cdot R_4 \\ I_5 \cdot R_5 \end{bmatrix} \quad (3)$$

### 2.5 Determination of the Degree of Membership of Indicators at Each Level through Expert Evaluation

In order to determine the degree of membership of the indicators at each level, N evaluation experts can be invited to carry out the indicator assessment and rating. The evaluation work is conducted item by item, focusing on the indicator items in the three levels. The evaluation results are introduced into the following equation, and the membership degree of each indicator can be calculated.

$$r_{ij} = \frac{\text{Number of times where } A_j \in V_i}{N} \quad (4)$$

In the above equation (4),  $r_{ij}$  - the membership degree of the third-level indicator item j in the expert evaluation result; N - the total number of the effectiveness evaluation samples;  $A_j$  - the evaluation score of the third-level indicator item j by the evaluation personnel.

### 2.6 Determination of the Effectiveness Evaluation Result of Ideological and Political Education in College Students

In order to improve the accuracy of the evaluation results of the ideological and political education in college students, based on the above evaluation set V, the median values of each evaluation level interval for  $V_1 - V_5$ , that is, 95 points, 85 points, 75 points, 65 points, and 30 points, are taken as the boundary value assignment for each level. The corresponding evaluation criteria set can be obtained as the following:  $S = \{S_1, S_2, \dots, S_m\} = \{95, 85, 75, 65, 30\}$ . In this way, the optimal evaluation, that is, 100% is rated as excellent, and the corresponding score is 95 points (not 100 points); the poorest evaluation, that is, 100% is rated as failed, and the score is 30 points (not 0 points). Finally, the P-value of the effectiveness comprehensive evaluation result can be obtained according to the following equation. Thus, the effectiveness

level of the evaluation object can be obtained according to the distribution of the P value in the evaluation set V as shown in equation (5).

$$P = B' \times S = \sum_{m=1}^5 r_m \times S_m \quad (5)$$

In the above equation,  $B'$  stands for the normalized vector of the comprehensive evaluation set B for the fuzzy comprehensive evaluation of the first-level indicators.

## 3. EFFECT VERIFICATION OF THE EFFECTIVENESS FUZZY COMPREHENSIVE EVALUATION OF IDEOLOGICAL AND POLITICAL EDUCATION IN COLLEGE STUDENTS

### 3.1 Selection of Evaluation Cases for Verification

Domestic scholars have established an indicator system for the effectiveness evaluation of ideological and political education in college students from the four aspects, that is, the ideological quality, political quality, moral quality, and psychological quality. In addition, the weights of indicators at all levels are determined by the AHP method. In the practical assessment, the team scoring method is adopted. The highest score and the lowest score are removed, and the final weighted average score is taken as the score for each indicator. Combined with the weights of the indicators, the final evaluation value is obtained. This method is used to evaluate the effectiveness of ideological and political education in the students of grade 2018 with the student number of 201814003 in the social science department of a university. The evaluation results are as the following: ideological quality  $B_1 = 81.43$  points, political quality  $B_2 = 82.33$  points, moral quality  $B_3 = 82.50$  points, psychological quality  $B_4 = 80.53$  points; effectiveness comprehensive evaluation score  $A = 81.75$  points. The evaluation result is determined to be good.



### 3.2 Determination of Each Factor Weight Set of the Evaluation Indicator System

$$I = \{I_1, I_2, I_3, I_4, I_5\} = \{0.389, 0.389, 0.053, 0.116, 0.053\}$$

$$I_1 = \{I_{1,1}, I_{1,2}, I_{1,3}, I_{1,4}\} = \{0.125, 0.260, 0.547, 0.068\}$$

$$I_2 = \{I_{2,1}, I_{2,2}, I_{2,3}\} = \{0.105, 0.636, 0.259\}$$

$$I_3 = \{I_{3,1}, I_{3,2}, I_{3,3}\} = \{0.649, 0.279, 0.072\}$$

$$I_4 = \{I_{4,1}, I_{4,2}, I_{4,3}\} = \{0.105, 0.259, 0.636\}$$

$$I_5 = \{I_{5,1}, I_{5,2}, I_{5,3}, I_{5,4}\} = \{0.055, 0.262, 0.565, 0.118\}$$

### 3.3 Determination of the Degree of Membership through Group Assessment

In order to determine the degree of membership of the indicators at each level, 10 teachers and students who are familiar with the situation of the student with the student number 2018014003 to establish an assessment team in this paper. The 17 indicators in third levels are rated item by item in strict accordance with the pre-established evaluation criteria and the rating level description table, and the conversion from qualitative evaluation to quantitative evaluation is implemented. Table 8 shows the summary of the assessment and rating results of the indicators in the three levels.

