

### Retraction

# **Retracted: Optimization of Online Teaching Quality Evaluation Model Based on Hierarchical PSO-BP Neural Network**

### Complexity

Received 13 September 2023; Accepted 13 September 2023; Published 14 September 2023

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

 L. Jiang and X. Wang, "Optimization of Online Teaching Quality Evaluation Model Based on Hierarchical PSO-BP Neural Network," *Complexity*, vol. 2020, Article ID 6647683, 12 pages, 2020.



## **Research Article**

# Optimization of Online Teaching Quality Evaluation Model Based on Hierarchical PSO-BP Neural Network

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Received 19 October 2020; Revised 13 November 2020; Accepted 17 November 2020; Published 27 November 2020

Academic Editor: Wei Wang

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In the evaluation of teaching quality, aiming at the shortcomings of slow convergence of BP neural network and easy to fall into local optimum, an online teaching quality evaluation model based on analytic hierarchy process (AHP) and particle swarm optimization BP neural network (PSO-BP) is proposed. Firstly, an online teaching quality evaluation system was established by using the analytic hierarchy process to determine the weight of each subsystem and each index in the online teaching quality evaluation system and then combined with actual experience, the risk value of each index was constructed according to safety regulations. The regression model is established through BP neural network, and the weight and threshold of the model are optimized by the particle swarm algorithm. Based on the online teaching quality evaluation model of BP neural network, the parameters of the model are constantly adjusted, the appropriate function is selected, and the particle swarm algorithm which is used in the training and learning process of the neural network is optimized. The scientificity of the questionnaire was verified by reliability and validity test. According to the scoring results and combined with the weight coefficient of each indicator in the online course quality evaluation index system, the key factors affecting the quality of online courses were obtained. Based on the survey data, descriptive statistics, analysis of variance, and Pearson's correlation coefficient method are used to verify the research hypothesis and obtain valuable empirical results. By comparing the model with the standard BP model, the results show that the accuracy of the PSO-BP model is higher than that of the standard BP model and PSO-BP effectively overcomes the shortcomings of the BP neural network.

### **1. Introduction**

With the rapid development of the Internet in the information age, online courses have a great impact on the traditional teaching mode of higher education. In order to give full play to the radiation effect of high-quality educational resources and meet the increasingly personalized learning needs of learners, educational institutions at all levels have carried out a comprehensive hybrid teaching reform of traditional and online courses. However, there are still some problems to be solved in the process of the development of online courses in China, whether it is the independent development or the introduction of highquality foreign courses. How to make a scientific and reasonable evaluation of the quality of online courses is one of the problems. At present, there is a lack of relevant quality assurance mechanism for online courses, and mixed teaching reform lacks objective and operational improvement strategies. Therefore, the high demand for online course quality urges us to start with the evaluation of the course by learners and educators and to monitor the course quality. Improving the quality of online education is an important issue that cannot be ignored in the development of higher education. At present, many colleges and universities have carried out extensive online course education, and the number of students learning online courses is increasing day by day. However, many problems have been exposed in the development of online courses, which have not been effectively solved at present.

