Cloud Education Model and Evaluation Based on AHP and BP Neural Network

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Abstract
Study the current state of cloud technology use in teaching, and train the cloud teaching mode and operational process. To judge whether the cloud mode of instruction has achieved the desired effect, the method of combining the analytical hierarchy process with the BP neural network is selected. A system for evaluating teaching is being explored for cloud-based teaching through theoretical research. The AHP method is used to select three primary indicators and twelve secondary indicators respectively. The judgment matrix method is used to determine the weight of each evaluation index, and the BP neural network principle is used to train the evaluation data, Verify the scientificity and rationality of the evaluation system, which can be applied to other courses in the future in combination with the characteristics of specific courses.

Keywords: *Cloud teaching; Analytic hierarchy process; Neural network; Evaluation system*

1 INTRODUCTION

What does Cloud Education mean?

Cloud-based learning is one way to bring Internet technology to classrooms. With the rapid development of network technology, network education based on cloud technology has been given increasingly greater attention [13].

1.1 Status of research in other countries

Studies in other countries include the concept, system and evaluation scheme of cloud-based models of education, and point out that a good assessment of teacher education can promote teacher development.

1.2 Research Status in China

Currently, some universities and educators have tried to teach cloud computing, but face-to-face teaching is still the dominant stream in class teaching [2].

2 TEACHING MODE OF CLOUD TEACHING

Cloud education will break the interaction between teachers and students, and allow for the sharing of learning resources and information through cloud computing.

In the traditional way of teaching, students can only passively understand the teacher's way of thinking, in the long term, students tend to lose the capacity to think. To prevent the eyes of students from getting busy with the rich and diverse online world, teachers must modify the mode of instruction, adjust the learning objects and the space, and use the power of information technology to enable them to obtain more knowledge in real and living situations.

2.1 Teaching links of cloud teaching mode

2.1.1 Clarification of teaching objectives

The goal of every lesson is the teacher's "stick" before, during and after class [1].

2.1.2 Pre-lesson task push

Teachers in the cloud education platform to create classes, so that students attend classes in class. Prior to the course, the teacher will be related to the content of this lesson, so that he can preview, understand the basic concepts, so that the course can be a more profound level of learning and discussion.

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2.1.3 In-class teaching

Course lead-in link to preview tasks to test, promote students to develop the habit of preview, timely acceptance of the teacher's preview task. Forms of classroom teaching may be diverse, for some of the most theoretical concepts to teach teachers, students and test as a supplement. As regards application problems, we should organize group discussions and present the results through group discussions.

2.2 Teaching evaluation

A set of scientific and effective evaluation system of teaching quality is needed to judge whether the cloud teaching mode achieves the expected effect or not, and adjust the teaching actively according to the evaluation results. Based on the AHP-BPNN (Analytic Hierarchy Process and BP Neural Network) method, this article builds a teaching assessment system for the mode of teaching through theoretical research.

3 TEACHING PROBLEMS SOLVED BY CLOUD TEACHING MODE

3.1 Sharing educational resources using cloud technology

The teaching resources of the course are mainly based on the integration of theory and practice of professional courses, and presented in various ways.

3.2 Break the conventional examination methods.

The test method changed from "paper test" to "full test"; each test is based on a complete set of cloud computing technologies.

4 CONSTRUCTING TEACHER EVALUATION MODEL BASED ON AHP-BP METHOD

4.1 General method and model of teaching evaluation

Standards and methods of evaluation vary from university to university, including expert evaluation, self-assessment, peer evaluation, and student evaluation [14].

General education evaluation models are weighted linear least squares, multivariate linear and partial. They're all based on linear and can't get close to the non-linear problem though.

4.2 Teaching evaluation model of AHP and BP neural network

A new teaching evaluation model based on BP neural network is proposed, which can not only overcome the problem of index weighting, but also deal with the nonlinear relationship between evaluation indexes and educational performance.

