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Establishment and Optimization Algorithm of Fuzzy Index Evaluation System for Course Ideological and Political Teaching

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Abstract: In recent years, ideological and political work is not only the necessary premise for schools to adhere to socialist education, but also the main purpose of school moral education. Based on the teaching research of ideological and political course, this paper established five first-level indicators, including teaching objectives, teaching contents, subject objects, course evaluation process and educational evaluation methods. Based on the analytic hierarchy process, this paper analysed the ideological and political teaching structure of the course from many angles. Professional teachers could be targeted in the process of ideological and political teaching of professional courses, with the help of evaluation index system of ideological and political teaching as support and guidance. In addition, this paper also optimized the initial indicators by expert correspondence and analytic hierarchy process to establish the evaluation index system of ideological and political course and determine the weight distribution. Through the analysis of the experimental data, it was found that the α coefficient of each dimension was higher than 0.85, which was qualified after inspection. The Sampling Suitability Quantity (KMO) value was greater than 0.86, indicating that the index system was stable, consistent and valid.

1. Introduction

The 19th National Congress of the Communist Party of China marks a new era. Chinese education must cultivate talents fitting this era. Schools integrate ideological and political education into their curriculum, yielding positive results. Evaluation should focus on significance. Effective teaching considers both student learning outcomes and teaching methods, avoiding mechanical explanations that disregard student learning patterns.

There isn't a lot of research being done on the evaluation of curriculum ideological and political teaching in China right now, and what little there is tends to focus on the techniques and connotations of such evaluation. The current successful curriculum ideological and political teaching assessment index system is filled up using this way.

2. Related Work

Academics view ideological and political curricula positively, emphasizing its role in educating students. Zhou Y highlighted how such courses cultivate professional outlook, legal outlook, and patriotism among students [1]. Wang Z noted the significant role of curricular ideology and politics in school ideological instruction [2]. Maurer M stressed the need for schools to leverage their unique advantages within curriculum ideology and politics for breakthroughs in ideological education in professional courses [3]. Overall, improving ideological and political teaching in courses requires enhancing teacher caliber, developing moral education materials, and promoting extracurricular activities for students. The creation of an evaluation index system for curriculum ideological and political instruction aids in guiding instructors and students, fostering perspective changes, method innovation, and material enhancement. Carlucci D proposed the fuzzy index system to enhance teaching quality in the short, medium, and long terms [4]. He H emphasized the need for merging BP neural network and fuzzy mathematics theory to improve assessment efficiency [5]. Fang C highlighted preprocessing of evaluation indicators and the creation of a support vector machine teaching evaluation model for teaching fuzzy indicators based on machine learning [6]. Zhang S suggested using AHP and Fuzzy AHP to derive weight coefficients for each evaluation index in a teaching evaluation system [7]. Despite existing research, there's a lack of focus on assessing ideological and political curriculum instruction.

3. Relevant Algorithms for Establishing an Evaluation System Based on Machine Learning

3.1 Design of the Evaluation System for Ideological and Political Teaching of Courses

(1) Demand analysis of the evaluation system

The completion of the course ideological and political teaching evaluation must be based on the needs analysis of the evaluation system, through the establishment of a basic information management platform to build an evaluation system, develop a corresponding data input or input platform, and conduct a comprehensive evaluation [8]. The evaluation of teaching quality is realized, and it is designed flexibly according to different stages. According to the network design of this system, each user's roles are situated in a different campus department and are connected to the system server and central switch [9]. The network structure diagram of the system is shown in Figure 1.