One is the conversation model, which mainly investigates the interaction between teachers and students, between students and students, and between students and the environment through media [1, 2] and examines the advantages and disadvantages of the virtual learning environment from the interactivity of various learning tools provided by online courses. The paper analyzes the characteristics of different online learning environments from the perspective of the linear conversation process and analyzes the comparison of different online learning environments in communication, flexibility, interaction, and feedback from the perspective of conversation principle [3, 4]. The other is the organizational model [5], which is mainly derived from the visual system model of management cybernetics. According to the model, students are self-managers in the teaching environment system, and they are learning under the assistance and supervision of teachers. The organizational model analyzes the performance of software tools supporting online learning from six aspects: resource organization, collaboration, learning monitoring, flexibility, automatic learning, and autonomous organization [6, 7]. Quality on the Line evaluation criteria based on Internet distance learning: the evaluation standard includes seven first-level indicators, namely, architecture, curriculum development, teaching and learning, curriculum structure, student support system, teacher support system, and evaluation and evaluation system [8, 9]. In addition, the first-level indexes are divided into two parts: the necessary indexes for each online course evaluation and the optional indexes that can be independently selected and expressed according to different evaluation needs, which are further refined into 24 second-level necessary indexes and 21 second-level optional indexes [10, 11], so as to make the evaluation standard more flexible and instructive. At the same time, it also provides a case study report on the evaluation of online courses in six schools using this evaluation standard. Analytic hierarchy process (AHP) to evaluate the characteristics of the teaching quality, which is the qualitative of classroom teaching quality evaluation method [12, 13], but as a result of the teaching quality is affected by the subjective and objective factors, the various factors influenced the evaluation objects as far as possible fully reflected. In front of the evaluation need to establish a comprehensive evaluation index system, the indicators reflect people's subjective cognition difference and change of qualitative indicators, these differences and changes of the connotation are not very clear by using AHP. It is very difficult to quantify those fuzzy qualitative indicators and determine the weight of all levels of indicators [14]. Based on BP neural network's self-organization, self-adaptability, self-learning habit, and other characteristics, the classroom teaching quality evaluation model based on BP neural network can better avoid the subjectivity and uncertainty in the process of artificial selection of weights and correlation coefficients and make the evaluation model more intelligent, adaptive, and available [15]. Since the evaluation of teacher teaching quality was proposed, there have been many evaluation methods for teacher teaching quality, such as expert evaluation method [16], analytic hierarchy process, neural network model evaluation method [17], fuzzy comprehensive evaluation method [18], gray relational degree evaluation method [19], distance comprehensive evaluation method, SOLO classification, and other evaluation methods. In order to reflect the scientific nature, objectivity, and impartiality of teacher's teaching quality evaluation, these evaluation methods not only systematically analyze the evaluation results

but also quantitatively and qualitatively analyze the evaluation from different perspectives. Three basic core issues of online course quality evaluation research [2, 20] are whether the target is suitable for social needs; whether the objectives are consistent with the means to achieve them; is the goal consistent with its evaluation? The current theoretical and practical situation of online course evaluation is summarized as follows: clear course objectives, smooth network communication, immediate and efficient result feedback, personalized course design, and student-centered and teacher-assisted combination [21, 22]. The principles and methods followed in the performance evaluation of university online course teachers believe that university online course is an important part of the school curriculum system and must have clear goals and effective organization [23, 24]. In order to ensure the quality of online courses [25], universities should further strengthen management and develop measures such as setting quality standards, monitoring key quality nodes, and municipal audit and evaluation. Multiobjective Evolution of Fuzzy Rough Neural Network has been researched [26, 27]. A minimum center distance rule activation method and Target Decorrelation in SAR are discussed [28, 29].

To online teaching quality security system for scientific and accurate classification, this paper is combined with expert advice on safety analysis at the same time, to determine the weight coefficient of each index and application of PSO and BP neural network for online related issues existing in the teaching process in risk assessment and effectively overcome the slow convergence speed of BP neural network and the shortcoming of easily plunging into local optimum. This method not only has the self-learning function of expert experience but also has high artificial intelligence. A system consisting of 16 three-level indicators is established, which combines qualitative indicators and quantitative indicators to make the model more convincing. Then the evaluation model was established, and the particle swarm optimization algorithm was used to optimize the training process of the neural network with MATLAB as the development platform. After constant debugging, a better model was finally established. The teaching quality evaluation model is based on a hierarchical PSO-BP neural network. Firstly, it introduces the basic idea of an artificial neural network for teacher teaching quality evaluation, describes the evaluation indicators of teacher teaching quality, and mainly introduces the algorithm of hierarchical PSO-BP neural network. The specific implementation in the teacher teaching quality evaluation system includes the determination of the number of BP neural network layers, the determination of the number of neurons in each layer, and the preprocessing of input data. Finally, through simulation experiments, the characteristics of teacher teaching quality evaluation methods based on improved BP neural network are analyzed.

