# The application of multi-criteria fuzzy evaluation method in the evaluation of healthy social mentality of new era college students

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**Abstract.** In order to further enhance the accuracy of college students' mental health assessment, a healthy social mindset assessment model for college students that combines the CRITIC assignment method with the multi-criteria fuzzy assessment method is proposed. The model first constructed a comprehensive assessment index system of healthy social mindset of college students, and then quantified the importance of each assessment index using the CRITIC assignment method and determined the corresponding weight values. On this basis, a multi-criteria fuzzy assessment algorithm was applied and the level of healthy social mentality of college students was comprehensively evaluated through the principle of maximum affiliation. The experimental study shows that the model has high accuracy in assessing the status of healthy social mentality of college students, and possesses the value of popularization in practical application.

**Keywords:** College students; Healthy social mindset; Multi-criteria fuzzy assessment algorithm; CRITIC empowerment approach.

## 1 Introduction

Social mentality is not only an important indicator of social change, but also a valuable psychological momentum that drives society forward. In the context of the new era, cultivating a healthy social mentality among college students is not only related to the grand blueprint of the country's future, but also closely associated with their historical mission as the bearers of the great responsibility of national rejuvenation[1-2]. With the insight of Marxist ideological and political education theory, we analyze the key issues of building a healthy social mentality among college students, aiming to establish a clear cultivation orientation and promote the flourishing and prosperous development of socialist culture with Chinese characteristics. This not only adds new impetus to the development of the discipline of ideological and political education, but also deepens the theoretical connotation of the study of social mentality, and lays a solid foundation for them to grow into a solid force for the cause of socialism with Chinese characteristics in practice[3]. However, at the current stage, some negative tendencies emerge in


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the social mentality of college students in the new era, which requires us to conduct in-depth research and put forward targeted solution strategies.

In order to obtain ideal results of social mentality assessment for college students, a big data-driven social mentality assessment model for college students is designed, with full consideration of the big data-driven background, applying efficient data clustering methods to big data, establishing a healthy social mentality assessment index system for college students, determining the weights of each index within the assessment index system, and utilizing multi-criteria fuzzy evaluation methods to assess the health and social mentality of college students. Social mentality is assessed using a multi-criteria fuzzy evaluation method to quantify the social mentality status of college students and provide an effective reference basis for the development of educational courses and social mentality counseling in colleges and universities.

## 2 Model Building

### 2.1 Evaluation Index System of Healthy Social Mentality of College Students in Higher Education

Cultivating healthy social mindset among college students is a complex subject, and there are many factors affecting the social mindset of college students. Applying data-driven methods to the assessment of college students' social mindset requires the calculation of the similarity of the huge amount of big data in different texts. As shown in Figure 1, “social mindset” and “mindset cultivation” have become hot areas of current research.

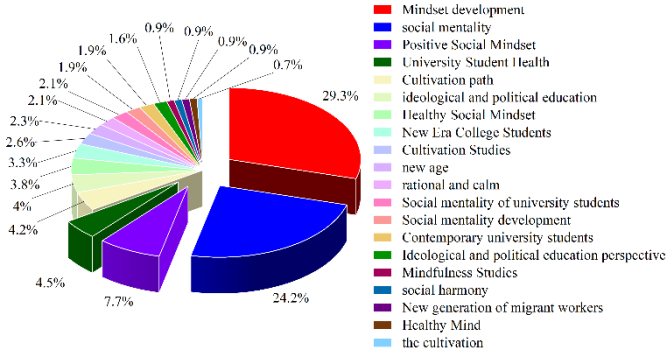


**Fig. 1.** Analysis of research themes

Research in these two fields involves not only psychology, but also covers a wide range of disciplines such as sociology, education, and cultural studies. Scholars have thoroughly explored the formation and change of social mindset and its influencing factors through various research methods, such as theoretical exploration, empirical analysis, questionnaire surveys and case studies. The study of social mindset aims to understand people's psychological states and behavioral patterns in specific social

environments, as well as the impact of these psychological states on social stability and development[4-6]. By counting the similarity of the number of occurrences of feature words between texts, if the feature words appear to be the same when the comparison result is 1, otherwise it is 0. The results of the comparison value will be summed up, and the calculation of the similarity between texts can be realized when the result of the summing up of feature words is 1. The formula is as follows:

