Application of Fuzzy Comprehensive Evaluation in Comprehensive Quality Evaluation of Higher Education Students

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Abstract—Scientific and reasonable evaluation of the comprehensive quality of higher education students provides a guarantee for the pertinent development of quality education in colleges, and offers an aid for students to determine goals and directions of development. Therefore, this paper first constructs an evaluation index system (EIS) for the comprehensive quality of higher education students, and then builds up an evaluation model for that quality based on fuzzy comprehensive evaluation (FCE). The FCE algorithm was designed in details, and applied to a real example. The application results show that the FCE can scientifically evaluate the comprehensive quality of the students from multiple aspects and levels. The research overcomes the difficulty in the comprehensive quality evaluation of college students, and enriches the theoretical and practical results in this field.

Keywords—Fuzzy comprehensive evaluation (FCE), analytic hierarchy process (AHP), com-prehensive quality evaluation, higher education students

1 Introduction

The fast-developing economy and increasingly-fierce market competition in Chinese society have raised higher demands for high-quality talents. Colleges and universities are the cradle of senior talents, in order to cultivate high-quality talents that can meet social demands, the reform of higher education in Chinese colleges and universities is deepening constantly, however, in terms of the evaluation of the comprehensive quality of college students, it is still a weak link. Therefore, for current higher education in China, establishing a scientific and reasonable student comprehensive quality evaluation system and adopting suited methods to evaluate students' comprehensive quality are meaningful for the pertinent development of quality education, and they can offer an aid for students to determine goals and directions of their future development.

In terms of the research on comprehensive quality evaluation, both the domestic and foreign research fields are quite active. As early as 1864, British scholars had designed a "Homework Scale" as a reference for teachers to assess the performance of students in various subjects [1]; after that, various new evaluation theories and models were proposed one after another, such as the behavior goal evaluation model, the

CIPP model, and the goal free model, etc. [2]. In China, the reform of quality education is being promoted vigorously in recent years, the government encourages to establish student evaluation mechanisms that are suitable for the requirements of quality education, as a result, the research on student comprehensive quality evaluation systems and methods has received more attention from experts and scholars in the field [3]. Conventional mathematical methods, multivariate statistical methods, and fuzzy mathematical methods are common methods in comprehensive quality evaluation, besides these methods, nowadays, the evaluation methods based on BP neural network have also been applied to the comprehensive quality evaluation of students [4]. In fact, although the related fields have won abundant research results, until now there isn't a model of student comprehensive quality evaluation that has been widely accepted and recognized by all parties. Based on the above analysis, this paper attempts to explore the application of fuzzy comprehensive algorithm in the evaluation of the comprehensive quality of higher education students, with a view to enriching the theoretical and practical research results of comprehensive quality evaluation of higher education students.

2 Related Theories

2.1 The FCE method

Principle of FCE: The FCE method uses concepts of fuzzy mathematics to quantify factors that are not easy to quantify [5]. This method has a good effect when dealing with multi-factor and multi-level complex problems. Whether the comment set, factors, and evaluation matrix can be scientifically determined is the key to the FCE method [6].

Steps of FCE

1. Determine factor set U and comment set V of evaluation object:

$$U=\{U_1,\ U_2,\cdots U_n\} \tag{1}$$

$$V=\{V_1,\ V_2,\cdots V_n\} \tag{2}$$

2. Calculate weight vector:

$$A=\{a_1,\ a_2,\cdots a_m\} \tag{3}$$

3. Construct evaluation matrix R:

$$R=\begin{Bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{Bmatrix} \tag{4}$$

4. Perform fuzzy comprehensive calculation to get evaluation result:

$$B = A \bullet R = \left(b_1, b_2, \cdots b_n\right) \tag{5}$$

2.2 AHP

Principle of AHP: The AHP method divides a complex problem into several orderly layers according to a certain relationship, then makes judgements according to certain objective facts, and quantitatively reflects the importance of each layer. This method is suitable for situations with complex structures and insufficient data, and it can quantify the experience of decision-makers [7].