### 2. Structure of PSO-BP Evaluation Index of AHP

2.1. The Hierarchical PSO-BP Model Was Established. The analytic hierarchy process (AHP) makes use of less quantitative information to make the factors of complex system

mathematically and hierarchically based on the in-depth analysis of the essence, influencing factors and their internal relations of the complex system. In practical application, there are actually some differences in the influence ability of each factor on the evaluation object. Therefore, we need to start from the actual influence ability of each factor and assign a different weight proportion to it. In the process of weighting, either objective weighting method or subjective weighting method can be adopted, or both can be combined to determine the final weight. But in this system, it is difficult to analyze all the factors quantitatively because of the influence of many factors. Based on the above situation, the research in this paper focuses on the expert evaluation method, starting from the second layer of the hierarchical structure model and forming a pair comparison matrix with the paired comparison method for each factor belonging to the upper layer, until the bottom layer:

$$B = \begin{bmatrix} b_{11}, b_{12}, \dots, b_{1n} \\ \dots \\ b_{n1}, b_{n2}, \dots, b_{nn} \end{bmatrix}.$$
 (1)

The matrix B is a real symmetric matrix. The eigenvalues and eigenvectors of the judgment matrix are solved by the square root method. The eigenvectors are normalized and the weight vectors are obtained.

After the hierarchy is established, the interrelationships between the factors at each level are determined. In determining the weight of factors at each level, a factor at the upper level is used as a criterion to compare each factor at the lower level of the criterion. In pair comparison, a certain scale value is adopted to show the importance of the two indicators. In this way, subjective judgments can be converted into numbers for quantification. For the scale value of comparing the importance of indicators, the nine numbers 1–9 are usually used to express. The meanings of these nine numbers are shown in Table 1.

Among them, RI is a random consistency index, which is related to the order of the judgment matrix. The corresponding relationship is shown in Table 2.

The coordination of the functional modules of the online teaching quality evaluation system based on the level of PSO-BP is the main consideration in the design of the system framework; the mining results provide support for the school decision-making level. This system has low investment, easy maintenance, and strong practicability. The framework of the entire system is shown in Figure 1.

# 2.2. Construction of the Membership Degree of the Hierarchical PSO-BP Evaluation Index

2.2.1. User Permission Management. Teaching quality evaluation system is a comprehensive system platform for school administrators, teachers, and students. In order to ensure the authenticity and rationality of teaching evaluation, different permissions should be provided for users who are not in use. That is, ordinary teachers should have the authority to evaluate themselves and other teachers, while teaching managers have the authority to modify, query, and view data mining results.

TABLE 1: Importance of scale values of indicators.

Index 1 versus index 2	Scale value
Equally important	1
Slightly important	5
Obviously important	3
Strongly important	6
Extremely important	9
Between the above importance	2, 3, 4, 7, and 8

TABLE 2: Random consensus indicators.

п	1	2	3	4	5	6	7	8	9
RI	0	0.1	0.56	0.87	1.14	1.25	1.34	1.43	1.48

2.2.2. Data Import of History Teaching Evaluation. In the past, teachers were evaluated by issuing paper questionnaires, and then school administrators sorted out and summarized the data into EXCEL tables. There was some hidden information in these data. Therefore, this system should realize the transformation and import of historical data, so as to make the results of data mining more objective.

2.2.3. Association Rule Mining. Through association rules, the author finds out "the influential factors that can effectively explain teaching quality as excellent" and "the association rules that can effectively explain the evaluation results of teaching quality as excellent," so as to provide a powerful scientific basis for school leaders and administrators to reform teaching quality.

2.2.4. Online Evaluation. With the widespread application of network technology in the field of education and teaching, the traditional paper evaluation method is no longer suitable for the development of the teaching era, so the system should provide a networked evaluation of teaching quality.