$$W_{ikjr} = \begin{cases} 1, s_{ij} = s_{kr} \\ 0, s_{ij} \neq s_{kr} \end{cases} \tag{1}$$

where, $W_{ikjr}$ denotes the contrast value between text $T_i$ and text $T_k$ feature words $s_{ij}$ and $s_{kr}$ ; text $T_i = \left(s_{i1}, s_{i2}, \cdots, s_{ij}\right)$ , $i = 1,2,\cdots,N$ ; $j = 1,2,\cdots,n_i$ ; $s_{ij}$ and $N$ denote the number of text feature words and the number of text, respectively; $k = 1,2,\cdots,N$ ; $i \neq k$ ; $r = 1,2,\cdots,n_k$ , $n_k$ denotes the number of feature words in text $k$ .

The results of feature word comparison between different texts are cumulatively calculated as:

$$W_{ik} = \sum_{j=1}^{j=n_i} W_{ikjr} \tag{2}$$

The similarity $L_{ik}$ between different texts is:

$$L_{ik} = \frac{W_{ik}}{\min\left(n_i, n_k\right)} \tag{3}$$

The same indicator is selected as the starting point for clustering, and a threshold is set to cluster the big data using the K-mean clustering algorithm[7-9], so that the texts with higher similarity are clustered into one class, and the result of clustering is used as a kind of evaluation index. The evaluation indexes established after clustering are shown in Table 1:

**Table 1.** Indicator system for assessing healthy social mentality of university students

| Target level | Level 1 evaluation indicators | Level II evaluation indicators |
|---|---|---|
| Evaluation of healthy social mentality among college students | Mental health status | Psychological stress<br>Anxiety level<br>Depressive symptom<br>Self-efficacy |
| | Interpersonal relationship | Social security<br>Interpersonal communication skills<br>Conflict resolution skills |
| | Values and | Healthy attitude |

| | | |
|---|---|---|
| | self-awareness | Attitude toward life |
| | | Self-respect |
| | | Self-recognition |
| | Social Adaptation | Ability to cope with stress |
| | | Adaptability to new environments |
| | | Participation in social events |

## 2.2 Determination of Evaluation Indicator Weights

The CRITIC assignment method was used to assign different weight values to the evaluation indicators of healthy social mentality of college students[10], and the process is as follows:

Step 1: Construct a judgment matrix $X$ , as shown in Table 2. with $m$ objects to be evaluated, $n$ evaluation indicators can constitute a data matrix $X = \left(x_{ij}\right)_{m\times n}$, and let the elements in the data matrix after indicator normalization and standardization be $X'_{ij}$ .

Step 2: If the indicator is negative, i.e., smaller is better, the treatment is as follows:

$$X'_{ij} = \frac{\max\left(x_j\right) - x_{ij}}{\max\left(x_j\right) - \min\left(x_j\right)} \tag{4}$$

If it is a positive indicator, i.e., the larger the better type of indicator, the treatment is as follows:

$$X'_{ij} = \frac{x_{ij} - \min\left(x_j\right)}{\max\left(x_j\right) - \min\left(x_j\right)} \tag{5}$$

Step 3: The CRITIC assignment method for assigning weights to indicators is centered around two aspects: contrast and contradiction. The standard deviation $\sigma_j$ is used to express the contrast of the $j$ indicator, which is calculated by the following formula:

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{n}\left(X'_{ij} - \bar{X}'_j\right)}{m-1}} \tag{6}$$

Contradiction reflects the degree of correlation between different indicators, if there is a significant positive correlation, the smaller the value of contradiction. Let the contradiction between indicator $j$ and the rest of the indicators be $f_j$ . The calculation formula is as follows:

$$f_j = \sum_{i=1}^{m}\left(1 - r_{ij}\right) \tag{7}$$

Where, $r_{ij}$ represents the correlation coefficient between Indicator $i$ and Indicator $j$, in this case the Pearson correlation coefficient is used, which is a linear correlation coefficient.

