International Journal for Housing Science and Its Applications
Publish August 6, 2025. Volume 46, Issue 3 Pages 5068-5075

https://doi.org/10.70517/ijhsa463434

# Algorithm design and application of mental health assessment algorithm in ideological and political education of college students oriented to multidimensional data

**Beilei Qiao[1] and Li Chang[1,*]**
[1] Henan Agricultural University, Zhengzhou, Henan, 450046, China
Corresponding authors: (e-mail: qbl921@126.com).

**Abstract** There is a disconnect between mental health intervention and value guidance in modern ideological and political education of college students, for this reason, this paper proposes a big data-driven mental health assessment model for college students. It constructs the college students' mental health assessment index system, defines the text similarity calculation model and weight allocation rules. Optimize the search process of FCM clustering center based on the firefly algorithm to avoid the local optimal problem of the traditional algorithm. Taking 5000 students in a university as the research object, relying on expert assessment to determine the weights of indicators. The effectiveness of this paper's algorithm is tested through controlled experiments, and the characteristics of different psychological state levels are analyzed with the help of clustering results. The clustering effect of the FCM-FA algorithm proposed in this paper has obvious advantages compared with the FCM algorithm and the Grid_PFcm algorithm, with short time-consuming and smooth movement, and the time is controlled within 0.1s. The difference between the career impact dimension scores of different mental health status groups is small, and the difference in the emotion regulation dimension is the largest, i.e., students with lower scores in the emotion regulation dimension are more likely to be categorized as “poor” or “bad”. The application of fuzzy cluster analysis in the analysis of college students' mental health can help colleges and universities to carry out early prevention of college students and formulate corresponding strategies for the intervention of psychological disorders.

**Index Terms** ideological and political education; mental health assessment; fuzzy clustering algorithm; firefly algorithm; FCM-FA

## I. Introduction

The age of college students is an important period of human physiological and psychological development, as well as a critical period for college students to perfect themselves and mature [1]. College students at this stage are characterized by coexistence of independence and dependence, conflict between ideals and reality, strong self-consciousness and poor self-control, etc., and are influenced by the external environment, which makes them prone to ideological and psychological problems [2]-[4]. In recent years, colleges and universities frequently appear due to ideological or psychological problems occurring in the suspension, withdrawal and suicide. Mental health education for college students has received unprecedented attention, and after years of development, it has also gradually formed its own specific field. Modern ideological and political education focuses on viewing and solving problems from the perspective of mental health education, focusing on the cultivation of mental health qualities of college students, focusing on the value recognition of the educated on the educational objectives and educational content, and also focusing on the “master” status of the educated [5]-[8]. Based on this, the effective integration of mental health education and the development of ideological and political education with both depth and temperature can continuously promote the improvement of the quality and effect of ideological and political education.

The assessment mechanism of college students' mental health can have a complete cognition and evaluation of mental health education, which should be based on the principles and standards of mental health education assessment [9], [10]. However, most colleges and universities have an imperfect assessment system for students' mental health and lack a strong supervisory and management mechanism, often judging the mental health status through past experience, lacking scientific and reasonable assessment methods [11]-[15]. For this reason, by constructing a mental health assessment model based on multi-dimensional data analysis, integrating and analyzing students' relevant data information, realizing teachers' real-time mastery of students' psychological status, so as to achieve the result of good development of college students' mental health.

In this paper, we first constructed a four-dimensional assessment index system containing emotion regulation, learning impact, life impact and career impact, and proposed an improved fuzzy FCM-FA model incorporating the firefly algorithm. The validity of the algorithm in mental health grading assessment is verified through the empirical analysis of the data of 5000 graduates from a university. Based on the analysis of clustering results, the distribution law of the characteristics of different psychological state groups is revealed.

