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Research on Strategies for Improving Young Teachers' Competence in Private Applied Colleges and Universities Based on Intelligent Optimization Algorithms

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Abstract The development of artificial intelligence technology provides more paths for the improvement and development of teachers' teaching ability. This paper takes young teachers in private applied colleges and universities as the research object. From the five perspectives of interdisciplinary teaching cognition, interdisciplinary theme design and integration, interdisciplinary activity organization and implementation, interdisciplinary teaching evaluation and reflection, and interdisciplinary teaching research, a set of evaluation index system for teaching ability of young teachers in colleges and universities with 19 secondary indexes is initially proposed. After two rounds of expert consultation, the index system was integrated and optimized, and the evaluation index system with 5 primary indicators and 14 secondary indicators was finally established. At the same time, the hierarchical analysis method was used to determine the subjective weights of the indicators, and the CRITIC method was used to complete the objective weights of the indicators. The subjective and objective weights of the indicators are calculated to get the comprehensive weights of the indicators. Particle swarm algorithm is adopted as the practical application method of the evaluation system of teaching ability of young teachers in colleges and universities, and the optimal weight value of the indicators is obtained through the characteristic particle swarm optimization search. In the scoring of teaching ability of teacher B, the root mean square error of particle swarm algorithm is 10.71%, the average absolute error is 15.32%, and the relative error is 12.63%, which is an excellent performance in practical application.

Index Terms particle swarm algorithm, young college teachers, hierarchical analysis, CRITIC method, teaching ability evaluation

I. Introduction

With the diversified needs of society for higher education, China's applied private colleges and universities have cultivated a large number of applied talents, promoted the reform of higher education, and contributed to the construction of China's educational power [1]-[3]. In recent years, private higher education has shown a booming trend, from infrastructure to focus on teacher training, the competition between colleges and universities is getting more and more intense, but in the final analysis, it still depends on talents [4]-[6]. As the scale of China's higher education expands, the new generation of teachers is also gradually expanding, and the proportion of young teachers is also increasing, which is a force to be ignored [7]-[9]. Young teachers in private schools generally have higher education and higher scientific quality, but they have insufficient teaching experience, have not received professional training, and have a single teaching method, plus they are new to the society, and there are problems in teaching concepts, teaching methods, research and other aspects [10]-[13]. Therefore, Chinese applied private colleges and universities must take effective strategies to strengthen the training of young teachers, and make the improvement of young teachers' quality and teaching ability as a priority [14], [15].

In actual teaching, young teachers face deficiencies in classroom teaching ability, specialized teaching ability, and research ability [16], [17]. The enhancement of these abilities requires the joint efforts of young teachers and schools, and the joint action of intrinsic motivation and external favorable atmosphere to establish a continuous development mechanism for the development of young teachers' teaching abilities from the aspects of young teachers' career goal planning, teachers' training, and teachers' appraisal [18]-[21]. Through strategies such as improving teaching methods, strengthening the updating of subject knowledge, enhancing teaching research, focusing on teaching quality assessment, strengthening teamwork, cultivating enthusiasm for teaching, and actively participating in educational and teaching reforms, the overall competence of young teachers can be enhanced to ensure that the objectives of talent cultivation are realized [22]-[25].

In this paper, combining with the existing research, a set of evaluation index system of teaching ability of young teachers in colleges and universities structured as 5 primary indicators and 19 secondary indicators is initially proposed. Two rounds of expert opinion solicitation are designed to modify this evaluation index system with reference to the experts' suggestions and establish a reasonable structure and content of the evaluation index system. Then, the hierarchical analysis method is utilized as the method of obtaining the subjective weights of the indicator system, and the objective weights of the indicators determined based on the CRITIC method are integrated to calculate the comprehensive weights of the indicators. Considering the actual needs of teaching ability evaluation, particle swarm algorithm is introduced to design the steps and process of optimization of indicator weights based on particle swarm algorithm. And compare the performance of this algorithm with similar algorithms in the application of actual teaching ability evaluation. Finally, based on the weights of different indicators and the actual application results of the teaching ability evaluation system, we put forward the suggestions for improving the ability of young teachers in private applied colleges and universities.

II. The Construction of Evaluation System of Teaching Ability of Young Teachers in Colleges and Universities

II. A. Initial formulation of the indicator system

After analyzing relevant theories, policy documents, curriculum standards, and existing research results, this paper constructs five first-level indicators including (A) interdisciplinary teaching cognitive ability, (B) interdisciplinary theme design and integration ability, (C) interdisciplinary activity organization and implementation ability, (D) interdisciplinary teaching evaluation and reflection ability, and (E) interdisciplinary teaching and research ability, as well as 19 second-level indicators of university The evaluation index system of young teachers' teaching ability is shown in Table 1.