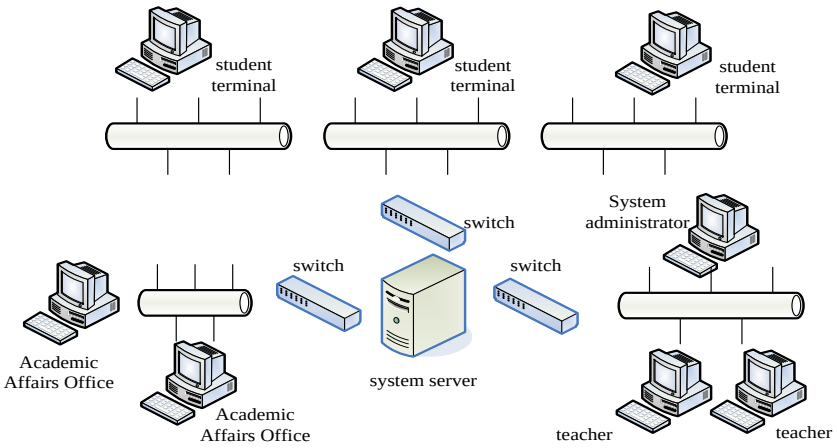


Figure 1: System network structure diagram

When designing the network structure (see Figure 1), ensure strict separation between internal

and external networks. External users should not access the internal network. The system meticulously controls user identity, logs user activities—including data queries and maintenance—and audits by administrators to track system activity and ensure data security [10-11].

Teaching evaluation adopts the method of evaluation management, which includes two levels of query and maintenance of evaluation management. The overall teaching evaluation process is shown in Figure 2.

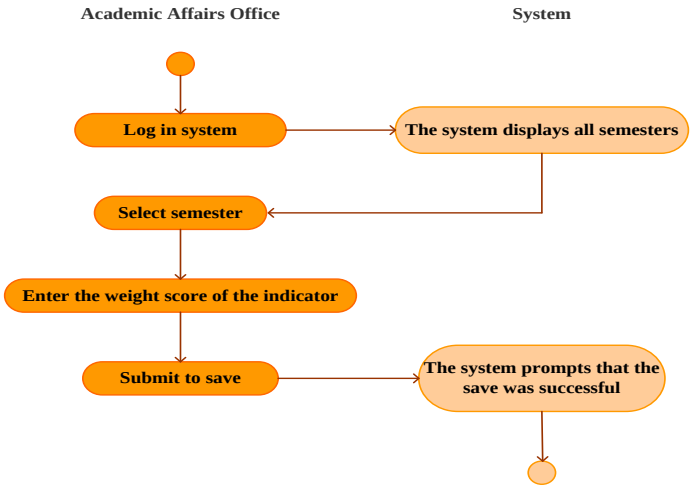


Figure 2: Flow chart of teaching evaluation formulation

As shown in Figure 2, the Academic Affairs Office first logs into the system, selects an academic year, enters the corresponding index data and archives it, and then enters the index data of each academic year and each semester in turn, and the system prompts that the storage is successful [12]. The method based on fuzzy comprehensive evaluation is to synthesize various evaluation indicators and file them in the system of the Academic Affairs Office. After being systematically processed, they are classified as “Very Satisfied”, “Satisfied”, “Basically Satisfied”, “Fair” and “Unsatisfactory” [13-14].

(2) Index analysis of the evaluation system

Curriculum ideological and political instruction is evaluated based on the integration of the original curriculum evaluation indicators, which emphasizes the fundamental idea of “cultivating morality and cultivating people”, rather than on the evaluation of the original curriculum evaluation indicators [15]. The basic process of using the fuzzy index evaluation method is shown in Figure 3.