2.2.5. Update the Teaching Evaluation System. By analyzing the mining results of historical data, the evaluation index system of the teaching quality evaluation system is adjusted and updated to make the teaching evaluation more reasonable and objective.

Eight major influencing factors for the quality of hierarchical PSO-BP online courses have been identified. In the following research, the questionnaire design is firstly distributed and recovered, and then the collected questionnaire data is analyzed to extract the appropriate factors (see Table 3).

The reliability of factor analysis is closely related to the number of samples. Most scholars believe that, for factor analysis, the number of samples should be more than 5 times the number of variables. If the number of samples is more than 10 times the number of variables, the results are more reliable. The number of variables in the author is 18, the number of data samples collected is 301, and the number of samples meets the requirements for factor



FIGURE 1: AHP PSO-BP online teaching quality evaluation framework.

TABLE 3: Factors matrix of PSO-BP online course qualityevaluation.

Торіс	Yes	No
Course description	222 (92.8%)	16 (7.2%)
Goal setting	206 (87.3%)	32 (12.7%)
Environmental creation	201 (84.8%)	37 (15.2%)
Interest inspire	192 (81.2%)	44 (18.8%)
Install and uninstall	171 (71.5%)	69 (28.5%)
Network transmission	184 (77.6%)	54 (22.4%)
Operation help	195 (82.3%)	43 (17.7%)
Goal coordination	191 (80.6%)	47 (19.7%)

analysis. The KMO statistic is obtained based on the partial correlation coefficient value between variables. When the variables are correlated, the simple correlation is very high, but the partial correlation coefficient between the variables is very small, indicating that the variables have common factors. On the contrary, if the partial correlation coefficient of each variable is larger, the common factors between the variables are less, which is not suitable for factor analysis. The KMO index value is between 0 and 1. When the KMO value is larger, the partial correlation coefficient between variables is lower, and it is more suitable for factor analysis. The specific judgment criteria are shown in Table 4.

Through a review of research data, relevant research has confirmed that if the number of variables is between 10 and 50, the factor extracted by the method with a feature value greater than 1 is reliable. The number of variables in this study is 20. It is appropriate to use the method of eigenvalue greater than 1 to extract factors. At the same time, the number of factors is determined by combining the diminishing variation of the lithograph. As shown in Figure 2, it can be seen that the number of factors with a characteristic value greater than 1 is 5.

The principal component analysis method is used for factor selection, and the factor rotation method selects the maximum variance method. The results obtained are shown in Table 5. The cumulative explained variation of common factors is more than 50%, and the factor analysis results of extracting 4 factors are acceptable.

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KMO statistic value	Discrimination note	Factor analysis applicability
Above 0.95	Ideal for factor analysis	Great
0.85 or more	Suitable for factor analysis	Good
0.75 or more	Factor analysis	Moderate
0.65 or more	Can barely perform factor analysis	Normal
0.55 or more	Not suitable for factor analysis	Poor
0.55 or less	Very unsuitable for factor analysis	Unacceptable
6		

TABLE 4: KMO judgment criteria.



FIGURE 2: Gravel map.

### 3. Online Teaching Quality Evaluation Model Based on Hierarchical PSO-BP Neural Network

BP neural network model is widely used, mainly because of its strong self-adaptability, fault tolerance, and robustness. BP neural network prediction process is mainly to establish a perfect evaluation index system, choose the right amount of sample data, carry on the training and learning, find out the relationship between input and output value, and get the optimal solution in the problem; the BP network model to establish a perfect and efficient e-government performance evaluation model has far-reaching significance.

The main steps of using hierarchical PSO-BP neural network to evaluate e-government performance are as follows:

Step 1: according to the relevant influencing factors in the development process of e-government, select the appropriate indicator data of e-government performance evaluation, use relevant algorithms to conduct standardized processing of indicator data [28], and then process the processed indicator data  $X_1, X_2, X_3, ..., X_n$  as the input value is of the PSO-BP neural network at the input level. Step 2: after the input data in the input layer, the data will be propagated in the neural network. The data will be processed layer by layer in the hidden layer, and then the processed data will be transmitted to the output layer. The data obtained by the output layer is the actual output value *Y*.