Table 1: Evaluation Index System for Teaching Ability of young teachers

Primary index	Secondary index
(A) Interdisciplinary teaching cognitive ability	(A1) The teaching ability of the subjects taught
	(A2) Cognitive ability of the teaching objects
	(A3) Interdisciplinary teaching comprehension ability
	(A4) The ability to connect knowledge from other disciplines
(B) Interdisciplinary theme design and integration ability	(B1) Interdisciplinary teaching ability
	(B2) Applicability interdisciplinary resource development capability
	(B3) Interdisciplinary content integration ability
	(B4) Interdisciplinary teaching process design ability
(C) The ability to organize and implement interdisciplinary activities	(C1) The ability to understand and use teaching materials
	(C2) The ability to apply disciplinary knowledge
	(C3) The ability to present interdisciplinary teaching content
	(C4) The ability to guide interdisciplinary teaching activities
(D) Interdisciplinary teaching evaluation and reflection ability	(D1) Evaluation criteria and basis determination ability
	(D2) The ability to select evaluation subjects and evaluation methods
	(D3) The ability to reflect on and improve teaching effects
(E) Interdisciplinary teaching and research ability	(E1) The ability to discover and explore problems in interdisciplinary teaching
	(E2) Interdisciplinary learning ability
	(E3) Interdisciplinary teaching communication and cooperation ability
	(E4) Interdisciplinary teaching innovation ability

II. B. Statistics and analysis of the results of the first round of expert consultation

Expert consultation questionnaires were designed based on the preliminary proposed index system for evaluating the teaching ability of young college teachers and distributed to 30 selected experts. A total of 30 questionnaires were distributed and 29 valid questionnaires were recovered, with an effective recovery rate of 96.67%.

II. B. 1) Analysis of statistical results and opinions on expert recognition of Level 1 indicators

The statistical results of each level of indicators of interdisciplinary teaching ability of young college teachers in the expert consultation are shown in Table 2, and the results of the mean and coefficient of variation boundaries are shown in Table 3, which are used to screen the level of indicators with reference to the criteria of the boundaries. At the same time, the indicators were corrected and analyzed according to the experts' opinions.

Table 2: Statistical results of the recognition degree of primary index

Primary index	Mean	SD	*CV*
(A)	4.063	0.855	0.211
(B)	3.689	0.794	0.216
(C)	3.876	0.886	0.229
(D)	4.126	0.886	0.216
(E)	3.939	0.855	0.218

Table 3: The cut-off value of the primary index

	Dividing value
Mean	$M \geqq 3.769$
CV	$V \leqq 0.225$

As can be seen from Table 2, in the degree of concentration, the mean value of expert agreement for the five level 1 indicators is greater than or 3.75, in the degree of dispersion, the standard deviation of each level 1 indicator is less than 1, and in the degree of harmonization, the coefficient of variation of each level 1 indicator is less than 0.25, which indicates that the experts' agreement on the level 1 indicators is relatively high and concentrated with a low degree of divergence of opinions. Second, the indicators were screened with reference to the mean bounds and the coefficient of variation bounds in Table 3. The mean value of the three first-level indicators of (A) cognitive ability of interdisciplinary teaching, (D) evaluation and reflection ability of interdisciplinary teaching and (E) research ability of interdisciplinary teaching is greater than the bounding value of 3.769, and the coefficient of variation is less than or equal to 0.225, which is in line with the screening criteria. The mean value of the indicators of (B) interdisciplinary theme design and integration competence is less than the threshold value of 3.769, and the coefficient of variation of the indicators of (C) interdisciplinary activity organization and implementation competence is greater than the threshold value of 0.225, which fails to meet the screening criteria, indicating that there is some controversy in the experts' opinions on these two indicators, which will be corrected in conjunction with the analysis of the experts' opinions.

According to the supplementary suggestions on subjective questions in the expert consultation questionnaire, the experts generally agree with the five level 1 indicators, which are in line with the overall competence requirements of interdisciplinary teaching for young teachers in universities.

Table 4: Statistical results of the recognition degree of secondary index

Primary index	Secondary index	Mean	SD	*CV*
(A)	(A1)	4.063	0.93	0.23
	(A2)	4.251	0.932	0.22
	(A3)	4.063	0.773	0.191
	(A4)	4.063	0.773	0.191
(B)	(B1)	4.251	0.857	0.202
	(B2)	4.189	0.835	0.2
	(B3)	4.001	0.895	0.225
	(B4)	4.126	0.886	0.216
(C)	(C1)	3.939	1.125	0.286
	(C2)	4.001	0.967	0.243
	(C3)	4.251	0.857	0.202
	(C4)	4.189	0.751	0.18
(D)	(D1)	4.126	0.807	0.196
	(D2)	4.189	0.751	0.18
	(D3)	4.189	0.835	0.2
(E)	(E1)	4.126	0.72	0.175
	(E2)	3.876	1.026	0.265
	(E3)	3.939	0.855	0.218
	(E4)	4.063	0.681	0.168

II. B. 2) Analysis of statistical results and opinions on expert recognition of secondary indicators

The statistical results of each secondary indicator of interdisciplinary teaching ability of young college teachers in the expert consultation are shown in Table 4, and the results of its mean and coefficient of variation boundaries are shown in Table 5, with reference to which the secondary indicators are screened. At the same time, the secondary indicators and their descriptions were corrected and analyzed with the experts' opinions.