Steps of AHP: When using AHP to solve a problem, the following steps are usually involved:

1. **Clarify the problem and construct the hierarchical structure**: Analyze the factors involved in the problem to be solved and the relationships between the factors, and construct the hierarchical structure of the system. The layers can be divided into the top layer (objective layer), middle layers (criteria and sub-criteria layers) and the bottom layer (alternatives layer). The number of layers is related to the complexity of the problem, but generally each layer dominates no more than 9 elements [8].
2. **Construct the judgement matrix**: Apply the pairwise comparison method to construct the judgment matrix. The judgment matrix reflects the importance of each element in this layer relative to an element in the previous layer [9], as shown in Formula (6):

$$\begin{array}{c} \\ B_1 \\ B_2 \\ \cdots \\ B_i \\ \cdots \\ B_n \end{array} \begin{array}{c} \begin{array}{cccccc} B_1 & B_2 & & \cdots & B_j & \cdots & B_n \end{array} \\ \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1j} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2j} & \cdots & b_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ b_{i1} & b_{i2} & & b_{ij} & \cdots & b_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ b_{n1} & b_{n2} & \cdots & b_{nj} & & b_{nn} \end{bmatrix} \end{array} \tag{6}$$

where, b_{ij} represents the importance of b_i with respect to b_j. According to the SAATY scale, b_{ij} can be judged according to Formula (7). When its value is an even number, it means that the relative importance of b_i and b_j is between two odd numbers [10].

$$b_{ij} = \begin{cases} 1 & B_i \text{ and } B_j \text{ are equally important} \\ 3 & B_i \text{ is slightly more important than } B_j \\ 5 & B_i \text{ is more important than } B_j \\ 7 & B_i \text{ is even more important than } B_j \\ 9 & B_i \text{ is extremely important than } B_j \end{cases} \tag{7}$$

For any judgment matrix, Formula (8) should be satisfied:

$$\begin{cases} b_{ij} = 1 \\ b_{ij} = \dfrac{1}{b_{ji}} \end{cases} \quad (i, j = 1, 2, \cdots, n) \tag{8}$$

For the judgement matrix, if there is $bij = \frac{bik}{bjk} \quad (i, j = 1,2, \cdots, n)$, it indicates that the judgments in the matrix are completely consistent. In practice, due to the influence of many factors, it is unlikely that the judgment matrix is completely consistent, therefore, it is necessary to check the consistency of the judgment matrix to determine whether the results of AHP are reasonable [11].

3. **Consistency check:** The consistency of the matrix can be judged by *CI* (consistency index):

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{9}$$

When the judgment matrix is completely consistent, $\lambda max = n$, $CI = 0$. This paper uses the *CR*, the ratio of *CI* to the average random consistency index *RI*, to judge the consistency of the matrix [3], as shown in Formula (10):

$$CR = \frac{CI}{RI} \begin{cases} =0 & \text{Fully consistent} \\ <0.1 & \text{Satisfactory consistency} \\ \geqslant 0.1 & \text{Unsatisfactory consistency} \end{cases} \tag{10}$$

3 Comprehensive Quality Evaluation of Higher Education Students

3.1 The EIS

The EIS of student comprehensive quality should be able to reflect the special needs of the new era for talent training, as well as the quality features and individual differences of college students at the university stage. For this purpose, we have carefully reviewed and analyzed relevant documents such as the talent training plans of colleges and universities, the Quality Development Plan issued by the Ministry of Education, the College Student Code of Conduct, and other files related to student cultivation and development [12]; then, combing with the actual requirements of the Chinese society for the talents and following the design principles of comprehensive, targeted, feasible, modularized, and hierarchical, this paper constructed an EIS for the comprehensive quality evaluation of higher education students, as shown in Figure 1 [13].