Step 3: when the output of the output layer to get the actual value and the expected value, if the output values and expectations are not equal, the formula and the error signal according to the original path reverse the spread through continuous cycle of transmission, in order to adjust the weights of hidden layer neurons, to make the error smaller.

Step 4: constantly repeat the previous step 2 and step 3, until the error can be small to a min value, then stop training and learning, The selected training sample of the neural network is more precise, and the input sample data is different with the output vector. When all the data sample values and expectations of minimum error is close, the neural network weight value generation of PSO is level-through training the BP neural network and adaptive learning by an internal representation.

Ingredient	Initial eigenvalue			Extract the sum of squares of the load				Rotating load sum of squares			
	Total	Variance percentage	Cumulative percentage	Total	Variance percentage	Cumulative percentage	Total	Variance percentage	e Cumulative percentage		
1	5.714	31.742	31.742	5.712	31.742	31.742	2.522	13.889	13.998		
2	1.372	7.618	39.361	1.373	7.618	39.361	2.416	13.417	27.414		
3	1.186	6.597	45.957	1.186	6.597	45.957	2.214	12.305	39.722		
4	1.044	5.805	51.761	1.044	5.805	51.763	2.168	12.042	51.763		

TABLE 5: List of explanations of the total variance.

To the selection of training samples, we can use hierarchical PSO for the training of the BP neural network model of e-government performance evaluation but also for largescale e-government performance evaluation, because the neural network has certain robustness and then leads to a subjective value in a certain degree which will be a small amount of deviation with the actual value, but the deviation will not affect the evaluation results. Its flowchart is shown in Figure 3.

The speed and position iteration formula of the PSO algorithm can also be written as

$$d_{id}^{t+1} = c_1 r_1 \left( s_{id} - y_{id}^t \right) + c_2 r_2 \left( s_{pd} - x_{id}^t \right) + q d_{id}^t, \qquad (2)$$

where q is the inertia weight. The particle swarm algorithm can adjust the global and local optimization capabilities by introducing the inertia weight. Appropriate inertia weight can avoid falling into the local optimum and be far away from the global optimum. The inertia weight here decreases linearly with the number of iterations to ensure convergence. The calculation formula is

$$q = q_{\max} - t_i * \left(\frac{(q_{\max} - q_{\min})}{t_{\max}}\right). \tag{3}$$

The two processes of signal forward propagation and backpropagation together constitute the whole process of BP neural network learning. After the training sample is input into the network, the input layer inputs the activation value, which is processed by each hidden layer in the system and delivered to the output layer and obtained the network input response from the neurons therein. If you get bigger differences between the output and desired output, then the network will be guided by the error minimization principle, to reverse transmission input information processing and distribution of each layer neuron response error processing tasks and then obtain the neurons of the error signal and, on this basis, weight ratio of each layer. In the process of weight proportion adjustment, the learning process of the network itself can be completed. The termination of this process is based on meeting the accuracy standard or learning time standard. After the network connection value is obtained, the new sample can be represented as a nonlinear image. A large number of practical research results fully prove the mapping capability of BP neural network, but there are some deficiencies in terms of convergence speed. The higher sensitivity to parameters, such as initial weights of network problem, is more outstanding. In the process of the actual

research, attaches give great importance to deal with this problem.

- (1) It is necessary to initialize the particle swarm to complete the initialization of the neural network and according to the corresponding rules to initialize the particle initialization processing.
- (2) Evaluate them accordingly. In the process of evaluation, the component mapping in the particle swarm is set as the form of network weight ratio, so as to form a complete neural network and then input samples for training. Weight optimization, in essence, is a cyclic iterative process, and in order to strengthen the basic ability of neural network, it is usually necessary to divide the sample space, one part of which is used for training, and the other part is used for testing. In fact, we should ensure the diversity of training sets during each training.
- (3) Calculate the corresponding hierarchical PSO-BP model. After the determination of whether the particle needs to be updated, taking the model as an example, the individual's flight speed was first modified and corrected. After this work, new particles were generated.