Table 5: The cut-off value of the secondary index

	Dividing value
Mean	$M \geqq 3.987$
CV	$V \leqq 0.240$

As can be seen from Table 4, in the degree of concentration, the mean value of the expert agreement of each secondary indicator is greater than the rank value of 3.75, which indicates that all experts have a high degree of agreement on the secondary indicators. Referring to the bounding value of the mean and the bounding value of the coefficient of variation in Table 5, firstly, the mean value of (E2) Interdisciplinary Learning Ability of the second-level indicators is less than the bounding value of 3.987, and the coefficient of variation is greater than the bounding value of 0.240, which is not up to the screening standard, which indicates that the experts' concentration and coordination of this indicator are not high, and it should be eliminated. Secondly, the mean values of (C1) Comprehension and use of language teaching materials and (E3) Interdisciplinary teaching communication and cooperation skills did not reach the threshold value of 3.986, indicating that experts did not agree with the indicators to a high degree. The value of the coefficient of variation for the indicator of (C2) ability to utilize subject knowledge exceeds the threshold value of 0.240, which indicates to a large extent that experts' opinions on this indicator are divided. Therefore, the indicators and descriptions of the indicators that fail to meet the screening criteria should be revised with the opinions of the experts. The remaining 15 level 2 indicators meet the screening criteria for boundaries and should be retained.

By analyzing the valuable comments and optimization suggestions made by the experts on the secondary indicators and indicator descriptions, it will provide a strong guideline for the amendment of the secondary indicators and the specification of the indicator descriptions. In the dimension of (B) Interdisciplinary theme design and integration competence, the experts have a relatively high degree of agreement with the secondary indicators, but at the same time, they also suggest to make some normative adjustments to the indicators. For example, for the secondary indicator (B1) Interdisciplinary Teaching Competence, Expert 1 suggested that "Teachers' interdisciplinary teaching is not what the textbook prescribes, but also requires teachers to have basic teaching competence in other subjects, so using interdisciplinary teaching competence alone is out of place." Accordingly, this paper combines experts' suggestions to modify the secondary indicator (B1) interdisciplinary teaching ability to: (B1) interdisciplinary cognitive ability. For the secondary indicator (B4) Interdisciplinary Teaching Process Design Competence, which is closely related to the indicator (B1) under the same dimension, it is revised to: (B4) Interdisciplinary Learning and Teaching Competence. In addition, for the secondary indicator (E1) Interdisciplinary Teaching Problem Identification and Inquiry Ability in the dimension of (E) Interdisciplinary Teaching and Research Ability, experts3 suggested that "due to the difference in the direction of academic specialization of teachers in different disciplines, it is difficult for them to carry out interdisciplinary teaching and learning on a deeper level in a short period of time, and they do not generally have the ability to identify and explore interdisciplinary teaching problems." Accordingly, this paper combined with experts' suggestions to delete the secondary indicator (E1) interdisciplinary teaching problem discovery and inquiry ability. Thus, the evaluation index system of teaching ability of young teachers in colleges and universities containing 14 secondary indicators under 5 dimensions is formed.

II. C.Results and analysis of the second round of expert consultations

For the second round of expert opinion consultation on the revised index system for evaluating the teaching competence of young university teachers. This time, the questionnaires were still distributed to the 30 experts selected in the previous paper. A total of 30 questionnaires were distributed and 28 valid questionnaires were collected, with an effective recovery rate of 93.33%.

II. C. 1) Results of the Tier 1 Indicator Consultation and Analysis

The results of the statistical analysis parameters of the first-level indicators in the second round are shown in Table 6. in which the mean values of each first-level indicator are, in order, 4.82, 4.95, 4.89, 4.95, 4.82, the standard deviations are, in order, 0.404, 0.251, 0.343, 0.251, 0.545, and the coefficients of variation are, in order, 0.085, 0.052, 0.071, 0.052, 0.114. The five as well as indicators meet the screening conditions, and the 28 experts are more agreeable to the modified level 1 indicators and their opinions are relatively united, so the five finalized (A) interdisciplinary teaching cognitive ability, (B) interdisciplinary thematic design and integration ability, (C) interdisciplinary activity organization and implementation ability, (D) interdisciplinary teaching evaluation and reflection ability, and (E) interdisciplinary teaching research ability are identified as the five Level 1 Indicators.