## II. Mental health assessment based on improved fuzzy C-mean clustering algorithm

In the new era of ideological and political education, the mental health of college students is a core variable that affects the shaping of ideology and the cultivation of values. Under the background of “Three-Whole Parenting”, how to build a dynamic and accurate mental health assessment model through multi-dimensional data integration has become an important issue to enhance the effectiveness of ideological and political education. However, there is a double contradiction in the existing research: on the one hand, the ideological and political education emphasizes the humanistic care of individual value guidance, but the traditional assessment method adopts the hard division logic and ignores the ambiguity and dynamic evolution of psychological characteristics, which results in the assessment results being out of touch with the goal of ideological and political education. On the other hand, the processing of high-dimensional heterogeneous data relies on manual feature extraction, which makes it difficult to capture the potential correlation between psychological state and elements of ideological education, and restricts the synergistic effectiveness of psychological intervention and ideological education.

Aiming at the above problems, this paper proposes a mental health assessment model integrating improved fuzzy C-mean clustering (FCM) and firefly algorithm (FA) with data-driven innovation of civic and political education as an entry point.

### *II. A. Construction of mental health assessment index system for college students in higher education institutions*

Applying big data-driven data clustering method to college students' mental health assessment data, we need to calculate the similarity of different texts in the large amount of big data, obtain the similarity by counting the number of the same feature words between different texts, compare all the feature words between text 1 and text 2, set the result of the comparison value to be 1 when the feature words are the same, or else it will be 0, and then realize the text similarity by summing up the feature words whose comparison value is 1. Calculation. $T_i = \left(w_{i1}, w_{i2}, \cdots, w_{ij}\right)$ denotes the text, $i = 1, 2, \cdots, N$; $j = 1, 2, \cdots, n_i$. $w_{ij}$ and $N$ denote the text feature words as well as the number of texts, respectively, and $n_i$ denotes the number of feature words for text $i$. $S_{ikjr}$ denotes the comparison value between text $T_i$ and text $T_k$ feature words $w_{ij}$ and $w_{kr}$, which can be obtained as follows:

$$S_{ikjr} = \begin{cases} 1, & w_{ij} = w_{kr} \quad (1) \\ 0, & w_{ij} \neq w_{kr} \end{cases} \tag{1}$$

where $k = 1, 2, \cdots, N$; $i \neq k$; $r = 1, 2, \cdots, n_k$. $n_k$ denotes the number of feature words of text $k$.

The cumulative value $S_{ikj}$ of the feature words $w_{ij}$ of text $T_i$ compared with all feature words of text $T_k$ is:

$$S_{ikj} = \sum_{r=1}^{r=n_k} S_{ikjr} \tag{2}$$

There are large differences in the feature words within the same text, there exists at most one feature word within the text $T_k$ that is the same as $w_{ij}$, so the value of $S_{ikj}$ can only be 0 or 1, which gives the following formula for the number of feature words within the text $T_i$ and the text $T_k$ that are the same as the number of feature words $S_{ik}$:

$$S_{ik} = \sum_{j=1}^{j=n_i} S_{ikj} \tag{3}$$

The ratio of the number of identical feature words within different texts to the smaller value of the total number of feature words is the text similarity, which can be obtained as the similarity $P_{ik}$ between texts $T_i$ and $T_k$:

$$P_{ik} = \frac{S_{ik}}{\min\left(n_i, n_k\right)} \tag{4}$$

The heuristic clustering method is used to implement clustering of massive network big data, randomly select an indicator as the starting point of clustering, expand the clustering indicator through the autonomous adaptive method, set a fixed threshold, and cluster the obtained text similarity higher than the threshold text into one class, and the obtained clustering results are used as evaluation indicators. After completing the text clustering, the evaluation index system is established with the corresponding indicators of the text collection as shown in Table 1. The primary indexes are 4 items of emotion regulation, learning impact, life impact, and career impact, and the secondary indexes are 15 items of independence, improvement ability, adaptability, collective cooperation, learning ability, learning motivation, learning strategy, test-taking psychology, emotion control, interpersonal communication, willpower, self-cognition, self-development, personal values, and career planning, respectively.

