

The Application of Modified Delphi-AHP Method in the College Students' Comprehensive Quality Evaluation System

Ao Yonghong, Yang Bohan, Yi Fan and Zou Gang

Abstract—The quality of the human beings trained by college schools affect the level of troop's battle effectiveness in the future. Establishing a scientific and rational appraisal system overall quality of students can promote the comprehensive development of students. In this paper, we use modified Delphi method to establish evaluation index system, then propose a kind of index weights ascertainment method based on the combination of modified Delphi and AHP. We quantitatively determine the evaluation index weights and the inverse proportions of the main evaluation comments' attitude, so as to establishing the comprehensive quality evaluation model of college student based on modified Delphi-AHP method and completing a comprehensive quality evaluation list for college students. It serves as the theory foundation of the comprehensive quality evaluation system of college students.

Index Terms—Delphi, AHP, comprehensive quality, evaluation system.

I. INTRODUCTION

Implementation of the overall quality of education is the essential requirement of the university education and eternal responsibility. The 21st century is a century full of challenges and drastic changes, with the continuous deepening of scientific and technological development and China's reform and opening up, and exploring contemporary Chinese college students overall quality of training development needs of high-quality talent, of great significance. Construction of the comprehensive quality of college students' evaluation system must keep pace with the times, and the training objectives should help to promote the comprehensive development of students, and fully mobilize the college students' initiative, to develop high-quality university commanders and promote scientific, standardized and institutionalized education management and digital. Therefore, it is an urgent issue for the colleges to construct a scientific and reasonable comprehensive quality evaluation system and exert the enthusiasm of the students. Referring to the modified Delphi-AHP method, this paper makes both qualitative and quantitative analysis of the college students'

comprehensive evaluation results. On the basis of identifying the evaluation index and weights, combined with the views of the evaluation main body, this paper establishes the college students' comprehensive quality evaluation model and lays a theoretical foundation to construct the college students' comprehensive quality evaluation system.

II. THE METHOD OF DESIGNING THE COMPREHENSIVE QUALITY EVALUATION MODEL

A. Modified Delphi Method (M-Delphi)

Delphi method [1] is a method which is based on systematic procedures and adopts the way of anonymous comments that means not another discussion among experts and only communications with the investigators; through multiple rounds of investigating experts' views to questions of the questionnaire, they finally form the consistent views by consultation, induction and modification time after time, which are regarded as the predicted results. Delphi method is an effective method to integrate experts' views. This paper adopts Delphi method to identify the weight coefficient of the evaluation main body.

B. Analytic Hierarchy Process (AHP)

AHP [2] is a systematic analysis method which was proposed by a professor in the University of Pittsburgh named Satai in the 70 years of 20th century. It regards the evaluation subjects or problems as a system, and breaks down the problems into different elements according to the nature of question and the expected overall objective, and gathers those elements at different levels in accordance with the correlation and subordination among the elements, to form a multi-level analysis system which makes the problems organized and hierarchical. This research adopts AHP and makes wise comparison and forms a matrix to calculate the relative compared weight, and makes the consistency test of the matrix. Form the framework of indicator system and the level indicators and identify the indicators' weight, which make the evaluation system more scientific and reasonable. This paper adopts AHP to identify the collection of the weight.

In order to establish the College students' Comprehensive Quality Evaluation System based on modified Delphi-AHP method, we should firstly build up a index system of evaluation model; secondly, we must

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calculate the weight of each evaluation index; thirdly, identify the weight coefficient of every evaluation main body; Fourth, the evaluation data to be obtained in order to support the evaluation of applications, and through the

application of, and constantly improve the evaluation model index system. The steps to establish the model and the corresponding designing methods are shown in Fig. 1.