Step 4: Calculate the information carrying capacity, then the information carrying capacity $C_j$ is:

$$C_j = \sigma_j f_j \tag{8}$$

Step 5: The larger the information carrying capacity can be considered as the larger the weight value, then the weight value $Q_j$ is:

$$Q_j = \frac{C_j}{\sum_{j=1}^{n} C_j} \tag{9}$$

Step 6: Calculate the maximum eigenvalue $\lambda_{\max}$ of the judgment matrix:

$$\lambda_{\max} = \sum_{j=1}^{n} \frac{x_j}{nQ_j} \tag{10}$$

**Table 2.** Judgment matrix

| $X$ | Mental health status | Interpersonal relationship | Values and self-awareness | Social Adaptation |
|---|---|---|---|---|
| Mental health status | 1 | 5 | 7 | 9 |
| Interpersonal relationship | 1/5 | 1 | 3 | 5 |
| Values and self-awareness | 1/7 | 3 | 1 | 1/5 |
| Social Adaptation | 1/9 | 7 | 5 | 1 |

### 2.3 Consistency Test

After calculating the judgment matrix evaluation criteria weights, it is necessary to conduct a consistency test, mainly to test the consistency ratio of the first-level evaluation indicators $C_R$, which is calculated as follows:

$$\begin{cases} C_1 = \dfrac{(\lambda_{\max} - n)}{n-1} \\ C_R = \dfrac{C_1}{R_1} \end{cases} \tag{11}$$

Where, $R_1$ is the average random consistency indicator, as shown in Table 3.

**Table 3.** Average Randomized Consistency Indicators $R_1$

| Matrix order | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| $R_1$ | 0 | 0 | 0.44 | 0.81 | 1.09 | 1.14 | 1.22 | 1.32 | 1.37 |

When $C_R < 0.1$, the consistency of the judgment matrix is satisfactory; when $C_R \geq 0.1$, the elements of the matrix need to be re-selected[11].

### 2.4 Multi-criteria Fuzzy Evaluation Model

$U = \{U_1, U_2, \cdots, U_k\}$ represents the set of first-level evaluation indicators; $A = \{Q_1, Q_2, \cdots, Q_k\}$ represents the corresponding set of weights for the indicator set[12-14]. The multi-criteria fuzzy assessment matrix for indicator $U_k$ is:

$$P_k = \begin{Bmatrix} r_{k11} & r_{k12} & \cdots & r_{k1m} \\ r_{k21} & r_{k22} & \cdots & r_{k2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{kn1} & r_{kn2} & \cdots & r_{knm} \end{Bmatrix} \tag{12}$$

Where, $r_{kij}$ indicates the correlation of indicator $U_{ki}$ of subfactor $i$ within indicator $k$ of the first level of evaluation to evaluative language $v_j$, and $V = \{v_1, v_2, \cdots, v_k\}$ indicates the result of the assessment.

Let the number of evaluations with level $v_1$ in assessment indicator $U_{ki}$ be $v_{i1}$, and the formula for obtaining $r_{kij}$ is:

$$r_{kij} = \frac{v_{ij}}{\sum_{j=1}^{m} vj} \tag{13}$$

The correlation of the first level indicator $U_k$ with respect to the evaluation result $V$ is calculated through the multiple evaluation criteria using fuzzy operations $\tilde{B}_k$ with the following formula:

$$\tilde{B}_k = X_k \bullet P_k = \left(b_{k1}, b_{k2}, \cdots, b_{kn}\right) \tag{14}$$

The calculated fuzzy matrix is the result set of the first assessment through the multi-criteria. The multi-criteria fuzzy assessment matrix is calculated based on the above formula and the matrix is obtained as follows:

$$P = \begin{bmatrix} \tilde{B}_1 \\ \tilde{B}_2 \\ \vdots \\ \tilde{B}_m \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1m} \\ b_{21} & b_{22} & \cdots & b_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nm} \end{bmatrix} \tag{15}$$