Table 1: Mental Health Assessment Index System

| Target layer | First-level evaluation index | Secondary evaluation index |
|---|---|---|
| Mental health evaluation of college students | Emotion regulation(A) | Independence(A1) |
| | | Improve ability(A2) |
| | | Adaptability(A3) |
| | | Collective cooperative power(A4) |
| | Learning influence(B) | Learning ability(B1) |
| | | Learning motivation(B2) |
| | | Learning strategy(B3) |
| | | Exam-oriented psychology(B4) |
| | Life influence(C) | Emotional control(C1) |
| | | Interpersonal communication(C2) |
| | | Willpower(C3) |
| | | Self-awareness(C4) |
| | Career influence(D) | Self-development(D1) |
| | | Personal values(D2) |
| | | Career planning(D3) |

### *II. B.Improved fuzzy C-mean clustering algorithm*

#### II. B. 1) Fuzzy C-mean clustering algorithm

Different from the traditional $C$ mean such hard clustering algorithm, in order to better solve the actual problem, the algorithm of the degree of affiliation from 0 or 1 improved to $[0,1]$, no longer divide the data into either this category or the other, fuzzy $C$ mean clustering is the proportional size of the clustering centers of the different categories into different clustering centers, rather than a strict division, a Data samples can belong to multiple categories, each category to determine a center, each sample has a different degree of affiliation, repeated iterations to optimize the clustering center and affiliation matrix, to seek the minimum value of the clustering objective function, to obtain the best clustering results.

The basic logic of the fuzzy $C$ mean clustering algorithm is the same as that of the $C$ mean clustering algorithm, which also has a set of clustered samples $X = \{x_1, x_2, x_3, \cdots, x_n\}$ with a number of clustering categories of $C$ and clustering centers of $C = V^b = \{v_1, v_2, v_3, \cdots, v_n\}$, and denote the first cluster by $\mu_{ij}\left(i = 1,2,3,\cdots,c, j = 1,2,3,\cdots,n\right)$ denotes the degree of affiliation of the $j$ th sample to the center of the $i$ th class clustering with $\mu_{ij} \in [0,1]$, and the objective function is:

$$J_{FCM}\left(U,C\right) = \sum_{i=1}^{c}\sum_{j=1}^{n}\mu_{ij}^{m}\left\|x_j - v_i\right\|^2 \tag{5}$$

where $\forall j = 1,2,3,\ldots,n$ has $\sum_{i=1}^{c}\mu_{ij} = 1$ and $\left\|x_j - v_i\right\|^2 = \left(x_j - v_i\right)\left(x_j - v_i\right)'$ is the Euclidean distance from the jth sample to the center of the clustering class of the $i$ th class $v_i$, and $m$ is the fuzzy weighting coefficient which is usually taken as $[1.5,2.5]$.

The specific steps of the algorithm are:

Step 1: Initialize the desired parameters, e.g., set the number of cluster centers to the desired number. Clustering iteration stopping threshold $\varepsilon$, total number of iterations $T$, fuzzy weighting coefficients $m$, select initial clustering centers $V^b = \{v_1, v_2, v_3, \ldots, v_n\}$ and initial affiliation matrices $\mu^{(0)} = \left(\mu_{ik}^{(0)}\right)$, which is usually taken as a uniformly distributed random number on $[0,1]$ to determine the affiliation matrix $\mu^{(0)}$.

Step 2: Calculate the clustering center $V^b$ according to equation (6)

$$V_i^{b+1} = \frac{\sum_{j=1}^{n} (\mu_{ij}^{(b+1)})^m X_j}{\sum_{j=1}^{n} (\mu_{ij}^{(b+1)})^m} \tag{6}$$

Step 3: Update the affiliation matrix according to equation (7):

$$V_{ij}^{(b)} = \left\{ \sum_{i=1}^{c} \left[ \left( \frac{d_{ij}^{(b)}}{d_{lj}^{(b)}} \right)^{\frac{2}{m-1}} \right] \right\}^{-1} \tag{7}$$

If $\exists i, r$, both have $d_{ir}^{(b)} = 0$, then $\mu_{ir}^{(b)} = 1$.