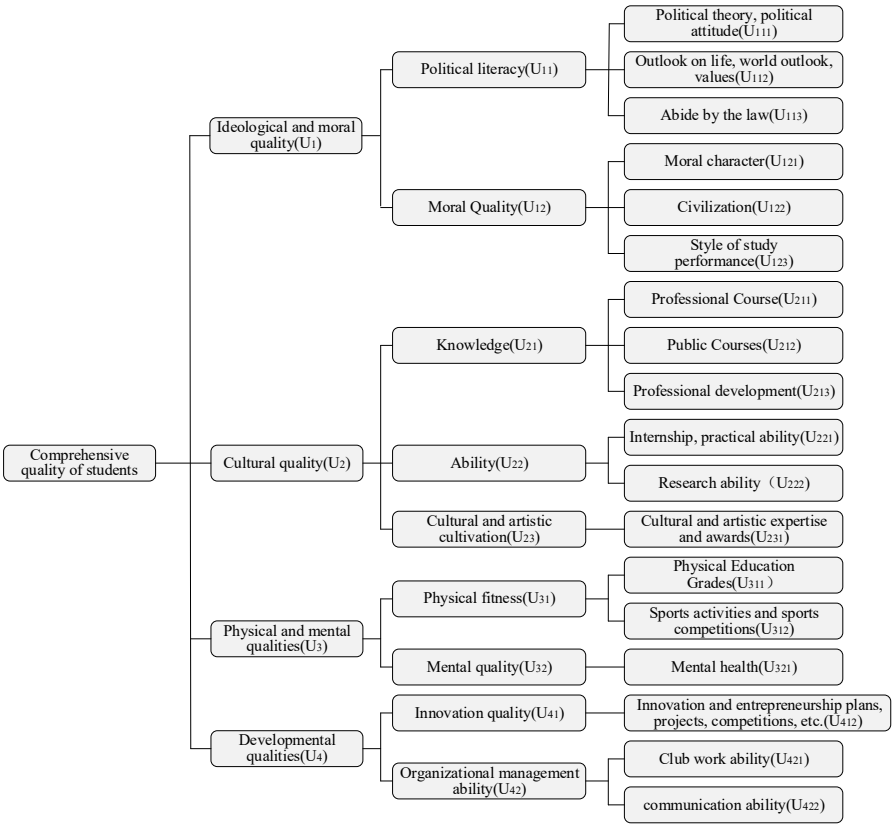

Fig. 1. The proposed EIS

3.2 Determination of index weights

In an index system, the index weight is the quantified importance of an index in the system, and the accuracy of the index weights of each layer directly affects the effectiveness of the final results of the evaluation [14]. In this paper, the AHP method was adopted to determine the weight values of the indexes.

According to the calculation method mentioned above, this paper took the first-level indexes as an example to perform index weight calculations.

Construct the judgment matrix A

$$A = \begin{bmatrix} 1 & 3 & 2 & 1/3 \\ 3 & 1 & 2 & 3 \\ 1/3 & 1/2 & 1 & 1/3 \\ 3 & 1/2 & 3 & 1 \end{bmatrix} \tag{11}$$

Normalize matrix columns: According to formula $bij = \frac{aij}{\sum_{i=1}^{n} aij}$, normalize the judgment matrix A to get matrix B:

$$B = [b_{ij}] = \begin{bmatrix} 0.1324 & 0.1456 & 0.2224 & 0.0908 \\ 0.4 & 0.4561 & 0.3322 & 0.5455 \\ 0.0654 & 0.1576 & 0.1112 & 0.0909 \\ 0.4 & 0.2345 & 0.3322 & 0.2726 \end{bmatrix} \tag{12}$$

According to formula $vi = \sum_{j=1}^{n} bij$, the matrix B is summed in rows to get:

$$v = \{v_i\} = \begin{bmatrix} 0.6001 \\ 1.7502 \\ 0.4223 \\ 1.2367 \end{bmatrix} \tag{13}$$