Substituting the multi-criteria fuzzy matrix calculations into Matrix $P$ and performing a quadratic integrated assessment, the correlation matrix of the target level indicators $U$ to the assessment results $V$ is obtained as follows:

$$\tilde{B} = X \bullet R \tag{16}$$

The multi-criteria fuzzy evaluation model can be obtained as:

$$\tilde{B} = X \bullet R = X \bullet \begin{bmatrix} \tilde{B}_1 \\ \tilde{B}_2 \\ \cdots \\ \tilde{B}_m \end{bmatrix} = X \bullet \begin{bmatrix} X_1 \bullet R_1 \\ X_2 \bullet R_2 \\ \cdots \\ X_m \bullet R_m \end{bmatrix} \tag{17}$$

Matrix $P$ was normalized and the results were as follows:

$$\tilde{B}^* = \left( \hat{b}_1, \hat{b}_2, \cdots, \hat{b}_m \right) \tag{18}$$

Based on the principle of affiliation the results of the assessment of healthy social mentality of college students can be obtained:

$$\hat{b}_j = \max \left\{ \hat{b}_1, \hat{b}_2, \cdots, \hat{b}_n \right\} \tag{19}$$

## 3 Case Study

The study drew a sample of 15,000 college students to assess their social mindset, ensuring diversity in age, gender, subject specialization, and grade level of enrollment. The study proposed an optimization model that included structured data collection, indicator definition, and the use of Python analysis software throughout to assign primary and secondary evaluation indicator weights through the CRITIC method. Consistency testing and cluster analysis were also used to improve accuracy. Finally, through the multi-criteria fuzzy assessment method, factors such as age, gender, and academic specialties were taken into account to assess the health status of college students' social mentality, and to rationally arrange corresponding educational measures and psychological guidance.

The research team utilized its innovative model to perform in-depth clustering analysis on the questionnaire data, verifying the model's powerful ability in large-scale data processing. Table 4 shows that the model has a false alarm rate and omission rate of

less than 1% when dealing with massive data, which significantly improves the accuracy and credibility of college students' mental health assessment and provides a precise basis for mental health intervention.

**Table 4.** Data clustering results

| Sample size (number) | No. of clusters (number) | Relevance (number) | False alarm rate (%) | Leakage rate (%) |
|---|---|---|---|---|
| 4000 | 3944 | 3851 | 0.63 | 0.57 |
| 8000 | 7986 | 7813 | 0.35 | 0.78 |
| 12000 | 11983 | 11962 | 0.69 | 0.41 |

The results of the application of this paper's model show a significant effect of consistency determination, as shown in Table 5. Through the model of this paper to determine the consistency of the target level and the first-level indicators, all the assessment results are lower than the threshold value of 0.1. This result clearly shows that the strict judgment criteria are met and the consistency test is successfully passed.

**Table 5.** Results of consistency determination for Tier 1 indicators

| Level 1 evaluation indicators | Mental health status | Interpersonal relationship | Values and self-awareness | Social Adaptation |
|---|---|---|---|---|
| Consistency findings | 0.03 | 0.038 | 0.036 | 0.04 |

The model proposed in this paper successfully calculates the weight allocation of the healthy social mindset assessment index system for college students, and the specific results are detailed in the data presented in Table 6.

**Table 6.** Weighting values for primary and secondary indicator systems

| Level 1 evaluation indicators | Weight value | Level II evaluation indicators | Weight value |
|---|---|---|---|
| Mental health status | 0.5127 | Psychological stress | 0.3125 |
| | | Anxiety level | 0.1527 |
| | | Depressive symptom | 0.2851 |
| | | Self-efficacy | 0.2497 |
| Interpersonal relationship | 0.0343 | Social security | 0.4728 |
| | | Interpersonal communication skills | 0.2947 |
| | | Conflict resolution skills | 0.2325 |
| Values and self-awareness | 0.3126 | Healthy attitude | 0.5728 |
| | | Attitude toward life | 0.1762 |
| | | Self-respect | 0.0936 |
| | | Self-recognition | 0.1574 |
| Social Adaptation | 0.1404 | Ability to cope with stress | 0.3148 |
| | | Adaptability to new environments | 0.3759 |
| | | Participation in social events | 0.3093 |

According to Table 6, the weights of the primary and secondary assessment indicators can be obtained as shown in Table 7.