Finally, the conditions for terminating the algorithm are given. The algorithm terminates when the number of iterations exceeds the designed maximum algebra or the objective function is less than the given value.

### 4. Experimental Verification

In this paper, the neural network toolbox (NNT) of Matlab 7.0 software is used for modeling. The neural network toolbox of MATLAB software is based on the theory of artificial neural network and uses MATLAB language to construct typical neural network excitation functions, such as S-type, linear, competitive, and other excitation functions, so that the designer can output the selected network. The calculation becomes a call to the excitation function. In addition, according to various typical rules for modifying network weights, plus network training in the process, use MATLAB language to write various network design and training subroutines. We can call the neural network design and training procedures in the toolbox according to our needs, thereby improving efficiency and quality of problem solving. Based on the teaching evaluation data of a university from 2009 to 2012, this paper uses the above modeling method to establish a prediction model of teacher teaching quality evaluation. In an artificial neural network, sample is a necessary condition for neural network training. The quality of sample selection directly affects the training result of neural network. Therefore, the selection of samples on the basis of summary and analysis on the classroom, which is typical of the questionnaires. Classroom teaching based on teaching quality evaluation indicators for students chose the indicators of instructor ratings. Each rating class has a lot of students, which is equivalent to have a lot of judges. This paper adopts the lowest points and eight input index values, which can eliminate some teaching quality evaluation data. As for the expected output index, this paper adopts the evaluation value of the teaching supervision group after the class lectures and uses such sample data to train the network. Its significance lies in that although the indicators of teachers are typed by students, the final evaluation result reflects the evaluation thought of the experts in the supervision group.

According to the standardized processing method of the index system, the collected sample data is standardized processing. The scoring data (0, 100) is converted into data between (0, 1) for neural network processing. The processed sample data are shown in Table 6. The first 1 to 10 groups of data in Table 6 were used as training data (including teacher data), and the remaining 4 groups were used as validation data (excluding teacher data) to verify the prediction results of the neural network model generated after training.

- (1) Initialization: set the initial value functions of weights and thresholds. Before BP neural network training, the initial values of weights and thresholds must be set, which can be achieved by the initial function.
- (2) Create a network prediction model: implemented by function NEWFF, the number of neurons is determined according to the sample data. At the same time, the user needs to determine the number of hidden layers, the number of hidden layers of neurons, transformation function, and training function. The number of hidden layer nodes is set as 8, the target error is 0.01, and the learning rate is set as 0.01. The procedure is as follows:

net = newfF (minmax (P), [5 8 1], {"tansig", "tansig", "purelin", "traingdm", "learngdm", "mse");

echo on

me = 10000;

net.trainParam.show = 12;

Net. TrainParam. Goal = 0.02;

Net. TrainParam. Lr = 0.02; net.trainparam.epochs = 1003; pause

[net, tratrain (net, P, T);

- (3) Network training: the network is trained by function train according to the sample input P, target vector T, and the parameters of the training function set in advance.
- (4) Network simulation: implemented by function Sim, the test data is simulated according to the trained network.

The evaluation results and actual evaluation results after network training are shown in Table 7. The experimental data show that the training and prediction accuracy of the model based on the hierarchical PSO-BP neural network is completely within the acceptable range and is a reasonable and feasible prediction model.

A comparison of the weighting results of the primary and secondary indicators of the online teaching evaluation model by experts and students and the results are as follows.