In the evaluation system, the BP neural network analytic hierarchy process is used, and the steps are as follows [11]:

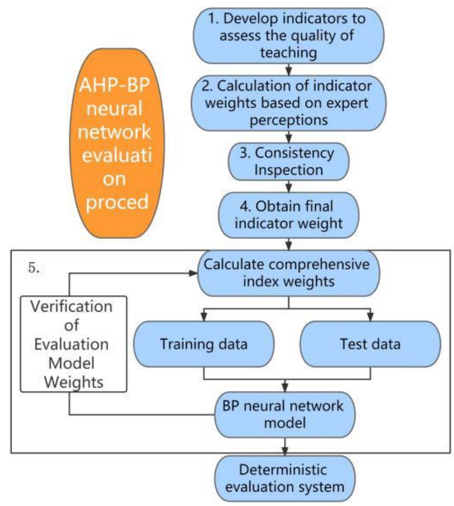

Fig. 1 Implementation steps of AHP-BP method

According to the above process, use data for validation.

4.2.1 Step 1: Modeling the hierarchy

Table 1 Teaching Evaluation Index Using the AHP method, a set of index model of teaching evaluation is established [7], as shown in Table 1.

Table 1 teaching evaluation index model

Target layer	Criterion level (primary index)	Scheme level (secondary index)
Teaching evaluation indexA	Work attitudeB1	Basic ideas and conceptsC11
		Choice of teaching content.C12
		Classroom information.C13
		Content proficiencyC14
	Operational levelB2	Logical thinkingC21
		Grasp the key points and difficulties.C22
		Verbal expressivenessC23
		Level of blackboard note designC24
		Level of lesson plan preparationC25
		Level of textbook selectionC26
	Teaching effectB3	Two-way communication between teachers and studentsC31
		Classroom teaching discipline.C32

4.2.2 Step 2: Construct the judgment matrix

The basic premise of the AHP is that the relative importance of each element is represented by a judgement matrix at all levels. Compare the two elements by their importance, as illustrated in Figure 2 below:

Table 2 Importance scale meaning table

Importance scale	Meaning
1	Indicates that two elements are of equal importance
3	Indicates that the first element is slightly more important than the second
5	Indicates that the former is significantly more important than the latter
7	Indicates that two elements are more important than one
9	Indicates that two elements are more important than one
2, 4, 6, 8	Represents the median value of the above judgment
reciprocal	If the importance ratio of element i to element j is b_{ij} , the importance ratio of element J to element i is $b_{ji}=\frac{1}{b_{ij}}$

On this basis, by arranging the single sequence of each level, we can get the weight of each level, that is, the overall ranking of levels. The general order of layers is up and down, assuming that the n elements of the k-1 layer are sorted through the object as follows:

$$w^{(k-1)}=(w_1^{(k-1)},\cdots,w_n^{(k-1)})^T \quad (1)$$

Single-order ordinal vector of K-level elements for level j above level.

$$u_j^{(k)}=(u_{1j}^{(k)},u_{2j}^{(k)}\cdots,u_{n_kj}^{(k)})^T \quad (2)$$

$$j=1,2.\cdots,n.\ k=1,2,\cdots,n_k \quad (3)$$

Of these elements, an order matrix can be obtained by setting the weights of elements not checked by element j to zero.

$$U^{(k)}=(u_1^{(k)},u_2^{(k)},\cdots,u_n^{(k)})=\begin{pmatrix} u_{11}^{(k)} & u_{12}^{(k)} & \cdots & u_{1n}^{(k)} \\ u_{21}^{(k)} & u_{22}^{(k)} & \cdots & u_{2n}^{(k)} \\ \vdots & \vdots & \vdots & \vdots \\ u_{n_k1} & u_{n_k2}^{(k)} & \cdots & u_{n_kn}^{(k)} \end{pmatrix} \quad (4)$$

In which the first row of elements k level for the first layer of elements j as criterion for the only row of order vector [5].