Table 6: Statistical analysis parameters of primary index

Primary index	Mean	SD	*CV*
(A)	4.82	0.404	0.085
(B)	4.95	0.251	0.052
(C)	4.89	0.343	0.071
(D)	4.95	0.251	0.052
(E)	4.82	0.545	0.114

II. C. 2) Results and analysis of the call for secondary indicators

The statistical results of the expert recognition of the second round of secondary indicators are shown in Table 7, in which the recognition is categorized as (I1) very important, (I2) relatively important, (I3) generally important, (I4) not too important, and (I5) very unimportant. 14 secondary indicators received an expert recognition of 100.00%, and therefore 14 secondary indicators were finalized.

Table 7: Statistical analysis parameters of secondary index (%)

Secondary index	I1	I2	I3	I4	I5	Total approval rate
(A1)	65	35	-	-	-	100
(A2)	68	32	-	-	-	100
(A3)	81	19	-	-	-	100
(A4)	68	32	-	-	-	100
(B1)	69	31	-	-	-	100
(B2)	72	28	-	-	-	100
(B3)	82	18	-	-	-	100
(B4)	69	31	-	-	-	100
(C3)	89	11	-	-	-	100
(C4)	78	22	-	-	-	100
(D1)	81	19	-	-	-	100
(D2)	79	21	-	-	-	100
(D3)	66	34	-	-	-	100
(E4)	86	14	-	-	-	100

III. Determination of the weights of indicators for evaluating teaching capacity

III. A. Methodology for calculating indicator weights

III. A. 1) Hierarchical Analysis Subjective Weight Determination

Hierarchical analysis method (AHP) is a weight determination method proposed by applying network system theory and multi-objective comprehensive evaluation method, and the calculation steps are as follows:

(1) Construct judgment matrix. Using 1~9 scalability method to get the judgment matrix $A=(a_{ij})_{n\times n}$ as in equation (1), so as to indicate the relative importance of a layer of factors.

$$A=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \tag{1}$$

(2) Calculate judgment matrix factor weights. Combining the scalar values, the individual factor weights ω_l of the judgment matrix A are obtained after normalization of equation (1) using equations (2)~(5).

$$\alpha_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \tag{2}$$

$$\beta_i = \sum_{j=1}^{n} \alpha_{ij} \tag{3}$$

$$\omega_i = \frac{\beta_i}{\sum_{i=1}^{n} \beta_i} \tag{4}$$

$$\omega_l = \left(\omega_1, \omega_2, \omega_3, \cdots, \omega_n\right)^T \tag{5}$$

where: α_{ij} is the column vector normalized to the matrix A. β_i is the sum of row vectors of the i th row of the matrix. ω_i is the actual weight of the matrix normalized. ω_l is the evaluation factor weight vector in the judgment matrix.

(3) Hierarchical single-ordered weight vectors of judgment matrices and consistency test. Calculate the maximum eigenvalue $\lambda_{\max}$ of each matrix, and utilize the consistency index CI and random consistency index RI for consistency test as in Eqs. (6)-(8).

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(A\omega)_i}{\omega_i} \tag{6}$$

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{7}$$

$$CR_{Sheet} = \frac{CI}{RI} \tag{8}$$

where: $(A\omega)_i$ is the i th component of the vector $A\omega$. When $CR < 0.1$, the judgment matrix passes the consistency test, otherwise it needs to be corrected again.

(4) The hierarchical total sorting power vector and consistency test of judgment matrix are shown in equation (9). In order to avoid the phenomenon of non-consistent accumulation of single sort consistency test, the hierarchical total sort is also necessary for consistency test.

$$CR_{\text{General}} = \frac{\sum_{j}^{m} \omega_j CI_j}{\sum_{j}^{m} \omega_j RI_j} \tag{9}$$

where: ω_j is the eigenvector value of the indicator layer matrix. CI_j is the single sort consistency indicator. RI_j is the corresponding average consistency indicator. Finally, the weight vector of the indicator layer that passes the consistency test with respect to the total objective of the program is denoted as ω_A.

III. A. 2) Determination of indicator weights based on CRITIC

The CRITIC weighting method is an objective weighting method to comprehensively measure the indicators according to the comparative strength and conflict of the evaluation indicators. For the comprehensive evaluation of multiple indicators and multiple objects, CRITIC weighting method eliminates the influence of some indicators with strong correlation, reduces the overlap of information between indicators, and is more conducive to obtaining credible evaluation results.

(1) Model construction

Firstly, m evaluation objects (the evaluation objects in this study are different years) and n comprehensive evaluation indexes related to teaching are selected, and $m \times n$-order raw data matrix $A = (a_{ij})_{m \times n}$ is established, where $i = 1, 2 \cdots m$. $j = 1, 2 \cdots n$. a_{ij} denotes the j th index value of the i th evaluation object.