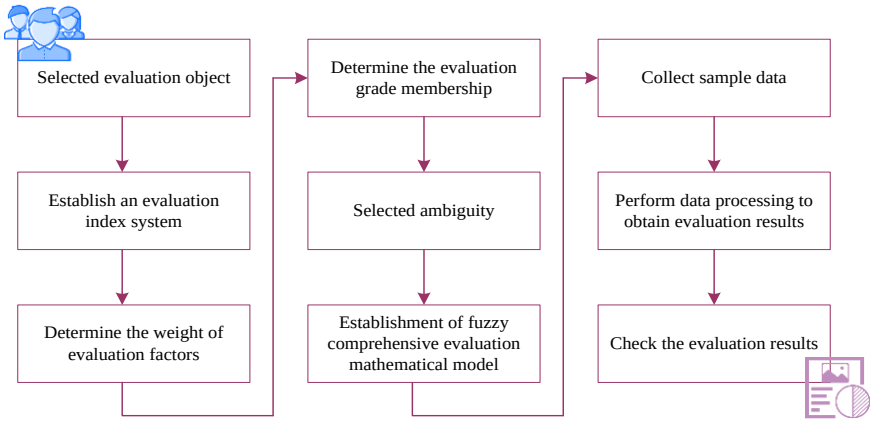


Figure 3: The basic process of using fuzzy index evaluation method

As shown in Figure 3, to use the fuzzy index evaluation method, it is first necessary to select the evaluation object. After selecting the fuzzy factors, the mathematical model of the evaluation is established, the sample data is collected, and the collected data is evaluated to obtain the results, and finally the results are tested [16]. While imparting subject knowledge and cultivating subject skills, the value guidance to students is firmly grasped. The emphasis should be on "preaching, teaching, and dispelling doubts" [17]. When designing assessment indicators, consider teaching preparation, organization, methods, and impact. Ideological and political teaching evaluation should encompass five perspectives, with specific indicators detailed in Figure 4.

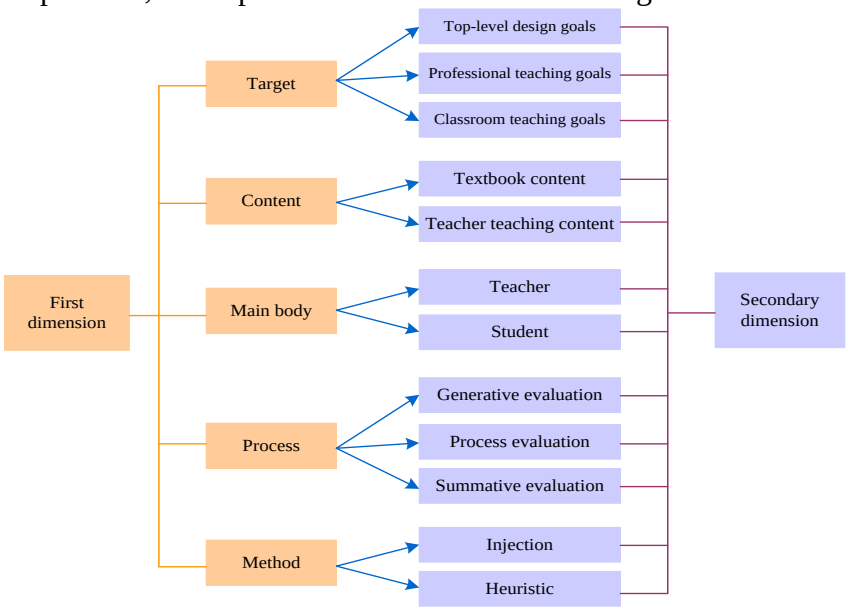


Figure 4: Course ideological and political teaching evaluation system indicators

As shown in Figure 4, the effective evaluation of curriculum ideology and politics mainly focuses on five aspects: teaching objectives, teaching content, subject objects, curriculum evaluation process and educational evaluation methods. Figure 5 depicts the five-dimensional ability model of political and ideological education.

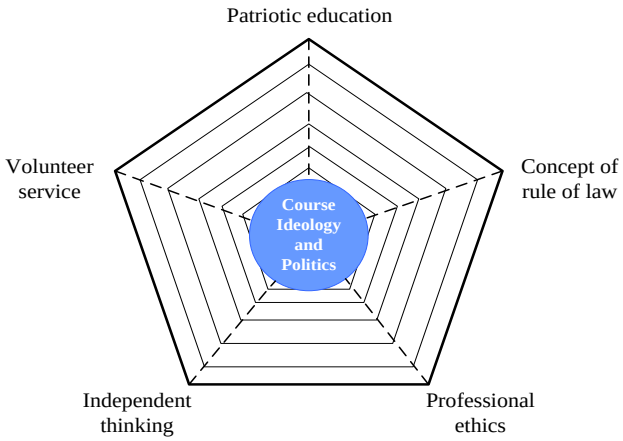


Figure 5: Five-dimensional ability model of course ideological and political teaching

As shown in Figure 5, to carry out the quality assessment of curriculum ideological and political teaching, the five-dimensional ability model of curriculum ideological and political teaching begins with five dimensions: patriotic education, the concept of the rule of law, independent thinking, professional ethics, and volunteer service.