Calculate eigenvector: According to formula $wi = \frac{vi}{\sum_{i=1}^{n} vi}$, find the eigenvector W:

$$W = \{w_i\} = \begin{bmatrix} 0.1497 \\ 0.4365 \\ 0.1053 \\ 0.3085 \end{bmatrix} \tag{14}$$

Calculate the largest eigenvalue

$$AW = \begin{bmatrix} 1 & 3 & 2 & 1/3 \\ 3 & 1 & 2 & 3 \\ 1/3 & 1/2 & 1 & 1/3 \\ 3 & 1/2 & 3 & 1 \end{bmatrix} \begin{bmatrix} 0.1497 \\ 0.4365 \\ 0.1053 \\ 0.3085 \end{bmatrix} = \begin{bmatrix} 0.6093 \\ 1.8205 \\ 0.4289 \\ 1.2939 \end{bmatrix} \tag{15}$$

$$\lambda_{\max} = \sum_{i} \frac{(AW)_i}{nw_i} = \frac{1}{4}\left(\frac{0.6093}{0.1497} + \frac{1.8205}{0.4365} + \frac{0.4289}{0.1053} + \frac{1.2939}{0.3085}\right) = 4.0144 \tag{16}$$

Check consistency

$$\begin{aligned} CI &= \frac{\lambda_{\max} - n}{n-1} = \frac{4.0144 - 1}{4 - 1} = 0.004825 \\ CR &= \frac{CI}{RI} = 0.00536 < 0.1 \end{aligned} \tag{17}$$

If it passes the consistency check, then it indicates the weights of first-level indexes are:

$$A_i = \begin{bmatrix} 0.1497 \\ 0.4365 \\ 0.1053 \\ 0.3085 \end{bmatrix} \tag{18}$$

In the same way, the weights of the second-level and third-level indexes could be calculated, Table 1 lists the weights of indexes of each level.

Table 1. Index weights

First-level index	Weight	Second-level index	Weight	Third-level index	Weight
Ideological and moral quality (U1)	0.1497	Political literacy (U11)	0.1002	Political theory, political attitude (U111)	0.0233
				Outlook on life, world outlook, values (U112)	0.0364
				Abide by the law (U113)	0.0405
		Moral Quality (U12)	0.0498	Moral character (U121)	0.0213
				Civilization (U122)	0.0151
				Style of study performance (U123)	0.0134
Cultural quality (U2)	0.4365	Knowledge (U21)	0.2273	Professional Course (U211)	0.1195
				Public Courses (U212)	0.0758
				Professional development (U213)	0.032
		Ability (U22)	0.1462	Internship, practical ability (U221)	0.0969
				Research ability (U222)	0.0483
		Cultural and artistic cultivation (U23)	0.0515	Cultural and artistic expertise and awards (U231)	0.0515
Physical and mental qualities (U3)	0.1053	Physical fitness (U31)	0.0732	Physical Education Grades (U311)	0.0464
				Sports activities and sports competitions (U312)	0.0268
		Mental quality (U32)	0.0464	Mental health (U321)	0.0464
Developmental qualities (U4)	0.3085	Innovation quality (U41)	0.1722	Innovation and entrepreneurship plans, projects, competitions, etc. (U412)	0.1722
		Organizational management ability (U42)	0.1332	Club work ability (U421)	0.0843
				communication ability (U422)	0.0489