(2) Normalized data

Each index is categorized as a positive or negative index. For positive indicators, the larger the index value, the better the effect. For negative indicators, the smaller the index value, the better the effect. In order to eliminate the effect caused by the difference in the scale of different indicators, it is necessary to standardize the data. The formulas are shown in equations (10)-(11):

For positive indicators:

$$r_{ij} = \frac{a_{ij} - \min\left\{a_{1j}, a_{2j}, \cdots, a_{mj}\right\}}{\max\left\{a_{1j}, a_{2j}, \cdots, a_{mj}\right\} - \min\left\{a_{1j}, a_{2j}, \cdots, a_{mj}\right\}} \tag{10}$$

For negative indicators:

$$r_{ij} = \frac{\max\left\{a_{1j}, a_{2j}, \cdots, a_{mj}\right\} - a_{ij}}{\max\left\{a_{1j}, a_{2j}, \cdots, a_{mj}\right\} - \min\left\{a_{1j}, a_{2j}, \cdots, a_{mj}\right\}} \tag{11}$$

where r_{ij} is the standardized value of the j th evaluation indicator in the i th program, and a_{ij} is the original value of the j th evaluation indicator in the i th program.

(3) Calculation of indicator variability

CRITIC expresses indicator variability in the form of standard deviation. AD_j represents the standard deviation of the j th indicator. In the CRITIC method, the standard deviation is used to indicate the difference fluctuation of the internal value of each indicator as in equation (12), the larger the standard deviation indicates that the greater the difference in the value of the indicator, the more information can be screened out, the evaluation strength of the indicator itself is also the stronger, and more weight should be assigned to the indicator.

$$AD_j = \sqrt{\frac{\sum_{i=1}^{m}\left(r_{ij} - \bar{r}_j\right)}{m-1}} \tag{12}$$

where AD_j is the standard deviation of the j th indicator and $\bar{r}_i$ is the mean of the j th indicator.

(4) Calculate the contradiction of indicators

Through the contradiction can reflect the degree of correlation of the indicators as in equation (13), if it is positively correlated, it means that the less contradictory it is. Set the size of the contradiction between indicator j and the rest of the indicators as f_j.

$$f_j = \sum_{i=1}^{m}\left(1 - p_{ij}\right) \tag{13}$$

where f_j is the ambivalence of the j th indicator.

p_{ij} denotes the correlation coefficient between object i and indicator j, in this case Pearson's correlation coefficient is used, the formula is as in equation (14).

$$p_{ij} = \frac{\sum_{i=1}^{m}\left(r_{ij} - \bar{r}_j\right)\left(r_{ij} - \bar{r}_j\right)}{\sqrt{\sum_{i=1}^{m}\left(r_{ij} - \bar{r}_j\right)^2\left(r_{ij} - \bar{r}_j\right)^2}}, i \neq j \tag{14}$$

(5) Calculate the amount of information of the indicator

E_j is used to indicate the amount of information contained in the j th indicator as in equation (15). The larger E_j is, the greater the amount of information contained in the j th evaluation indicator is, and the greater the relative importance of the indicator is.

$$E_j = AD_j f_j \tag{15}$$

(6) Calculate the weights of the indicators as in equation (16).

$$\omega_j = \frac{E_j}{\sum_{i=1}^{n} E_j} \tag{16}$$

where ω_j is the objective weight coefficient of the j th indicator.

III. A. 3) Combined weighting of indicators

Indicator composite weight W_z is calculated according to formula (17):

$$W_z = \theta w_i + (1-\theta) w_j \tag{17}$$

where W_z denotes the composite weight of the indicator. w_i denotes the subjective weights calculated by hierarchical analysis and w_j denotes the objective weights calculated by CRITIC method. θ denotes the linear weighting coefficient, $0 < \theta < 1$. In this paper, θ is taken as $\theta = 0.5$, indicating that the objective weighting is equally important as the subjective weighting.

III. B. Determination of the weights of the indicator system

Based on the scores of experts on each indicator, combined with the above weight calculation method, the (W1) subjective weights and (W2) objective weights of each indicator are calculated, and the (W3) comprehensive weights are calculated. The results of the calculation of subjective weights, objective weights and comprehensive weights are shown in Table 8.