3.2 Evaluation Algorithm of Fuzzy Index

When crafting assessment indices, adhere to clear objectives, comprehensive requirements, and holistic consideration of the object. Minimize overlap, enhance independence, representativeness, and contribution of indicator groups. Select concise indicators initially for accurate and objective evaluation results.

(1) Single-level fuzzy evaluation algorithm

The set of evaluation factors is determined, as shown in formula 1:

$$W = \{w_1, w_2, ..., w_i\} \tag{1}$$

The evaluation frame consists of factor $w_m, m = 1,2,..., i$, where i represents the number.

Secondly, the set of evaluation results is determined, as shown in formula 2:

$$R = \{r_1, r_2, ..., r_j\} \tag{2}$$

The number of grades j determines $r_n, n = 1,2,..., j$.

The weight set is determined, as shown in formula 4:

$$E = \{e_1, ..., e_j\} \tag{3}$$

Among them, $e_m, m = 1,2,..., j$ represents the importance of factor $w_m, m = 1,2,..., j$, the weight assigned to $w_m, m = 1,2,..., j$, so:

$$\sum_{m=1}^{j} Em = 1, 0 \le Em \le 1 \tag{4}$$

(2) Multi-level fuzzy evaluation algorithm

When there are several components, it is difficult to determine the weighting factor, which divides these factors into groups according to their nature. Firstly, the set Q of factor class weights is determined. If the weight of the m-th factor $w_m, m = 1,2,..., l$ is $e_m, m = 1,2,..., l$, the set of weights for this factor classification is:

$$Q = (e_1, e_2, ..., e_j) \tag{5}$$

Next, a set of factor weights, Q_m, is determined. Each factor in each element is assigned a matching weight based on its importance. The weight of the n-th factor $w_{mn}, m = 1,2,..., m; n = 1,2,..., i$ in the m-class is set to be $e_{mn}, m = 1,2,..., m; n = 1,2,..., i$, and the factor weight set represents:

$$Q_m = (e_{m1}, e_{m2}, ..., e_{mi}), m = 1,2,..., l \tag{6}$$

(3) Fuzzy comprehensive evaluation of the lowest and second lowest factors

Based on each factor in a category, a thorough review is carried out. The single-factor membership degree matrix of the comprehensive evaluation is as follows:

$$V_m = \begin{pmatrix} v_{m11} & v_{m12} & \cdots & v_{m1t} \\ v_{m21} & v_{m22} & \cdots & v_{m2t} \\ \cdots & \cdots & \cdots & \cdots \\ v_{mi1} & v_{mi2} & \cdots & v_{mit} \end{pmatrix}, m = 1,2,...,l \tag{7}$$

In fuzzy comprehensive evaluation, one factor's values are combined to assess overall impact. When evaluating a single factor within comprehensive evaluation, aim for the simplest fuzzy evaluation matrix.

$$P = \begin{matrix} P_1 \\ P_2 \\ \cdots \\ P_l \end{matrix} = \begin{pmatrix} Q_1 & \bullet & V_1 \\ Q_2 & \bullet & V_2 \\ & \cdots & \\ Q_l & \bullet & V_l \end{pmatrix} = (p_1 \quad p_2 \quad \cdots \quad p_l) \tag{8}$$

3.3 Common Optimization Algorithms

(1) Indicator weights based on AHP

In order to prove the validity of the weight, the maximum eigenvector value $\lambda \max$ of the matrix is determined, then:

$$Wx = \Pi_y^j nxy (x = 1,2,..., j) \tag{9}$$

The nth root of Wx is computed:

$$\bar{uy} = \sqrt[n]{Wx} \tag{10}$$

$\bar{ux}$ formula is:

$$\bar{ux} = \frac{ux}{\sum_{y=1}^{n} uy} \tag{11}$$

The average random consistency index PI value is shown in Table 1.