The general order for each element in level k is as follows:

$$w^{(k)} = (w_1^{(k)}, \cdots, w_n^{(k)})^T \tag{5}$$

There is

$$w^{(k)} = U^{(k)}\ w^{(k-1)} = \begin{pmatrix} u_{11}^{(k)} & u_{12}^{(k)} & \cdots & u_{1n}^{(k)} \\ u_{21}^{(k)} & u_{22}^{(k)} & \cdots & u_{2n}^{(k)} \\ \vdots & \vdots & \vdots & \vdots \\ u_{n_k 1}^{(k)} & u_{n_k 2}^{(k)} & \cdots & u_{n_k n}^{(k)} \end{pmatrix} \begin{pmatrix} w_1^{(k-1)} \\ w_2^{(k-1)} \\ \vdots \\ w_n^{(k-1)} \end{pmatrix}$$

$$= \begin{pmatrix} \sum_{j=1}^{n} u_{1j}^{(k)} w_j^{(k-1)} \\ \sum_{j=1}^{n} u_{2j}^{(k)} w_j^{(k-1)} \\ \vdots \\ \sum_{j=1}^{n} u_{n_k j}^{(k)} w_j^{(k-1)} \end{pmatrix} \tag{6}$$

$$w_i^{(k)} = \sum_{j=1}^{n} u_{ij}^{(k)} w_j^{(k-1)}, \quad i = 1,2,\cdots,n_k \tag{7}$$

Based on the theoretical knowledge of AHP, the relative importance of the evaluation indexes in the teaching evaluation index system is calculated, and the corresponding matrix is shown in Tables 3-8 below:

Table 3 Judgment Matrix B1-C

B_1	Basic ideas and conceptstsC11	Choice of teaching contentC12	Classroom information .C13	Content proficiency C14	Wi
Basic ideas and conceptsC11		1	1	1	0.2464
Choice of teaching contentC12			1	1/2	0.2107
Classroom information C13				1	0.2464
Content proficiency C14					0.2964

Table 4 Judgment Matrix B2-C

B_2	Logical thinking C21	Grasp the key points and difficulties C22	Verbal expressiveness C23	Level of blackboard note design C24	Level of lesson plan preparation C25	Level of textbook selection C26	Wi
Logical thinkingC21		1	3	3	1	4	0.2657
Grasp the key points and difficultiesC22			2	3	3	3	0.2810
Verbal expressivenessC23				2	1	3	0.1454
Level of blackboard note designC24					1/2	2	0.0893
Level of lesson plan preparationC25						2	0.1547
Level of textbook selectionC26							0.0639

Table 5 Judgment Matrix B3-C

B_3	Two-way communication between teachers and students C31	Classroom teaching discipline C32	Wi
Two-way communication between teachers and studentsC31		3	0.7500
Classroom teaching disciplineC32			0.2500

Table 6 Judgment Matrix A-B

A	Work attitude B1	Operational level B2	Teaching effect B3	Wi
Work attitude B1		1	1	0.3278
Operational level B2			1/2	0.2611
Teaching effect B3				0.4111

4.2.3 Step 3: Verify consistency

Start at the top, take a look at this. Set the uniform exponent of the specific factors in Layer K for the single arrangement of the j cells in Layer K, the mean of stochastic consistency, and the uniform ratio of the sequences throughout Layer K:

$$CR^{(k)} = \frac{\sum_{j=1}^{n_k} w_j^{(k-1)} CI_j^{(k)}}{\sum_{j=1}^{n_k} w_j^{(k-1)} RI_j^{(k)}} \quad (7)$$

In the case of less than 0.10, consistency is desirable.

Table 7 Matrix Consistency

Judge an object	Consistency
Judgment matrix A-B	0. 0516
Judgment matrixB1−C	0. 0227
Judgment matrixB2−C	0. 0337
Judgment matrixB3−C	0

4.2.4 Step 4: Get the total judgment matrix

Table 8 Total judgment matrix

Indicators	Combination weight	Indicators	Combination weight	Indicators	Combination weight
B1	0.3278	C11	0.0808	C23	0.0380
B2	0.2611	C12	0.0691	C24	0.0233
B3	0.4111	C13	0.0808	C25	0.0404
		C14	0.0972	C26	0.0167
		C21	0.0694	C31	0.3083
		C22	0.0734	C32	0.1028

4.2.5 Step 5: Evaluate the AHP evaluation system with BP neural network [3].

In order to compensate for the influence of subjective arbitrariness noted by experts on index weight, the BP neural network is used to optimize index weight. The characteristic of BP neural network is that the signal propagates forward, and the error propagates backward. It is not necessary to set up a fixed model beforehand, but only to form training samples. The BP neural network is made up of three layers. A hidden layer is added between the input and output layers to form a multilayered return.