Table 8: The index weights of the evaluation system

Index	W1	W2	W3	Index	W1	W2	W3
(A)	0.264	0.200	0.232	(A1)	0.106	0.059	0.083
				(A2)	0.075	0.044	0.060
				(A3)	0.082	0.039	0.061
				(A4)	0.058	0.083	0.071
(B)	0.252	0.200	0.126	(B1)	0.115	0.103	0.109
				(B2)	0.066	0.077	0.072
				(B3)	0.037	0.036	0.037
				(B4)	0.041	0.115	0.078
(C)	0.163	0.200	0.0815	(C3)	0.088	0.105	0.097
				(C4)	0.075	0.044	0.060
(D)	0.215	0.200	0.1075	(D1)	0.041	0.061	0.051
				(D2)	0.047	0.061	0.054
				(D3)	0.082	0.089	0.086
(E)	0.106	0.200	0.053	(E4)	0.087	0.084	0.086

The order of subjective weights among the five first-level indicators is (A) cognitive ability of interdisciplinary teaching (0.264) > (B) ability of interdisciplinary theme design and integration (0.252) > (D) ability of interdisciplinary teaching evaluation and reflection (0.215) > (C) ability of interdisciplinary activity organization and implementation (0.163) > (E) ability of interdisciplinary teaching research (0.106). Plotting the subjective weights, objective weights, and combined weights of the first-level indicators in Fig. 1, it can be clearly seen that after correction, the weight of (A) indicator is still the maximum weight, and this problem is due to the higher actual score of (A) indicator, which leads to a larger entropy value obtained, and ultimately causes a larger impact on the overall system. This indicates that the expert's empirical value of the subjective weights is appropriately corrected so that they are in a reasonable range, and it also indicates that the combination of assignment methods used in this paper has a certain degree of reasonableness.

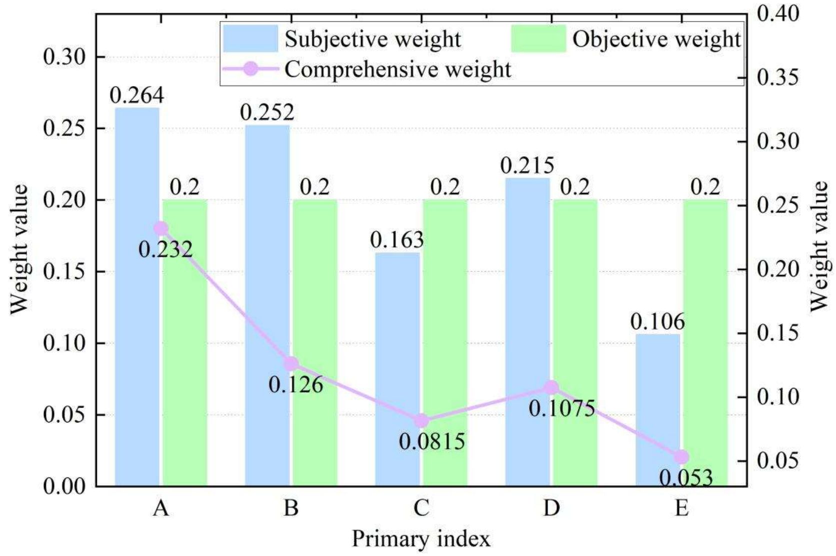

Figure 1: Primary index subjective weight,objective weight,comprehensive weight

IV. Optimization and application of the teaching competence evaluation system

IV. A. Optimization process based on particle swarm algorithm

In the case that the judgment matrix A has been determined, it is proposed to use the particle swarm algorithm (PSO) to encode the particles, construct the fitness function and optimize the nonlinear programming problem so that the consistency indicator function is taken to the minimum value to find the optimal weight value solution.

The matrix equation (18) is used as an example:

$$A = \begin{bmatrix} 1 & 0.20 & 3 \\ 5 & 1 & 5 \\ 0.33 & 0.20 & 1 \end{bmatrix} \tag{18}$$

In the matrix A by hierarchical analysis method to find $CR = 0.13$, that is, $CR > 0.1$, the consistency test is unacceptable. The optimization process by particle swarm algorithm is shown in Fig. 2, and the specific steps are as follows:

(1) The fitness function $F(n)$ is shown in Equation (19):

$$\begin{gathered} F(n) = \sum_{i=1}^{n} \left| \sum_{j=1}^{n} (a_{ij}\omega_j) - n\omega_i \right| \Big/ n \\ s.t. \sum_{j=1}^{n} \omega_j = 1, \omega_j > 0, j = 1, 2, \cdots, n \end{gathered} \tag{19}$$

The process of solving $F(n)$ is to solve the eigenvectors and matrix eigenroots by columns for all the matrices composed of initialized populations, and the eigenvectors corresponding to the largest eigenroots are derived and normalized.

(2) Initialize the population particles, extract the upper triangular elements $a = 0.2$, $b = 3$, and $c = 5$, and randomly assign i population particles ranges of $[0.15, 0.25]$, $[2.95, 3.05]$, and $[4.95, 5.05]$, respectively. Within the population, each combination is represented as a separate individual. For example, matrix equation (20) is a random individual:

$$A_i = \begin{bmatrix} 1 & a_i & a_j \\ 1/a_i & 1 & a_k \\ 1/a_j & 1/a_k & 1 \end{bmatrix} \tag{20}$$

(3) Assume that the matrix obtained by PSO after the first generation of optimization is Eq. (21):

$$A_1 = \begin{bmatrix} 1 & 0.22 & 3.1 \\ 4.55 & 1 & 4.9 \\ 0.32 & 0.21 & 1 \end{bmatrix} \quad (21)$$

Then $CR = 0.11$ is obtained from the first generation particle matrix. Recorded as the current optimal particle swarm position and fitness.