Table 1: Average stochastic consistency indicator PI values

j	1	2	3	4	5	6
PI	0.1	0.3	0.59	0.93	1.16	1.36

According to Table 1, the higher the CI value obtained, the less consistent the matrix is. If the test effect $CR = 0$, the matrix has strong consistency; if $CR < 0.10$, the matrix has good consistency; if $CR \geq 0.10$, the judgment matrix must be reconsistent.

(2) Multi-objective optimization analysis

Conflicting requirements often arise in scientific research because several requirements must be satisfied simultaneously for a complex problem. The MOP framework is shown in Figure 6.

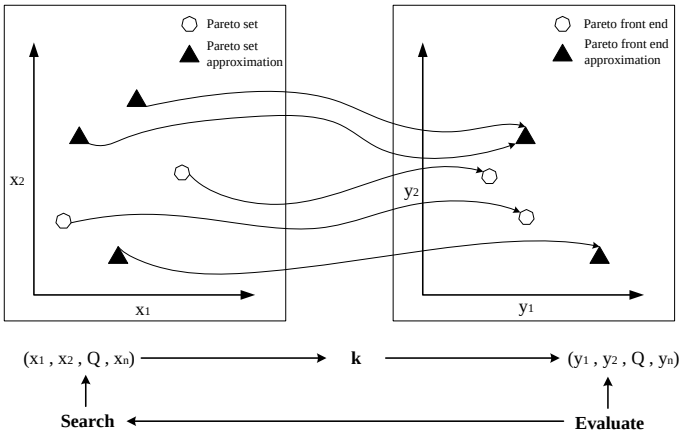


Figure 6: MOP framework

If the MOP is to be expressed mathematically, it is assumed that there are m objective functions and n-dimensional decision variables. Selection from all non-inferior solutions is performed according to the requirements, circumstances and preferences of the specific problem.

$$\begin{gathered} \min Y = K(x) = (k_1(x), k_2(x), ..., k_n(x)) \\ r.g \quad h_m(x) \le 0, m = 1,2,..., q \\ u_n(x) \le 0, m = 1,2,..., p \\ x \in O \end{gathered} \tag{12}$$

$x \in O$ represents the m-dimensional decision variable of the m-dimensional decision space $x = (x_1, x_2, ..., x_m), x_m$.

4. Experimental Results on the Evaluation of Fuzzy Ideological and Political Indicators of the Curriculum

4.1 Results of the Expert Inquiry Letter Analysis

When determining indicator weights, 15 experts were invited to make relevant comparisons. At the same time, the AHP was used to determine the weights to make the weights more scientific, reasonable and accurate. The specific assignments are shown in Table 2.

Table 2: Indicator familiarity assignment table

Familiarity	Very Familiar	Relatively Familiar	Generally Familiar	Relatively Unfamiliar	Unfamiliar
Assign	0.9	0.7	0.5	0.3	0

As shown in Table 2, the familiarity is divided into 5 grades, which are very familiar, relatively familiar, general familiar, not very familiar, and completely unfamiliar. Table 3 shows the coordination of correspondence by experts.

Table 3: Degree of coordination of expert opinion for round 2 correspondence

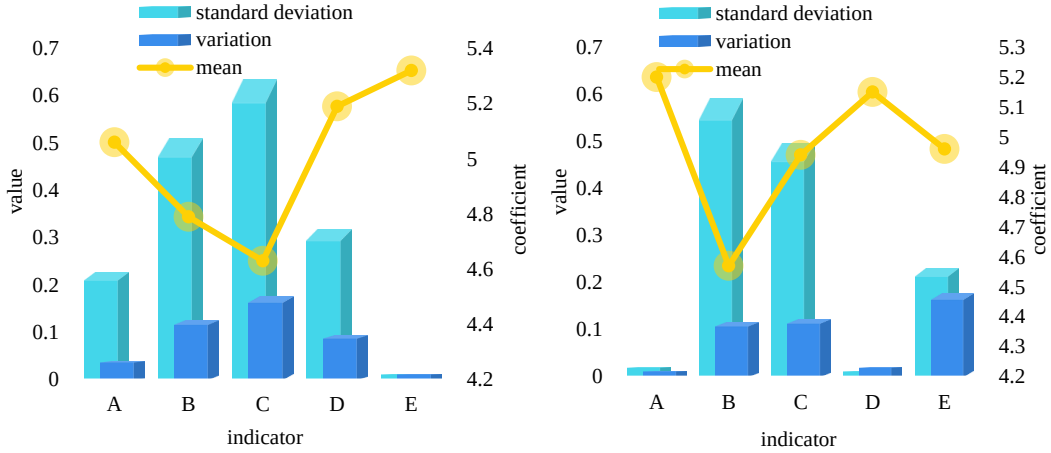
Project	First Round (Index)			Second Round(Index)		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
W	0.27	0.261	0.214	0.315	0.298	0.307
X	22.351	74.98	188.69	25.93	71.36	290.572