**Table 7.** Results of the assessment of primary and secondary indicators

| Level 1 evaluation indicators | Evaluation results | Level II evaluation indicators | Evaluation results |
|---|---|---|---|
| Mental health status | 4.3 | Psychological stress | 3.7 |
| | | Anxiety level | 4.5 |
| | | Depressive symptom | 4.6 |
| | | Self-efficacy | 2.4 |
| Interpersonal relationship | 3.2 | Social security | 3.7 |
| | | Interpersonal communication skills | 3.9 |
| | | Conflict resolution skills | 2.8 |
| Values and self-awareness | 3.8 | Healthy attitude | 4.1 |
| | | Attitude toward life | 3.7 |
| | | Self-respect | 4.5 |
| | | Self-recognition | 3 |
| Social Adaptation | 3.3 | Ability to cope with stress | 3.8 |
| | | Adaptability to new environments | 4.1 |
| | | Participation in social events | 2.9 |

According to Table 6 and Table 7, the model of this paper effectively assessed the healthy social mindfulness status of university students. The assessment results show that the total score of mental health status is 3.65, which is good. However, the scores of first-level indicators such as self-efficacy, conflict resolution ability, and participation in social activities are low, indicating that mental health education needs to formulate specific improvement measures for these weak links.

## 4 Summary

In order to assess the healthy social mindset of college students, the study proposes an optimization model, including structured data collection, CRITIC assignment method and multi-criteria fuzzy assessment technique were adopted. Firstly, by establishing a detailed assessment indicator system and assigning weights to each indicator; secondly, to improve accuracy, consistency test and cluster analysis were also used; finally, through the multi-criteria fuzzy assessment method, the health status of college students' social mindset was assessed by taking into account college students' age, gender, and disciplinary specialties. Although the overall mental health status is satisfactory, areas such as self-efficacy and conflict resolution skills require targeted interventions. The model has practical applications in educational settings to improve mental health support services in higher education.

## References


1. Peng, Z.: Cultivation of Positive Social Mindset of College Students from the Perspective of Chinese Excellent Traditional Culture. Western Quality Education. PP. 102-106 (2024).
2. Jenkins A, Weeks M S, Hard B M. General and specific stress mindsets: Links with college student health and academic performance. PloS one (2021).
3. Chen, X. Z.: Research on the Path and Mechanism of Cultivating Good Social Mentality among College Students in the New Era. Science Herald (2024).
4. Yang, J.: A Tracer Study of Interdependent Self-Construals Affecting Mental Health - A Cross-Lag Model Mediated by Social Support. Journal of Southwest Normal University: Natural Science Edition. PP. 80-87 (2020).
5. Liu. H. D.: A study of a K-Means clustering algorithm based on improved differential evolution. modern electronics. PP. 156-162 (2024).
6. Bernecker K, Job V. Mindset theory. Social psychology in action: Evidence-based interventions from theory to practice. PP. 179-191 (2019).
7. Makak E, Medina D A, Osei H D. Exploring the relationship between mindset, mental health, and academic performance among college students (2023).
8. Zhao. N.: Estimation of the number of larval ages of Xingyi diminutives based on k-means clustering algorithm. Journal of Guizhou Medical University. PP. 1120-1127 (2024).
9. Wen. H. B.: Confidence analysis of K-means clustering method in standard setting of secondary school examinations. PP. 69-78 (2024).
10. Zhu, R.: Evaluation of Ecological Environment Vulnerability in Tianshui City Based on CRITIC Objective Empowerment Approach. Chinese Desert. PP. 321-331 (2024).
11. Chang, C.: eview of virtual dimensionality for hyperspectral imager. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. PP. 1285-1305 (2018).
12. He, S. F.: Research on multi-criteria decision-making method based on heterogeneous online review information. PP. 1349-1364 (2024).
13. Xue, S. K.: Research on the Evaluation of Regional Cultural Value of Traditional Villages Based on AHP-Fuzzy Comprehensive Evaluation Method--Taking Mogou Village as an Example. Agriculture and technology. PP. 175-180 (2024).
14. Lu, L. C.: Power quality analysis based on multi-criteria decision-making fuzzy evaluation model. Science and Technology Innovation Herald. PP. 89-90 (2020).