It can be seen from Figure 4 that the weights of the first-level indicators scored by experts in descending order are curriculum design, teacher team, courseware production, learning interaction, and system design; the weights of the first-level indicators scored by students are teacher team and curriculum in descending order design, courseware production, learning interaction, and system design. For indicator system design, courseware production, and learning interaction, the weights assigned by experts and students are not very different, and the order of the weights of these three indicators is also the same. As for the two indicators of curriculum design and teacher team, the weights assigned by experts and students are quite different: experts pay more attention to the design of the curriculum, while students pay more attention to the teacher team.

It can be seen from Figure 5 that, among all the secondary indicators, comparing the results of the empowerment of experts and students, the weights of the four indicators of scientificity and interest, professionalism, personal charm, and collaborative teaching are quite different, while of other indicators the weight difference is relatively small. Among them, experts pay more attention to content science and fun than students, while students pay more attention to the three indicators of professionalism, personal charm, and collaborative teaching.

The BP neural network optimized by the hierarchical PSO is used to train and test the samples. In order to ensure the consistency of the test results, the training process is shown in Figure 6.





Sample	1	2	3	4	5	6	7	8	9
1	0.93	0.93	0.65	0.88	0.85	0.93	0.88	0.67	0.95
2	0.97	0.87	0.52	0.87	0.85	0.88	0.93	0.64	0.83
3	0.98	0.87	0.63	0.97	0.71	0.81	0.94	0.63	0.95
4	0.92	0.98	0.66	0.98	0.73	0.87	0.97	0.66	0.91
5	0.96	0.97	0.62	0.94	0.97	0.83	0.92	0.33	0.97
6	0.96	0.97	0.98	0.91	0.73	0.91	0.92	0.67	0.97
7	0.93	0.96	0.94	0.96	0.97	0.92	0.84	0.97	0.96
8	0.98	0.98	0.91	0.98	0.98	0.87	0.78	0.93	0.94

TABLE 6: Sample data after initialization.

TABLE 7: Comparison of actual evaluation results and simulation evaluation results.

	1	2	3	4	5	6	7	8	9
Actual evaluation result	0.812	0.764	0.923	0.732	0.623	0.792	0.858	0.678	0.832
Network evaluation results	0.819	0.761	0.926	0.726	0.621	0.783	0.862	0.683	0.824
Error	0.003	0.003	0.003	0.006	0.002	0.009	0 004	0.005	0.008

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FIGURE 4: Comparison of the first-level indicator empowerment results of experts and students.



FIGURE 5: Comparison of the second-level indicator weighting results of experts and students.



FIGURE 6: Online teaching parameter training based on hierarchical PSO-BP neural network.



FIGURE 7: Training process diagram.

As shown in Figure 7, because the BP neural network is easy to fall into the local optimum, we chose to use the PSO algorithm to optimize its weight and threshold adjustment. The model optimized by the PSO will not have the local optimum problem, and the PSO-BP network model will have a faster convergence speed and smaller errors within 100 power (w).

### 5. Conclusion

After verification in this paper, it is found that the introduction of particle swarm algorithm into the BP neural network to optimize the setting of its connection weight and threshold can effectively improve its convergence speed and show more powerful performance indicators in the global search process which effectively improve the inherent problems of BP neural network. The online teaching quality evaluation factors with relatively large weights are selected as the basis, the hierarchical PSO-BP model of safety evaluation is established, and the evaluation results are verified accordingly. The hierarchical PSO-BP algorithm considers both in the process of network weight adjustment. The weight correction is carried out by the error backpropagation of each training sample of the basic BP algorithm, and the weight is updated by tracking the historical best weight of the individual network and the historical best weight of the group network after each training. The verification results show that the results given by the model studied in this paper are in line with the actual situation. This model has the characteristics of a simple algorithm, high evaluation, and high intelligence. Compared with the traditional neural network model, the hierarchical PS0-BP model studied in this paper has a better performance in online teaching quality evaluation and provides a new method for the safety evaluation of online teaching quality.

### **Data Availability**

The data used to support the findings of this study are available from the corresponding author upon request.

### **Conflicts of Interest**

The authors declare that they have no conflicts of interest regarding this paper.

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