As can be seen from Table 3, the results of two rounds of expert correspondence show that the

overall coordination coefficient of experts is high. The comparison of the results of the first-level indicators of the two rounds of correspondence is shown in Figure 7.

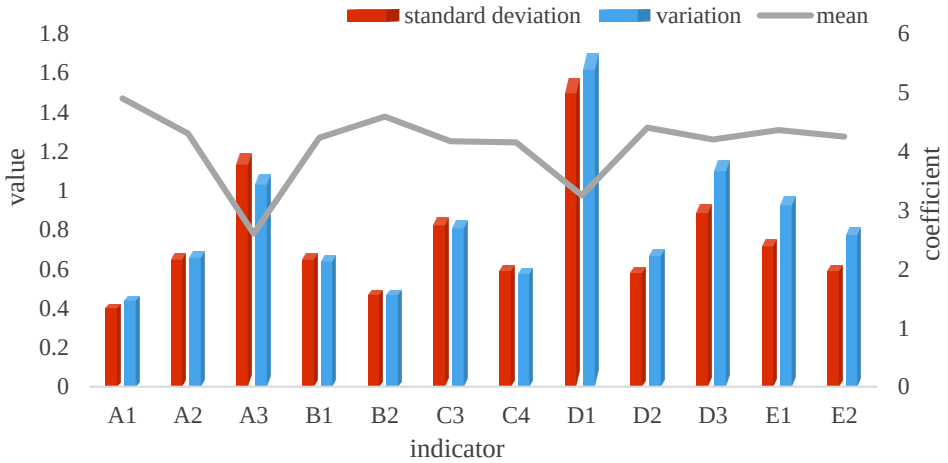
It can be seen from Figure 7(a) that the coefficient of variation is 0-0.2, the mean of assignment is greater than 4.2, the standard deviation is less than 0.7, and the coefficient of variation is less than 0.3. As can be seen from Figure 7(b), the mean value of importance assignment is 4.5-5.2, the standard deviation is 0.01-0.6, the coefficient of variation is 0.01-0.02, and the mean value of assignment is greater than 4.55. The standard deviations are all less than 0.6, and the coefficients of variation are all less than 0.18, which meet the standard.

The results of the two rounds of correspondence for the second-level indicators are compared in Figure 8.

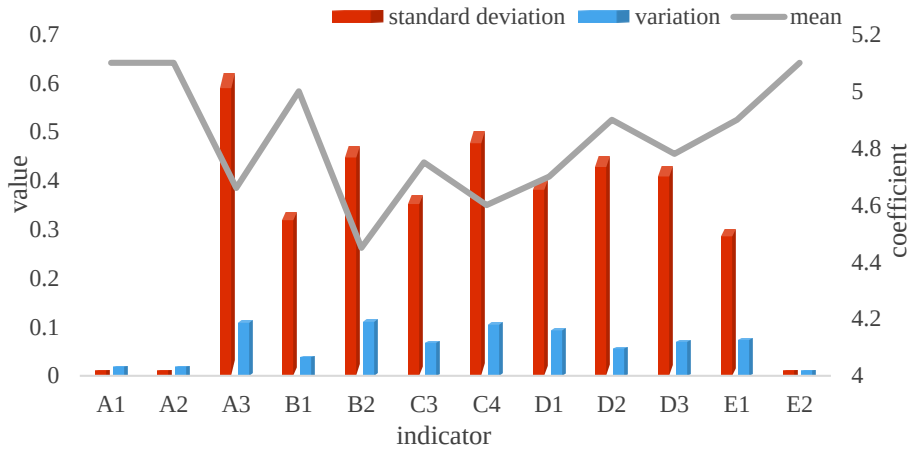


(a) Results of the first round of primary indicators (b) Results of the second round of primary indicators