Table 8 Summary of the rating results of the indicator items in the three levels by the assessment team

Description	Excellent	Good	Medium	Qualified	Failed
$I_{1,1}$	2	3	3	2	0
$I_{1,2}$	2	3	2	3	0
$I_{1,3}$	4	3	2	1	0
$I_{1,4}$	2	3	3	1	1
$I_{2,1}$	3	4	2	1	0
$I_{2,2}$	4	3	1	2	0
$I_{2,3}$	1	3	3	2	1
$I_{3,1}$	3	3	3	0	1
$I_{3,2}$	4	4	0	2	0
$I_{3,3}$	4	2	2	2	0
$I_{4,1}$	3	4	3	2	1
$I_{4,2}$	3	3	2	1	1
$I_{4,3}$	2	4	3	1	0
$I_{5,1}$	2	4	2	1	1
$I_{5,2}$		3	2	3	2
$I_{5,3}$	1	0	4	4	1
$I_{5,4}$	1	3	3	2	1

Table 9 Evaluation team rating rank table

Serial number	$I_{1,1}$	$I_{1,2}$	$I_{1,3}$	$I_{1,4}$	$I_{2,1}$	$I_{2,2}$	$I_{2,3}$	$I_{3,1}$	$I_{3,2}$	$I_{3,3}$	$I_{4,1}$	$I_{4,2}$	$I_{4,3}$	$I_{5,1}$	$I_{5,2}$	$I_{5,3}$	$I_{5,4}$
1	3	9	5	12	2	7	8	4	10	1	13	6	11	14	15	17	16
72	2	7	8	10	5	12	14	6	4	3	11	1	9	16	17	15	13
3	8	11	4	5	10	3	14	13	2	1	16	7	6	9	17	15	12
4	7	10	2	14	5	3	12	9	1	4	17	6	11	15	16	13	8
5	9	6	3	16	4	7	15	11	5	1	13	2	8	17	12	10	14
6	8	11	2	16	4	3	14	9	1	5	12	6	13	7	15	10	17
17	8	13	2	14	5	3	16	11	1	4	9	6	7	12	17	15	10
8	13	8	2	12	3	4	10	9	1	7	17	6	5	15	11	16	14
9	8	11	4	17	6	3	5	12	2	1	14	7	15	13	10	9	16
10	8	10	3	11	4	2	13	9	1	5	14	6	7	15	16	17	12

In addition, according to the scores for each indicator rated by the evaluation team members, the ranking table of the indicators in the three levels is obtained, as shown in Table 9. The Kendall coordination coefficient W test is carried out on the data in Table 9 by using the statistical analysis software SPSS, to test the consistency of the scores given by the 10 team members. The test results are as the following:  $W = 0.709$ ,  $P < \alpha = 0.05$ . Hence, under the condition of  $\alpha = 0.05$ , the assessment team has given consistent scores to the 17 indicators for the assessment target in the third levels.

The data in Table 8 can be normalized to obtain the degree of membership for the indicators in the three levels (as shown in Table 10).

Table 10 Summary of the membership degree of evaluation indicators at each level

Description	Excellent	Good	Medium	Qualified	Failed
$R_1$	0.2	0.3	0.3	0.2	0
	0.2	0.3	0.2	0.3	0
	0.4	0.3	0.2	0.1	0
	0.2	0.3	0.3	0.1	0.1
$R_2$	0.3	0.4	0.2	0.1	0
	0.4	0.3	0.1	0.2	0
	0.1	0.3	0.3	0.2	0.1
	0.3	0.3	0.3	0	0.1
$R_3$	0.4	0.4	0	0.2	0
	0.4	0.2	0.2	0.2	0
	0	0.4	0.3	0.2	0.1
	0.3	0.3	0.2	0.1	0.1
$R_4$	0.2	0.4	0.3	0.1	0
	0.2	0.4	0.2	0.1	0.1
	0	0.3	0.2	0.3	0.2
	0.1	0	0.4	0.4	0.1
$R_5$	0.1	0.3	0.3	0.2	0.1

### 3.4 Comparative Analysis of the Fuzzy Comprehensive Evaluation Results of Effectiveness

The effectiveness fuzzy comprehensive evaluation set

$$B = B' = \{0.287, 0.305, 0.209, 0.172, 0.027\} \text{ an}$$

d the final score  $P = 80.86 \in [80, 90]$  for the fuzzy comprehensive evaluation can be obtained from the above analysis. Compared with the evaluation set V, the evaluation result is determined to be good. This result is consistent with the results of the existing methods described above.

### III. CONCLUSIONS

(1) For the same evaluation object, the evaluation results of the fuzzy comprehensive evaluation model for the ideological and political education in college students are consistent with the evaluation results of the existing methods, which suggests that the fuzzy comprehensive evaluation model established in this paper can be used to evaluate the level of ideological and political educational effectiveness in college students accurately.

(2) The evaluation of the effectiveness of ideological and political education in college students is a typical nonlinear qualitative problem. The comprehensive evaluation model based on the fuzzy hierarchical statistical model has implemented the evaluation of multi-level indicators by integrating the multiple evaluation subjects. In this way, the quantitative transformation to quantitative analysis can be implemented. In addition, it can minimize the adverse effects of subjective factors on the evaluation subject and ensure the objectiveness and accuracy of the evaluation results.

(3) With the continuous progress of ideological and political education in colleges and universities, the ideological quality, political quality, moral quality, legal quality and psychological quality of college students will change to varying degrees accordingly. Hence, the evaluation of the effectiveness of ideological and political education in college students should be a dynamic and continuous process. The application of the effectiveness evaluation model for ideological and political education in college students based on the fuzzy

hierarchical statistical model can implement a reliable assessment of the effectiveness of ideological and political education in college students in different periods objectively and accurately.

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