Through Matlab simulation test, 300 values between 60 and 100 were generated, as shown in Table 7, xi represents the score of each index item of the teacher, and y represents the overall evaluation results.

Table 9 Training Data

Serial number	X1	X2	X3	......	X12	y
1	83	94	78	......	90	84.9096
2	69	66	86	......	80	71.3032
3	77	76	83	......	90	76.4508
4	66	87	80	......	95	86.0617
5	82	75	97	......	91	85.0740
6	80	92	75	......	64	82.6814
7	89	93	91		97	78.7929
......	......	......	......	......	......	......
300	89	85	83		68	86.0823

The BP algorithm is described as follows:

Initialisation of the weight and threshold. First, the original data is normalized, and then the connection weights and corresponding thresholds are randomly selected within (-1, 1), among which, the weights and thresholds from input to hidden layer, and the weights and thresholds directly from hidden layer to output are normalized.

Calculate the output values per layer. If the input sample is (i = 1, 2, ..., m), then the node output values on each level are [4]:

$$Zj=f(\textstyle\sum_{j=1}^{m} \omega_{ij} - \theta_j), \; j=1, 2, \ldots, q \quad (8)$$

$$yk=f(\textstyle\sum_{j=1}^{q} \omega_{jk} Z_j - \theta_k), \; k=1, 2, \ldots, n \quad (9)$$

Where f (x) is the activation transfer function, Zj is the output value of each node of the hidden layer, yk is the output value of each node of the output layer, and m, q, and n are the number of nodes of the input layer, the hidden layer, and the output layer, respectively [10].

Compute every layer error. The specific formula is this:

$$\delta_k = (y'_k - y_k) \cdot y_k \cdot (1 - y_k) \quad (10)$$

$$\delta_j=[\textstyle\sum_{k=1}^{n} \delta_k \cdot \omega_{jk}] Z_j (1-Z_j) \quad (11)$$

The error of the output layer and the cached layer is the target value of the sample [8].

Weight and threshold adjustment. The weights and thresholds Q_k from the hidden layer to the output layer can be modified according to the output layer error and the output Z_j of the hidden layer, wherein 0 <α< 1.

$$\omega_{ij}(N+1) = \omega_{jk}(N) + \alpha \cdot \delta_k \cdot z_j \quad (12)$$

$$\theta_k(N+1) = \theta_k(N) + \alpha \cdot \delta_k \quad (13)$$

The weights and thresholds from the input layer to the hidden layer can be modified according to the error of the hidden layer and input of the input layer, wherein $0 < \beta < 1$.

$$\omega_{ij}(N+1) = \omega_{ij}(N) + \beta \cdot \delta_j \cdot x_i \quad (14)$$

$$\theta_j(N+1) = \theta_j(N) + \beta \cdot \delta_j \quad (15)$$

During the learning process, if the error is within an acceptable range, the learning is completed; otherwise, the return step (2) Adjust the step length and threshold for further learning until the specified error, accuracy or training times are met.

According to the algorithm principle, the BP neural network is applied to the assessment of the quality of cloud education. There is no need to build a fixed model in advance, but simply enter the data from the assessment indices as a BP neural network. The specific structural design is that:

First, the structure containing a concealed layer is selected in the Class H BP network to determine the number of layers [12].

Then determine the number of knots in each layer: the number of indicators predefined by the AHP method is equal.

The number of nodes in the output layer is only the overall score of the teacher according to the teaching evaluation model, so the number of nodes in the W output stage is only one.

The basic principle of the hidden layer is to reduce the number of hidden neurons as much as possible, and at the same time to accurately express the input, reducing the complexity of the network. This article is based on the following empirical formula.

$$h = \sqrt{m+n} + a; \quad (16)$$

m and n are the number of entry and exit neurons in the BP network, and 'a' is an integer, taking a value between 1 and 10 [9].