Step 4: If $\left\| V^b - V^{b+1} \right\| < \varepsilon$, prove that there has been convergence, clustering stops, the cluster center and the affiliation matrix are output, and the classification is completed by determining the classification of all the samples based on the final affiliation value. If the criterion is not met, the computation continues iteratively until the maximum number of iterations, and the classification process is performed again.

The flow of the fuzzy $C$ mean clustering algorithm is shown in Figure 1.

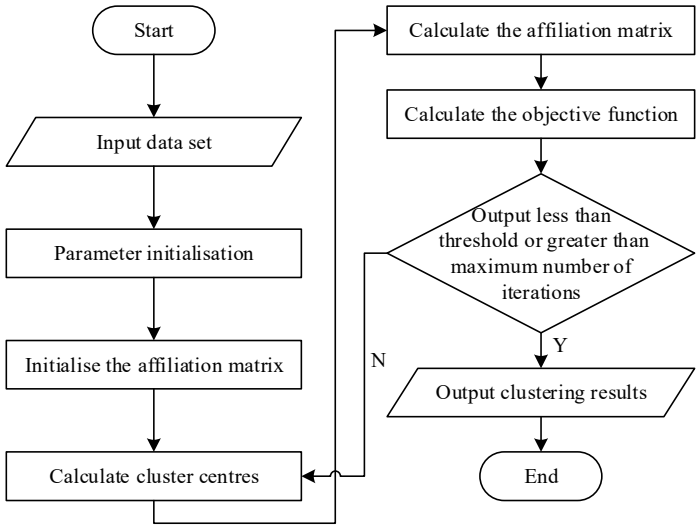



Figure 1: FCM algorithm process

**II. B. 2) Fuzzy C-mean Clustering-Firefly Algorithm**

Based on the idea of clustering algorithm, the band that can represent each class is selected to form a subset of bands, so the band closest to the cluster center in each class can be regarded as a representative band, but the local optimal solution is easy to be obtained by calculating the position of the cluster center by FCM, and FA can increase the probability of obtaining the global optimal solution, therefore, the movement process of the firefly can be replaced by the calculation process of the cluster center, and after obtaining the coordinates of the cluster center, the calculated objective function value $J$ can be directly used as the basis for judgment. Fireflies with large objective function values move towards fireflies with small objective function values. For hyperspectral data $X$, each band is considered a clustering object, and the number of bands selected is the number of clusters. In this paper, the index value of the band is not used as the position coordinates of each firefly, but the cluster center matrix

$C \in \square^{p \times m}$ is directly used as the position of a firefly, and a column in the matrix $C$ is the coordinates of a cluster center, and its dimension is the number of cells in a single-band image, and the specific value is expressed as the gray value of the hyperspectral image. Treating the gray value as a coordinate value and measuring it through distance can more directly reflect the correlation between bands. In order to simplify the calculation, one firefly is taken out at a time and compared with other fireflies in turn, and the specific process of fuzzy $C$ mean clustering-firefly algorithm (FCM-FA) is shown in Figure 2.