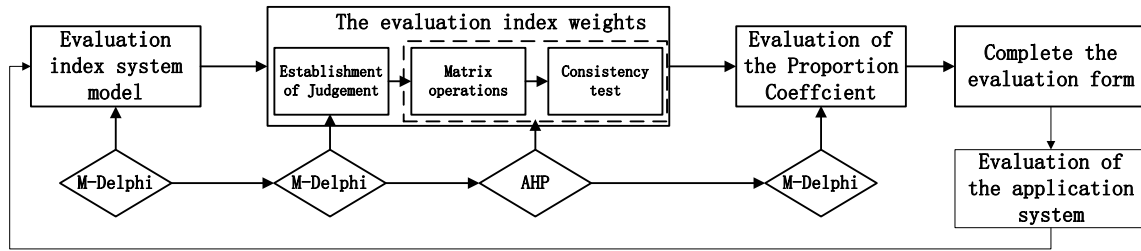


Fig. 1. The Overall Quality of College students' Method of Map Design Process Assessment Model

III. COLLEGE STUDENTS' COMPREHENSIVE QUALITY EVALUATION MODEL

A. The Evaluation Model Index System

Evaluation indicator is the principle of qualitative description and quantitative evaluation to the evaluation elements of the cadets' comprehensive quality, which is the basis for the examiners to determine the assessing and evaluating levels. In order to make the evaluation effective, we should depend on the scientific evaluation

index system. Referring to the related materials on the students' comprehensive quality evaluation in recent 10 years evaluation, consulting the current related files on college students' comprehensive quality evaluation, the author lists the possible evaluation indicators and designs the table for the expert advice, and hires 35 experts who have engaged in relevant research, teaching and management for a long time, and adopts the M-Delphi method and organizes three rounds of expert consultation (see Table I).

TABLE I: EXPERTS COMPLEXION³

| Item | Count | Proportion (%) | |
|--------------------------|---------------------------------|----------------|-------|
| Department director | 3 | 8.57 | |
| Party branch secretaries | 2 | 5.71 | |
| Principal ship | Department Director or teachers | 13 | 37.14 |
| | Students counselor | 6 | 17.14 |
| | Education and technical workers | 11 | 31.43 |
| distinction | High | 21 | 60 |
| | Intermediate | 14 | 40 |

According to the requirement of the M-Delphi method, it needs a detailed guide of completing tables at every consultation, and feeds back the responses of last round to the participants. After all the data being collected, the

author makes the statistical analysis and identifies the evaluation indicators according to the consultation results. The hierarchical structure of the evaluation indicator collection is shown in Fig. 2.

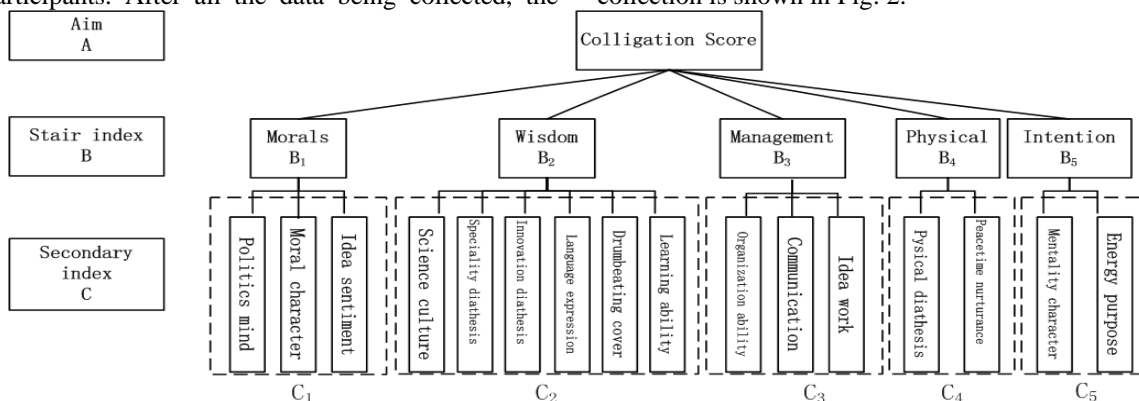


Fig. 2. The level of structure evaluation indicators

B. The Indicators' Weights of the Evaluation Model

1) Form the comparison matrix by using the M-Delphi method and get the indicator weight of each level

a) Identify the first-level evaluation indicators' weight coefficients

First-level indicators: Virtue (B₁), Intelligence (B₂), Management (B₃), Physical Quality (B₄), Mental Quality (B₅). In this paper, the author uses sum-product method to calculate weight coefficient for each indicator. The comparison matrix and indicators' weights are as follows:

TABLE II: MATRIX COMPREHENSIVE EVALUATION INDEX

| A | B ₁ | B ₂ | B ₃ | B ₄ | B ₅ | W |
|----------------|----------------|----------------|----------------|----------------|----------------|--------|
| B ₁ | 1 | 5/4 | 5/2 | 5/3 | 5/2 | 0.3125 |
| B ₂ | 4/5 | 1 | 2 | 4/3 | 2 | 0.2500 |
| B ₃ | 2/5 | 1/2 | 1 | 2/3 | 1 | 0.1250 |
| B ₄ | 3/5 | 3/4 | 3/2 | 1 | 3/2 | 0.1875 |
| B ₅ | 2/5 | 1/2 | 1 | 2/3 | 1 | 0.1250 |

The expected feature vector $W_1 = [0.3125, 0.2500, 0.1250, 0.1875, 0.1250]^T$, is the weight coefficient of each first-level evaluation indicator. As $CR = 0 < 0.1$, it passes the consistency test.

b) Identify the second-level evaluation indicators' weight coefficient

Referring to Figure 1, following the operation idea of the first step, we can deal with the importance of second-level C level to the first-level B level respectively, and get the comparison matrix and the final results (due to the limitation of space, the comparison matrix is omitted). They are:

$$W_{B_1} = [0.2857, 0.2857, 0.4286]^T,$$

$$W_{B_2} = [0.2727, 0.1818, 0.1818, 0.0909, 0.0909, 0.1818]^T,$$

$$W_{B_3} = [0.5250, 0.3700, 0.1050]^T,$$

$$W_{B_4} = [0.6667, 0.3333]^T,$$

$$W_{B_5} = [0.5000, 0.5000]^T.$$

The above two steps are the second and third steps of the AHP method, which complete the establishment of comparison matrix and the arrangement the single-judge

order and the consistency test.

2) The table of evaluation indicators' weights

According to the integration methods of AHP method, the calculation process of weights vector W which is C level is:

$$W = \begin{bmatrix} W_{B_1} & 0 & 0 & 0 & 0 \\ 0 & W_{B_2} & 0 & 0 & 0 \\ 0 & 0 & W_{B_3} & 0 & 0 \\ 0 & 0 & 0 & W_{B_4} & 0 \\ 0 & 0 & 0 & 0 & W_{B_5} \end{bmatrix} W_1$$

= (0.0893 , 0.0893 , 0.1339 , 0.0682 , 0.0455 , 0.0455 , 0.0227 , 0.0227 , 0.0455 , 0.0656 , 0.0463 , 0.0131 , 0.1250 , 0.0625 , 0.0625 , 0.0625)^T, and the overall levels order satisfies the request of consistency test. After identifying the evaluation indicators and their weights, we can see the table of evaluation indicators' weights in Table III.

TABLE III: EVALUATION MODEL WEIGHT TABLE

| Aim level | Stair index | Secondary index | |
|--|------------------------------|-----------------|--------|
| Synthesis diathesis account A | Morals B ₁ | C ₁₁ | 0.0893 |
| | | C ₁₂ | 0.0893 |
| | | C ₁₃ | 0.1339 |
| | Wisdom B ₂ | C ₂₁ | 0.0682 |
| | | C ₂₂ | 0.0455 |
| | | C ₂₃ | 0.0455 |
| | | C ₂₄ | 0.0227 |
| | | C ₂₅ | 0.0227 |
| | | C ₂₆ | 0.0455 |
| | Management B ₃ | C ₃₁ | 0.0656 |
| | | C ₃₂ | 0.0463 |
| | | C ₃₃ | 0.0131 |
| | Physical B ₄ | C ₄₁ | 0.1250 |
| | | C ₄₂ | 0.0625 |
| | Intention B ₅ | C ₅₁ | 0.0625 |
| C ₅₂ | | 0.0625 | |

IV. CONSTRUCT THE COMPREHENSIVE QUALITY EVALUATION TABLE

College students' comprehensive quality evaluation is an issue of multi-index comprehensive evaluation, which integrates several evaluation indicators into an overall comprehensive result. Considering the feature of cadets' comprehensive quality evaluation, we use the weighted average method [3].

$$A = \sum_{j=1}^n \omega_j x_j, j = 1, 2, \dots, n$$

In the formula, A is the numerical value of the evaluation object; ω_j is the weight coefficient, and x_j is the numerical value of the weight, and they satisfy the following relationship:

$$0 \leq \omega_j \leq 1, \sum_{j=1}^n \omega_j = 1$$

In order to get the college students' comprehensive scores, we need to identify the weights from two respects: one is the respect of evaluation main body, that is, identifying the weight coefficient of scores given by the evaluation main body according to the degree of importance of various evaluation advices; the other one is from the respect of indicator system, which needs to identify the weights collection of each level in the indicator system.