(4) The optimal fitness value obtained in the first generation is compared with the historical optimal particle swarm fitness value to update the historical optimal fitness value. With this, n cycles are performed to find out the optimal fitness value (i.e., $CR < 0.1$), if the constraints are satisfied, then jump out, otherwise, continue the cycle iteration.

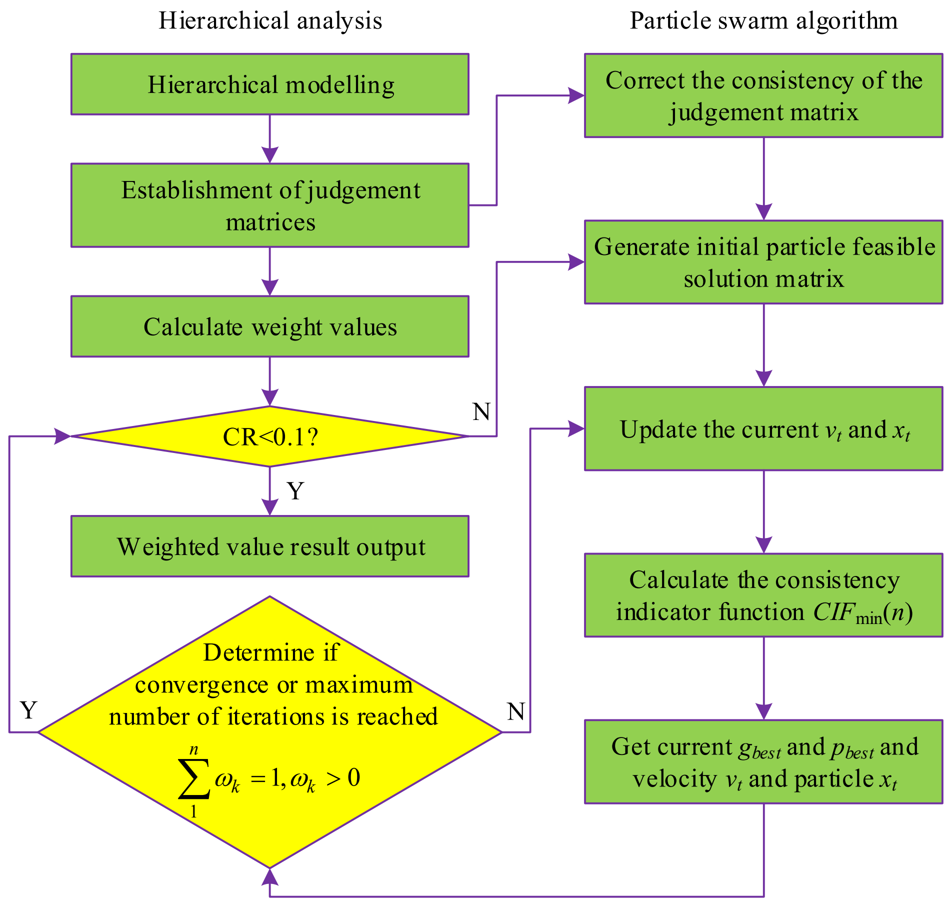

Figure 2: Optimize the process of the Analytic Hierarchy Process

(5) Under n iterations of the loop, find the historical optimal solution set and find the CR value corresponding to the optimal solution set. The particle swarm satisfies the improved PSO algorithm (IPSO) Eq. (22) during the looping process.

$$\begin{aligned} v_i &= v_i + c_1 * rand(0 \sim 1) * (pbest_i - x_i) \\ &\quad + c_2 * rand(0 \sim 1) * (gbest_i - x_i) \\ &\quad + c_3 * rand(0 \sim 1) * (x_e - x_i) \\ x_i &= x_i + v_i \end{aligned} \quad (22)$$

x_e denotes the upper triangular element characteristic particle population in the original matrix, the initialization population to x_e position near the range to find the optimal value.

In Equation (22), is the original particle swarm algorithm to update the particles to do the improvement. The first is based on the original single optimal particle position as well as the group optimal particle position, a new particle population is added as a matrix element characteristic particle. At the same time, in the early stage of the algorithm, the value of c_3 is set to be greater than c_1 and c_2, the idea is to guide the initial population of particles to move toward the initial eigenvector weight value of the AHP, in order to improve the algorithm's optimization efficiency. As the algorithm is run in newer iterations, c_3 then gradually decays, reducing the ability of the feature particles to be guided, thus resulting in the final optimal weight value.