To achieve this objective, the standardization process is performed and compressed in a closed range from 0 to 1, and its standard expression is as follows.

$$Y = (xi-min)/(max-min) \quad (17)$$

The data in this table is pre-processed and divided into 300 training data and 200 test data. The experiment results were introduced into the teaching evaluation model after training, and the prediction results and real results of the experiment samples were obtained by using AHP and BP neural network. This scatter diagram is illustrated in Figure 2:

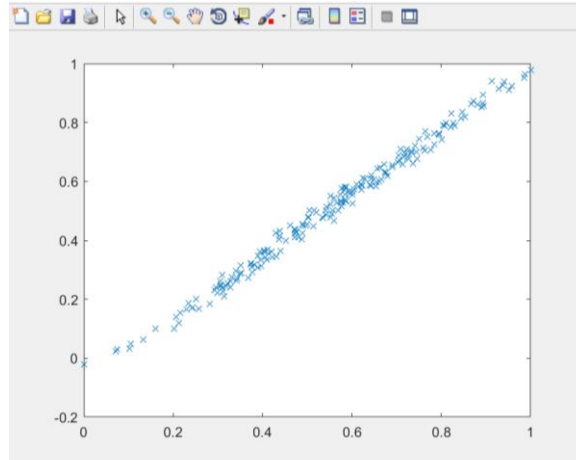

Fig. 2 Difference curve between predicted value and real value

Following practice, the model MSE was 0.0025.

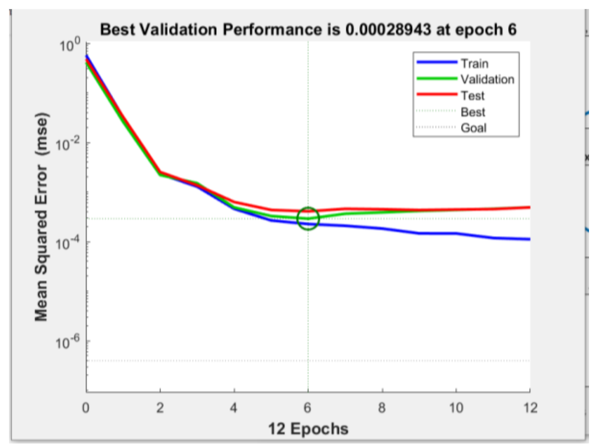

Figure 3 Performance diagram of a neural network

From the best point and line can be seen in the sixth generation of training, BP network is the best. The trajectories of the three colors are: the performance of BP's MSE index for each generation of learning process, the performance of BP's cross-check MSE index for each generation, and the testing of BP's MSE index for each generation.

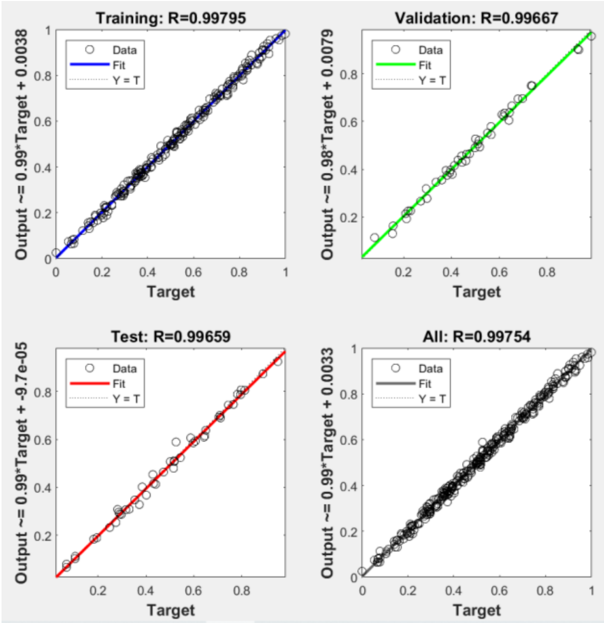

Figure 4 Results from training, validation, test, and overall samples

Figure 4 shows the predictive results of training samples, verification samples, test samples and all samples. All R values are very close to 1 based on the R value. In summary, the BP neural network designed in this article can obviously improve the calculation efficiency of the improved AHP method. When we need to assess the impact of instruction in practice.

5 CONCLUSION

This article aims to study the teaching mode based on "cloud technology" and make it a good effect in practice.

The AHP and BP neural network can be used to construct a new educational assessment model.

Meanwhile, this evaluation system has some reference to other courses and universities [6].

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