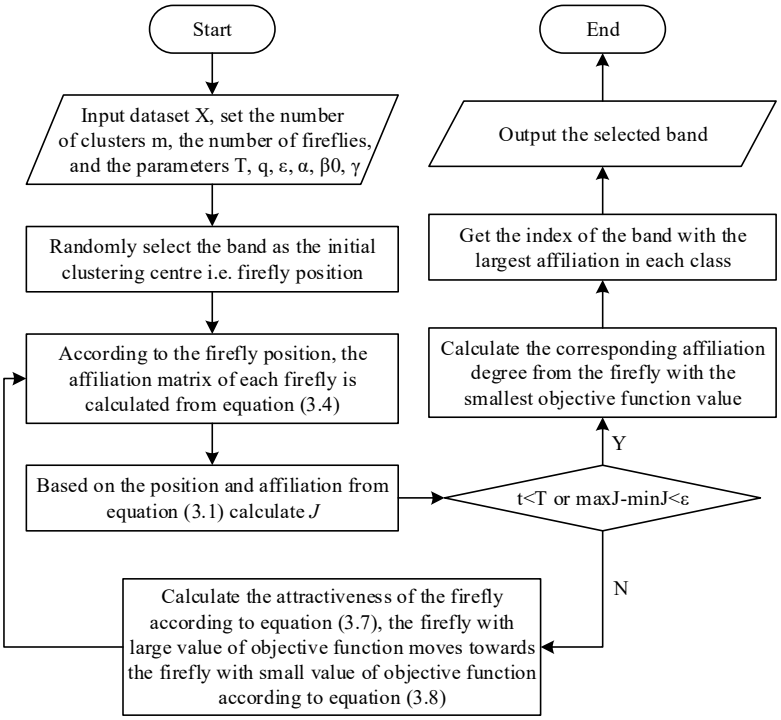



Figure 2: FCM-FA process

## III. Empirical research on mental health assessment in ideological and political education of college students

### *III. A. Performance testing*

A college was selected as the experimental object, and the historical data of 5000 fresh graduates of the college in the past 5 years, such as psychological census, students' basic situation, social support, etc., were used as the experimental dataset. The assessment method of this paper was utilized to assess the mental health of college students. Ten authoritative experts in mental health were invited to score each treatment, and the average value of each expert was the assessment result of secondary indicators. The estimated grade combines the mental health status of the assessed students, and the assessment criteria are shown in Table 2.

Table 2: Assessment Criteria for Mental Health of College Students

| Serial number | Comprehensive assessment score | Evaluation grade |
|---|---|---|
| A | 80~100 | Excellent |
| B | 60~79 | Good |
| C | 40~59 | General |
| D | 20~39 | Rather poor |
| E | <20 | Poor |

In order to verify the effectiveness of the assessment methods in this paper, the psychological assessment methods based on FCM algorithm and Grid_PFcm algorithm were used for comparison experiments respectively. From the historical data of 5000 college students, 2000 data samples were selected and divided into 5 data sets, and the three methods were used to test the performance of number clustering, and the comparison results are

shown in Figure 3. With the increase of the number of data samples, the time consumed by the three methods is on the rise, but the clustering effect of this paper's algorithm has an obvious advantage compared with the FCM algorithm and the Grid_PFcm algorithm, with a short time consuming and smooth movement, and the time is controlled to be within 0.1s. This is because the algorithm in this paper utilizes both the advantage of removing redundancy based on the clustering method and the advantage of solving the global optimal solution based on the search method to ensure the stability of the results.

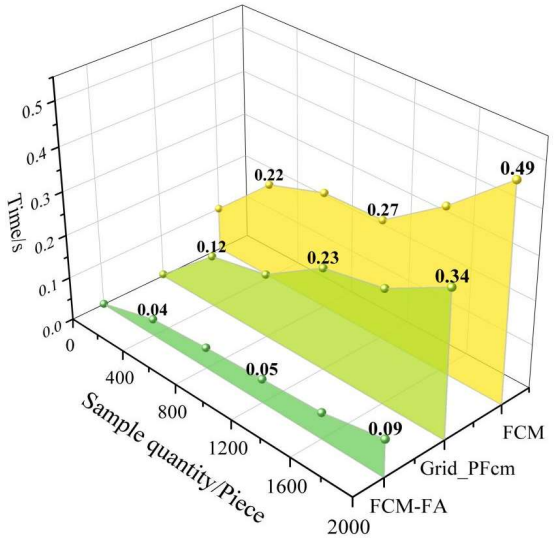



Figure 3: Data clustering comparison results

### *III. B. Analysis of clustering results*

The fuzzy weight details of each indicator obtained by using the algorithm of this paper are shown in Table 3, and the weights of the four first-level indicators of emotional regulation, learning impact, life impact, and career impact are 0.4086, 0.1277, 0.3562, and 0.1075, respectively.