3.3 Design of evaluation method

Construct fuzzy sets

1. Determine the main factor index set U and the corresponding weight set A_1:

$$U=\{U_1,\ U_2,\cdots U_n\} \tag{19}$$

$$A_1=\{a_1,\ a_2,\cdots a_n\} \tag{20}$$

$$\sum_{k=1}^{n} a_k = 1 \tag{21}$$

2. Construct sub-factor index set U_k and the corresponding weight set A_k:

$$U_k=\{U_{k1},\ U_{k2},\cdots U_{km}\} \tag{22}$$

$$A_k=\{a_{k1},\ a_{k2},\cdots a_{km}\} \tag{23}$$

$$\sum_{i=1}^{m} a_{k1} = 1 \tag{24}$$

3. Construct comment set V:

$$V=\{v_1,v_2,\cdots,v_m\} \tag{25}$$

Generally speaking, the comprehensive evaluation of students can be divided into five categories: excellent, good, general, barely, and poor [15], namely:

$$V=\{\text{excellent},\text{good},\text{general},\textit{barely},\text{poor}\} \tag{26}$$

The corresponding fuzzy evaluation vector is:

$$F=\{\text{excellent}(90\sim100),\text{good}(80\sim89),\text{general}(70\sim79),\textit{barely}(60\sim69),\text{poor}(\leqslant59)\} \tag{27}$$

Determine the fuzzy evaluation matrix: The comment set of each index could be obtained from the exam scores of students or the scores given by experts, for index U_{ki}, there are $V_{i1}V_1$-level comments, …, and $V_{im}V_m$-level comments, then for i=1,2,…m, there is:

$$r_{ij}=\frac{V_{ij}}{\sum_{j=1}^{n} V_{ij}} \tag{28}$$

where, rij represents the degree of membership of Uki (index in the sub-factor layer) with respect to the j-level comment Vj.

Then the fuzzy evaluation matrix is:

$$R_k = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n1} & \cdots & r_{nn} \end{bmatrix} \tag{29}$$

Fuzzy matrix operations

$$B_k = A_k \bullet R_k = \{b_{k1}, b_{k2}, \cdots b_{km}\} \tag{30}$$

$$R = \begin{bmatrix} B_1 \\ B_2 \\ \cdots \\ B_n \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{bmatrix} \tag{31}$$

$$B = A \bullet R = \begin{pmatrix} a_1 & a_2 \cdots a_n \end{pmatrix} \bullet \begin{bmatrix} B_1 \\ B_2 \\ \cdots \\ B_n \end{bmatrix} = \begin{pmatrix} b_1 & b_2 \cdots b_n \end{pmatrix} \tag{32}$$

where, B_k and B are respectively the membership degree vectors of each factor layer U_k and objective layer index U to the comment set. When $\sum_{j=1}^{n} bj \neq 1$, perform normalization processing; besides, $\vec{bj} = \frac{bj}{\sum_{j=1}^{n} bj}$, then we can get:

$$\vec{B} = (\vec{b_1}, \vec{b_2} \cdots \vec{b_n}) \tag{33}$$

Comprehensive evaluation model

$$B = A \bullet R = A \bullet \begin{bmatrix} B_1 \\ B_2 \\ \cdots \\ B_n \end{bmatrix} = A \bullet \begin{bmatrix} A_1 \bullet R_1 \\ A_1 \bullet R_1 \\ \cdots \\ An \bullet R_n \end{bmatrix} \tag{34}$$

Evaluation result: The final evaluation result is a value between 0 and 100; by comparing it with the fuzzy evaluation vector F, the comprehensive quality evaluation result of the student can be obtained. According to Formula (34), the membership vector of the objective layer index to the comment set V is:

$$\vec{B} = (\vec{b}_1, \vec{b}_2 \cdots \vec{b}_n) \tag{35}$$

3.4 An application example

This study selected a few senior year students from a university as the evaluation objects. Since the objects were approaching graduation and their academic data on the campus was relatively complete, the meaning of the comprehensive student quality evaluation system could be fully reflected. After collecting the students' exam scores of each subject and their mental quality assessment results, Class I of the graduation grade was finally chosen as the evaluation object. There're 25 students in this class, their evaluation information was collected, and their comprehensive quality was evaluated by the FCE method. Through the above analysis, the weights of indexes at all layers in the EIS were obtained.