Figure 7: Comparison of the results of the first-level indicators of two rounds of correspondence



(a) Results of the first round of secondary indicators



(b) Results of the second round of secondary indicators

Figure 8: Comparison of the results of the second-level indicators of two rounds of correspondence

As shown in Figure 8(a), after evaluating the 12 secondary indicators, the coefficient of variation is between 0.4 and 1.7, of which 2 indicators have a mean value of less than 3.9 and a standard deviation greater than 1.1. As shown in Figure 8(b), after evaluating the 12 secondary indicators, the mean of the index importance assignment is 4.4-5.2, the standard deviation is 0.01-0.65, the coefficient of variation is 0.01-0.12, and the mean of assignments are all greater than 4.4. The standard deviations were all less than 0.7, and the coefficients of variation were all less than 0.15. They meet the inclusion criteria of research indicators, and since experts have not commented on the secondary indicators, the secondary indicators in this round have not been revised.

4.2 Reliability and Validity Analysis of Teaching Fuzzy Index Evaluation System

Reliability can reflect the actual degree of the measurement results. In terms of reliability test, the Cronbach's α coefficient is used in this experiment to verify its consistency and stability. The higher the α coefficient is, the better the consistency of the scale is. The reliability test coefficient is shown in Table 4.

Table 4: Reliability test coefficient

	Number of Items	α Coefficient
Target	6	0.879
Content	7	0.867
Main Body	9	0.889
Process	6	0.893
Method	8	0.915

As shown in Table 4, for the criterion of α coefficient, 0.85 or more is an acceptable range. After inspection, the α coefficient values in this study are all higher than 0.85, indicating that the reliability is very high and the situation is ideal.

Validity is the degree to which the validity of the results is measured and is an important measure. Construct validity is the degree to which a concept or property of a theory is measured, and the most commonly used test is factor analysis. The quantity of samples has a direct impact on the reliability of factor analysis. Teachers' data are used in this experiment for factor analysis, and the KMO value is chosen for assessment. The KMO value ranges from 0 to 1. If the KMO value is less than 0.6, it means that the scale item is not suitable for factor analysis; if it is between 0.6 and 0.8, it means that the relationship between the scale items is moderate and that factor analysis can be done;

and if it is greater than 0.85, it means that the relationship between the scale items is good. Table 5 displays the specific outcomes.

Table 5: KMO and Bartlett's sphericity test

	KMO Value	Bartlett's x^2	Sig.
Target	0.888	447.96	0
Content	0.862	325.35	0
Main Body	0.873	396.587	0
Process	0.893	635.891	0
Method	0.882	535.963	0

As shown in Table 5, the KMO value of each dimension is greater than 0.86. Moreover, the P values associated with Bartlett's sphericity test of each dimension and total scale are all 0, so this experiment is suitable for factor analysis.

5. Conclusions

The educational idea of curriculum ideological and political education has already clarified its future development path, and it conforms to the development of educational thought in the new era. Currently, academic research is productive and the ideological and political construction of the curriculum is continually evolving, but there is a dearth of practical and applied research. Curriculum ideological and political evaluation research is a crucial starting point for enhancing and increasing the quality of curriculum ideological and political teaching since it is a practical and applied field of study. The evaluation method created by fuzzy indicators exhibited good reliability and validity, according to experiments. This study utilized the effective and precise curricular ideological and political teaching evaluation index approach. It could fully comprehend the process of implementing ideological and political teaching in professional courses, the accomplishment of desired outcomes, and the impact, and quickly identify any issues and areas where ideological and political teaching in professional courses needs to be strengthened.

Acknowledgement

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