Table 3: Weight of mental health indicators for college students

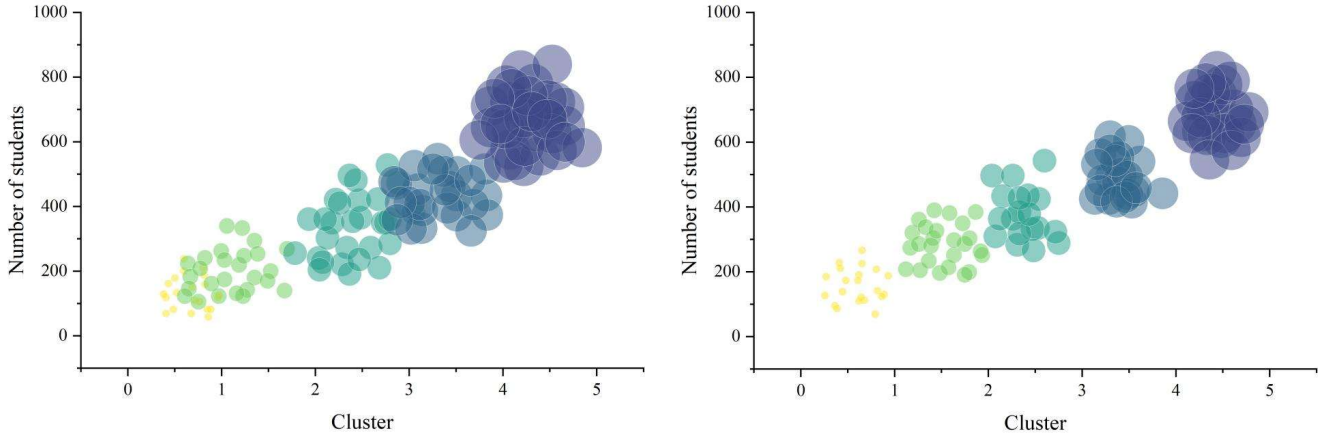
| First-level evaluation index | Weight | Secondary evaluation index | Weight |
|---|---|---|---|
| A | 0.4086 | A1 | 0.3027 |
| | | A2 | 0.1128 |
| | | A3 | 0.2296 |
| | | A4 | 0.3549 |
| B | 0.1277 | B1 | 0.1286 |
| | | B2 | 0.2865 |
| | | B3 | 0.1047 |
| | | B4 | 0.4802 |
| C | 0.3562 | C1 | 0.5264 |
| | | C2 | 0.1038 |
| | | C3 | 0.1172 |
| | | C4 | 0.2526 |
| D | 0.1075 | D1 | 0.3082 |
| | | D2 | 0.3219 |
| | | D3 | 0.3699 |

Combined with the evaluation criteria and indicator weights, the number of fuzzy clusters c = 5 is determined, and the results of fuzzy clustering center obtained using the algorithm of this paper are shown in Table 4, which shows that the 15 factors have different degrees of influence on different clustering results.

Table 4: Results of fuzzy clustering

| | | | | | |
|---|---|---|---|---|---|
| Center 1 | 0.397 | 0.138 | 0.247 | -0.187 | 0.475 |
| Center 2 | 0.173 | 0.308 | -0.183 | 0.099 | 0.103 |
| Center 3 | 0.497 | 0.013 | -0.086 | -0.153 | 0.208 |
| Center 4 | 0.115 | 0.299 | 0.308 | 0.208 | -0.165 |
| Center 5 | 0.297 | 0.107 | -0.226 | 0.325 | 0.038 |
| Center 6 | -0.134 | 0.208 | 0.297 | 0.073 | 0.177 |
| Center 7 | 0.255 | 0.015 | 0.196 | -0.028 | 0.395 |
| Center 8 | 0.128 | 0.037 | 0.206 | -0.177 | 0.293 |
| Center 9 | 0.209 | 0.135 | 0.374 | -0.028 | 0.106 |
| Center 10 | 0.486 | 0.208 | -0.222 | 0.091 | 0.027 |
| Center 11 | 0.335 | 0.107 | 0.083 | -0.173 | 0.202 |
| Center 12 | 0.433 | 0.083 | 0.182 | 0.297 | -0.271 |
| Center 13 | -0.292 | 0.386 | 0.293 | 0.115 | 0.637 |
| Center 14 | 0.074 | 0.108 | 0.553 | 0.028 | -0.222 |
| Center 15 | 0.027 | 0.397 | -0.216 | 0.517 | 0.271 |