1. Construct the factor set: The main factor set included four aspects: ideological and moral quality, cultural quality, physical and mental quality, and developmental quality; it's denoted as $U = (U1, U2, U3, U4)$, and the corresponding weight set was $A = (a1, a2, a3, a4) = (0.1497, 0.4365, 0.1053, 0.3085)$.
2. Construct sub-factor index set and corresponding weight set: Taking the sub-factor set U_1 as an example, the sub-factor index sets were: $U1 = (U11, U12)$,$U11 = (U111, U112, U113)$, $U12 = (U121, U122, U123)$; and the corresponding weights were: $a1 = (a11, a12) = (0.1002, 0.0498)$, $a11 = (a111, a112, a113) = (0.0233, 0.0364, 0.0405)$, $a12 = (a121, a122, a123) = (0.0213, 0.0151, 0.0134)$.
   $F = \{\text{excellent}(90), \text{good}(80), \text{general}(70), \textit{barely}(60), \text{poor}(50)\}$
3. Construct comment set: The comment set was: $V = \{v1, v2, v3, v4, v5\} = \{\text{excellent,good,general,}\ \textit{barely}\text{,poor}\}$
   The corresponding fuzzy evaluation vector was: $F = \{\text{excellent}(90), \text{good}(80), \text{general}(70), \textit{barely}(60), \text{poor}(50)\}$.
4. Calculate the evaluation results of second-level indexes: First, determine the fuzzy relation evaluation matrix. The evaluation matrix was obtained based on the students' exam scores and the evaluation results given by an assessment team on the students. It is assumed that there were 20 members in the assessment team, for the determination of the fuzzy evaluation matrix, taking one of the students as an example, Table 2 shows the evaluation results of the assessment team on this student's political quality.

Table 2. Political quality evaluation results

Grade / Evaluation index	Excellent 90-100	Good 80-89	General 70-79	Barely 60-69	Poor ≤59
Political theory, political attitude (U111)	4	10	6	0	0
Outlook on life, world outlook, values (U112)	7	10	3	0	0
Abide by the law (U113)	5	7	8	0	0

After Table 2 was normalized, the evaluation matrix was obtained as:

$$R_{11}=\begin{bmatrix} 0.2 & 0.5 & 0.3 & 0 & 0 \\ 0.35 & 0.5 & 0.15 & 0 & 0 \\ 0.25 & 0.35 & 0.4 & 0 & 0 \end{bmatrix} \tag{36}$$

The evaluation result of the political quality of the student U_{11} was:

$$\begin{aligned} B_{11} &= a_{11} \bullet R_{11} = (0.0233, 0.0364, 0.0405)\begin{bmatrix} 0.2 & 0.5 & 0.3 & 0 & 0 \\ 0.35 & 0.5 & 0.15 & 0 & 0 \\ 0.25 & 0.35 & 0.4 & 0 & 0 \end{bmatrix} \\ &= (0.0225 \quad 0.0545 \quad 0.0230 \quad 0 \quad 0) \end{aligned} \tag{37}$$

after normalization, $B11 = (0.225 \quad 0.545 \quad 0.23 \quad 0 \quad 0)$.

In the same way, the evaluation result of the moral quality of the student U_{12} was: $B12 = (0.6668 \quad 0.2394 \quad 0.0938 \quad 0 \quad 0)$

The evaluation result of the knowledge quality of the student U_{21} was: $B21 = (0.5336 \quad 0.3614 \quad 0.1050 \quad 0 \quad 0)$.

The evaluation result of the ability quality of the student U_{22} was: $B22 = (0.5333 \quad 0.3667 \quad 0.1 \quad 0 \quad 0)$.

The evaluation result of the cultural and artistic quality of the student U_{23} was: $B23 = (0.4998 \quad 0.3001 \quad 0.2001 \quad 0 \quad 0)$.