As for the college students' comprehensive quality, there are four kinds of evaluation body, and they are classmates, department director, education and technical workers and party groups. As several evaluation main bodies participant into the decision making process, the evaluation belongs to group decision making issues, and we should identify the importance degree of the advices from those four kinds of evaluation main bodies. M-

Delphi method is an effective method for solving group decision making issues, and it can integrate the experts' advices to the greatest extent and get the relatively precise results. Therefore, through adopting the M-Delphi method, consulting to experts in related fields, we finally identify the evaluation main bodies, that is, classmates, corps leaders, teachers and Party Group, and the coefficient collection of their advices' importance degree $W_2=(0.3,0.2,0.2,0.3)$.

College students' comprehensive quality evaluation scores $A = W^T X W_2^T$. In the matrix, numerical values in each row are the scores given by the evaluation bodies from 16 second-level indicators. The magnitude order of A reflects the level order of college students' comprehensive quality.

After identifying each level's evaluation indicator weights of college students' comprehensive and the importance degree coefficient of the evaluation main bodies, we can form the college students' comprehensive quality evaluation table (see in Table 4).

V. CONCLUSION

The great significance of constructing the college students' comprehensive quality evaluation system is not only to form a scientific motivating mechanism but also to guide the healthy development of college students. We combine the evaluation result with the selection, and the scores reflect the individual's capability and his contribution to the collectivity, which the great significance of constructing the college students' comprehensive quality evaluation system is

TABLE IV: SYNTHESIS DIATHESIS EVALUATION OF COLLEGE STUDENTS

| Stair index | Secondary index | Proportion | graduation | | | | Subtotal |
|---------------|-----------------------|------------|---------------|--------------|--------------|------------|----------|
| | | | A (100-90) | B (89-80) | C (79-60) | D (<60) | |
| Morals | Politics mind | 0.0893 | | | | | |
| | Moral character | 0.0893 | | | | | |
| | Idea sentiment | 0.1339 | | | | | |
| Wisdom | Science culture | 0.0682 | | | | | |
| | Speciality diathesis | 0.0455 | | | | | |
| | Innovation diathesis | 0.0455 | | | | | |
| | Language expression | 0.0227 | | | | | |
| | Drumbeating cover | 0.0227 | | | | | |
| | Learning ability | 0.0455 | | | | | |
| Management | Organization ability | 0.0656 | | | | | |
| | Communication | 0.0463 | | | | | |
| | Idea work | 0.0131 | | | | | |
| Physical | Physical diathesis | 0.1250 | | | | | |
| | Peacetime nurturance | 0.0625 | | | | | |
| Intention | Psychological quality | 0.0625 | | | | | |
| | Energy purpose | 0.0625 | | | | | |
| Overall score | | | | | | | |

not only to form a scientific motivating mechanism but also to guide the healthy development of college students. We combine the evaluation result with the selection, and the scores reflect the individual's capability and his contribution to the collectivity, which provide the evidence of selecting backbones and party activists among the college students; combining the evaluation results with assessing process can motivate college students' learning and training passion; combining the evaluation results with graduation assignment can help establish an assignment mechanism involved the assignment with the evaluation.

In this paper, the author adopts the M-Delphi method to establish an evaluation indicator system and takes the feature of college students' comprehensive quality evaluation into account, and suggests combining the AHP with the M-Delphi method to identify the indicator weights. This paper solves the key problems in the college students' comprehensive quality evaluation process from a quantitative view, that is, identifying the evaluation indicator weights and the importance degree of the advices from the evaluation main bodies, based on which the author also constructs the college students'

comprehensive quality evaluation model and forms the evaluation table. Provides the theoretical basis for the establishment of the college students' comprehensive quality evaluation system, enable the evaluation of evaluation results are more accurate and scientific. The assessing process can motivate college students' learning and training passion; combining the evaluation results with graduation assignment can help establish an assignment mechanism involved the assignment with the evaluation.

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