The results of the FCM algorithm and the improved FCM-FA algorithm of this paper on the clustering analysis of college students' mental health data are shown in Fig. 4(a~b), respectively. It can be seen through Fig. 4(a) that there is an obvious intermingling phenomenon between students with excellent assessment grades and those with good assessment grades, indicating that the FCM algorithm cannot clearly divide these two types of students with different psychological conditions. Through Fig. 4(b), it can be seen that the boundaries between students with different psychological conditions in each category are obvious, indicating that the improved FCM-FA algorithm of this paper is relatively more scientific in determining the center point of clustering, which further verifies the effectiveness of the improved scheme of this paper.




(a) FCM (b) FCM-FA

Figure 4: Results of cluster analysis

Table 5: Mean difference and variances of each variable distribution of Clustering

| | | A | | B | | C | | D | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. | Mean | Std. | Mean | Std. | Mean | Std. |
| Cluster | 1 | 89.84 | 2.66 | 92.11 | 2.58 | 80.26 | 2.95 | 85.51 | 2.35 |
| | 2 | 75.49 | 2.05 | 87.22 | 2.36 | 76.37 | 2.46 | 83.13 | 2.24 |
| | 3 | 50.52 | 2.13 | 75.18 | 2.11 | 60.66 | 2.77 | 81.25 | 2.07 |
| | 4 | 21.72 | 2.04 | 61.06 | 2.07 | 42.13 | 2.58 | 72.09 | 2.18 |
| | 5 | 4.21 | 2.19 | 37.07 | 2.12 | 20.25 | 2.16 | 61.98 | 2.02 |
| Combined | | 26.25 | 3.05 | 77.62 | 3.35 | 72.11 | 3.39 | 80.07 | 3.31 |

In order to have a clearer presentation of the mean and standard deviation of each variable in each cluster, a pivot table was developed, and the distribution of the mean and variance of each variable in the clusters based on

the FCM-FA algorithm is shown in Table 5. The difference in career impact dimension scores between different mental health status groups is small, and the difference in emotional regulation dimension is the largest, i.e., students with lower scores in emotional regulation dimension are more likely to be categorized as “poor” or “bad”.

## IV. Conclusion

In this paper, we designed a mental health assessment method for college students based on the FCM-FA algorithm, and selected a college as the experimental object to explore the practical application effect of the algorithm.

With the increase of the number of data samples, the time consumed by the three methods are on the rise, but the clustering effect of this paper's algorithm has obvious advantages compared with the FCM algorithm and the Grid_PFcm algorithm, with a short time consumption and smooth movement, and the time is controlled to be less than 0.1 s. The FCM algorithm has obvious intermingling of the students with excellent assessment grades and those with good assessment grades, and the FCM-FA algorithm The boundaries between students with different psychological conditions of clustering are obvious, which further verifies the effectiveness of the improvement program of this paper.

Using this algorithm to obtain the fuzzy weights of the indicators, the weights of the four first-level indicators of emotional regulation, learning impact, life impact, and career impact are 0.4086, 0.1277, 0.3562, and 0.1075, respectively, and the difference in the scores of the career impact dimension of the groups with different mental health statuses is relatively small, and the difference in the emotional regulation dimension is the largest, i.e., the students with lower scores on the emotional regulation dimension are more likely to be categorized as “lower” students. The greatest difference was found in the emotional regulation dimension, which means that students with lower scores in the emotional regulation dimension were more likely to be categorized as “poor” or “bad”.

## Funding

1. Research and practice project on undergraduate education reform in Henan Agricultural University: Research on the reform and practice of academy system education mode of Henan Agricultural University (2023XJGLX037).

2. Prosperous Philosophy and Social Science Application Research Project of Henan Agricultural University: Research on the construction path of counselors' studios in local agricultural and forestry colleges under the framework of "great ideological and political education" (FRZS2024B03).

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