The evaluation result of the physical quality of the student U_{31} was: $B31 = (0.0573 \quad 0.7142 \quad 0.2285 \quad 0 \quad 0)$.

The evaluation result of the mental quality of the student U_{32} was: $B32 = (0.2693 \quad 0.2829 \quad 0.4478 \quad 0 \quad 0)$.

The evaluation result of the innovation quality of the student U_{41} was: $B41 = (0.5264 \quad 0.2984 \quad 0.1752 \quad 0 \quad 0)$.

The evaluation result of the organizing and managing quality of the student U_{42} was: $B42 = (0.5670 \quad 0.2336 \quad 0.1994 \quad 0 \quad 0)$.

5. **Calculate the evaluation results of first-level indexes**: The evaluation result of the student's ideological quality U_1 was:

$$\begin{aligned} B_1 &= a_1 \bullet R_1 = a_1 \bullet \begin{bmatrix} B_{11} \\ B_{12} \end{bmatrix} = (0.1002, 0.0498) \bullet \begin{bmatrix} 0.225 & 0.545 & 0.23 & 0 & 0 \\ 0.6688 & 0.2394 & 0.0938 & 0 & 0 \end{bmatrix} \\ &= \begin{bmatrix} 0.0556 & 0.0667 & 0.0277 & 0 & 0 \end{bmatrix} \end{aligned} \tag{38}$$

after normalization, we can get: $B1 = [0.3706 \quad 0.4447 \quad 0.1847 \quad 0 \quad 0]$.

In the same way, the evaluation result of the student's cultural quality U_2 was: $B2 = [0.5286 \quad 0.3546 \quad 0.1168 \quad 0 \quad 0]$.

The evaluation result of the student's physical and mental quality U_3 was $B3 = [0.1099 \quad 0.6071 \quad 0.2830 \quad 0 \quad 0]$.

The evaluation result of the student's developmental quality U_4 was $B_4 = [0.5751 \quad 0.2595 \quad 0.1654 \quad 0 \quad 0]$.

6. Calculate the evaluation result of comprehensive quality

$$B = A \bullet R = (a_1, a_2, a_3, a_4) \bullet \begin{bmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{bmatrix} \tag{39}$$

After data substituting and normalization processing, we can get $B = [0.4577 \quad 0.3676 \quad 0.1738 \quad 0 \quad 0]$.

The student's comprehensive evaluation result was $B \cdot F = 83.73$ points, and the comprehensive quality evaluation grade was good.

In order to evaluate the comprehensive quality of students more accurately, we can also calculate the scores of each second-level indexes and give evaluations of students from multiple aspects and levels, so that the students could understand their own strengths and weaknesses according to the evaluation results and find the right directions for their future efforts; moreover, the implementation of quality education in higher education schools could be carried out in a more targeted manner. After calculation, this student scored 78.32 points in political quality and 77.12 points in mental quality, and his/her scores in other factors were all above 80 points, indicating that this student need to work on the political quality learning and mental quality training in the future.

4 Conclusion

As the quality education reform is advancing continuously in China, the comprehensive quality of college students has received more attention from all walks of life. Aiming at scientifically and reasonably evaluate the comprehensive quality of college students, this study employed the fuzzy comprehensive evaluation method to carry out research on its application in the evaluation of the comprehensive quality of higher education students. The specific conclusions are:

1. After carefully reviewing and analyzing the relevant documents of talent training and student management of colleges and universities, this paper combined with the actual requirements of the society for talents at the current stage to construct an EIS for the evaluation of the comprehensive quality of college students.
2. AHP and FCE methods were employed to construct an evaluation model for the target matter, and the design details were elaborated in the text.
3. Using an example, this paper introduced the specific application of the proposed FCE algorithm in the evaluation of the comprehensive quality of college students in detail, and the research results showed that, the proposed method can scientifi-

cally and reasonably evaluate these students' comprehensive quality from multiple aspects and levels.

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