IV. B. Evaluation of Young Teachers' Teaching Ability in Higher Education Institutions

In this section, Teacher B of a university is selected as an experimental subject to start the comparison between the algorithm of this paper (N1) and four different algorithms on the scoring of this teacher's teaching ability on 14 indexes, in which each index is scored out of 10, and the scoring of Teacher B by the teaching management department of the university is used as a reference. The algorithms selected for comparison are: BP neural network algorithm (N1), BSO algorithm (N2), LSTM algorithm (N3), and GA algorithm (N4).Comparison of the scores of the five algorithms on Teacher B as well as the actual scores are shown in Table 9, and comparison of the results of the root-mean-square-error (RMSE), the mean-absolute-error (MAE), and the relative-error (RMSE) between the five algorithms and the actual scores are shown in Table 10.

Table 9: Comparison of the scores of the five models

Index	Actual score	N1	N2	N3	N4	N5
(A1)	8	7	7	9	8	8
(A2)	8	10	7	7	5	9
(A3)	8	9	7	6	7	5
(A4)	8	8	6	7	9	4
(B1)	8	8	7	5	8	6
(B2)	10	9	6	9	5	6
(B3)	9	8	8	6	6	5
(B4)	10	7	8	6	8	7
(C3)	8	9	8	6	5	8
(C4)	9	10	7	6	6	7
(D1)	9	10	7	8	8	5
(D2)	8	10	8	6	7	7
(D3)	8	8	7	8	6	4
(E4)	9	8	6	8	5	9
Total	120	121	99	97	93	90

Table 10: Comparison of error results of five algorithms

Algorithm	N1	N2	N3	N4	N5
RMSE (%)	10.71	28.63	45.11	53.28	55.56
MAE (%)	15.32	23.74	43.46	50.35	53.89
MAPE (%)	12.63	20.25	49.81	60.46	63.19

In terms of scoring performance, (N1) the overall algorithm of this paper is closest to the actual scoring results. And the error rate is low, the root mean square error is 10.71%, the average absolute error is 15.32%, and the relative error is 12.63%, which are much lower than the remaining four similar algorithms. That is, compared with other algorithms, the particle swarm algorithm is more suitable for the application of the evaluation index system of teaching ability of young teachers in colleges and universities designed in this paper.

IV. C. Strategies for Improving the Competence of Young Teachers in Private Applied Colleges and Universities

Combined with the analysis above, this section stands on the three perspectives of teachers, schools and the government, and puts forward the following three suggestions for enhancing the teaching ability of young teachers in private applied colleges and universities:

(1) Encourage teachers' positive independent development

As a fundamental way to improve the teaching ability of young teachers in colleges and universities, self-development is a necessary path for every young teacher to improve his or her teaching ability. Therefore, young teachers in colleges and universities should take the development of their teaching ability as an important goal and direction of their career development. By establishing high professional ideals, improving independent learning ability, paying attention to teaching feedback suggestions, etc., constantly consolidate their own professional knowledge, improve and enhance teaching ability.

(2) Construct and improve the teacher management system

The school level should take into account the actual situation of teachers and build and improve the framework of teaching management system. Special attention should be paid to strengthening and improving the mentor system for young teachers, as well as the incentive mechanism and title evaluation system. In teacher ethics, teaching, teaching and research to be young teachers to guide and cultivate at the same time, to scientific and effective incentive mechanism to stimulate the enthusiasm and commitment of young teachers, for the enhancement of the teaching ability of young teachers in colleges and universities to provide effective institutional support.

(3) Increase government policy support

Relevant government policies provide a solid foundation for the improvement of teaching ability of young teachers in colleges and universities. At the government level, the supporting documents and resources related to teaching in colleges and universities should be improved as well as the access system. Through the access system, the development of teachers' teaching ability is dynamically monitored, and teachers are encouraged to continuously update their teaching concepts and knowledge structure, thus promoting the continuous improvement of teaching ability. Secondly, we should also improve the guarantee system for young teachers to improve their teaching ability, and mobilize the enthusiasm of young teachers to improve their teaching ability through the construction of a more perfect income distribution system.

V. Conclusion

In this paper, a set of evaluation index system of teaching ability of young teachers in colleges and universities with 14 secondary indexes is proposed from five aspects, namely, interdisciplinary teaching cognition, interdisciplinary theme design and integration, interdisciplinary activity organization and implementation, interdisciplinary teaching evaluation and reflection, and interdisciplinary teaching research, combined with the suggestions of experts. In the practical application of the evaluation index system, the root mean square error of the particle swarm optimization algorithm used is 10.71%, the average absolute error is 15.32%, and the relative error is 12.63%. Based on the performance of the practical application of the algorithm, three suggestions are given to improve the teaching ability of young teachers in private applied colleges and universities: encouraging teachers to actively develop on their own, constructing a perfect teacher management system, and increasing government policy support.

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