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Research on the Quality Evaluation of Online and Offline Teaching in Universities and Colleges based on BP Neural Network

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Abstract. With the deepening of teaching reform and the development of online teaching, the online and offline teaching mode has become a hot spot in the current teaching reform in colleges and universities. In this paper, the BP neural network will be used in the teaching quality evaluation of the mixed teaching mode in colleges and universities, and the evaluation system will be innovated for the particularity of the mixed teaching mode. Evaluate the whole process of the online and offline teaching modes from three different perspectives: supervisors, teachers, and students, so as to better ensure the objectivity of the evaluation results and provide a reference for the research on teaching quality evaluation.

Keywords: online and offline teaching, teaching quality evaluation, BP neural network

1. Introduction

Colleges and universities are important talent training bases, and teaching quality is the foundation for colleges and universities to gain a foothold. Teaching quality is not only related to the survival and development of a university, but also related to the overall competitiveness of a university as a whole [1]. Therefore, improving the quality of teaching is the eternal theme of education. With the deepening of teaching reform and the development of online teaching, the online and offline teaching mode has become a hot spot in the current teaching reform in colleges and universities.

Compared with traditional teaching, mixed teaching has great differences in teaching forms, teaching methods and teaching resources [2]. Due to the different application environments, teaching methods and feedback mechanisms of the online and offline teaching modes [3], the teaching effectiveness of teachers in the mixed teaching mode is also changing, and the teaching quality evaluation indicators of the full offline teaching mode cannot be fully applied. Therefore, in order to promote the further deepening and innovation of teaching reform [4], teaching quality evaluation should also be reformed, so as to create a teaching quality evaluation system that conforms to the blended teaching method, and further, help scientifically evaluate the effect of mixed teaching.

As the evaluation of teaching quality is a multi-variable, fuzzy, complex nonlinear problem, which involves some subjective factors [5], and these subjective factors will affect the evaluation results. Therefore, it is difficult to accurately use traditional mathematical models to evaluate teaching quality. Based on BP neural network, a feasible teaching quality evaluation model is established [6], and the objectivity of evaluation is improved through the application of information technology. Fan and Ma [7] used the optimized BP neural network to systematically simulate the research on the teaching quality of college teachers and its influencing factors, and established a corresponding evaluation model. On this basis, Hou designed the evaluation process of the mixed teaching mode, which has achieved good results in practical application. Kim and Wenwen used BP neural network and related theories to develop an evaluation index system [8], constructed an effective computer graphics teaching quality evaluation model, and used the model to evaluate the actual teaching situation of related courses [9]. Z confirmed the application of BP neural network in blended teaching in higher education [10]. It has broad application prospects in teaching evaluation. In terms of research methods, Gu evaluated the teaching quality based on Grey Correlation Analysis and Neural Network[11], Chen establish a

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multi-evaluation model with the internet and mobile terminals[12], Peng[13] and Cao[14] used BP neural network as the research method to evaluated teaching quality in university. Sum up, this paper aims to establish a innovation evaluation system to evaluate the quality of online and offline teaching, and BP neural network will be used as research method.

In this paper, the BP neural network will be used in the teaching quality evaluation of the mixed teaching mode in colleges and universities, and the evaluation system will be innovated for the particularity of the mixed teaching mode. Evaluate the whole process of the online and offline teaching modes from three different perspectives: supervisors, teachers, and students, so as to better ensure the objectivity of the evaluation results and provide a reference for the research on teaching quality evaluation.

2. Discussion

2.1. Characteristics of online and offline mixed teaching

As a new model that combines two different teaching methods, online and offline, mixed teaching not only retains the leading role of teachers in traditional teaching, but also enables students to fully exert their enthusiasm in the online teaching process. This can greatly improve the teaching effect, and further improve the basic quality of students. In this process [15], the learning effect of students in the two different teaching methods, online and offline, needs to be considered. At the same time, the three parts called 'before the class', 'during the class' and 'after class' are also the necessary links that need to be included in the evaluation of teaching quality. In addition, scoring the teaching effect from the three perspectives of the supervisor, teacher and students can evaluate the quality of teaching more objectively and accurately. Therefore, this paper aims at the characteristics of mixed teaching, and follows the three scientific principles to make new adjustments to the teaching quality evaluation mechanism [16].

2.1.1. Principle 1: Whole Process Teaching

Mixed teaching divides the teaching process into two parts, online and offline. Therefore, when evaluating the teaching effect, the online and offline parts need to be assessed separately. Moreover, in the whole process of teaching, from the construction of the curriculum to the teaching process and then to the teaching effect, all need to be considered, so as to highlight the importance of process learning. The whole process evaluation is the quantitative evaluation reflected in these learning links [17].

2.1.2. Principle 2: Three Subjects

The principle of three subjects emphasizes that in the evaluation of teaching quality, the teaching effect should be evaluated from the perspective of the three subjects of supervision, teachers and students. The traditional evaluation system is mainly based on teacher evaluation, and it is one-sided when evaluating students; it may lead some students to seek shortcuts in order to obtain high scores. In order to accurately and objectively evaluate the learning situation and enable all students to actively participate in learning activities, mixes teaching should use the method of joint scoring by supervisors, teachers and students to evaluate the teaching effect.

2.1.3. Principle 3: Transparency

Evaluation results are a comprehensive reflection of course learning and an intuitive reflection of students' learning achievements. In order to ensure the fairness of evaluation results, the evaluation process should be open, transparent and convincing [18]. Online learning activities in mixed teaching can query traces and statistical results through the course network platform, and offline learning activities can realize real-time quantitative assignment and be supervised by students.

2.2. Overview of BP neural network

2.2.1. Structure of BP Neural Network

BP network is a neural network with three or more layers of neurons, including input layer, hidden layer, and output layer. The upper and lower layers are fully connected, and there is no connection between neurons

in each layer [19]. When a pair of learning samples is provided to the network, the activation value of neurons propagates from the input layer to the output layer through each intermediate layer, and each neuron in the output layer obtains the input response of the network. Next, along the direction of reducing the error between the target output and the actual output, the activation value is reversed from the output layer through each intermediate layer and returned to the input layer, thereby correcting the connection weight layer by layer.

BP neural network structure is shown as figure 1 below.

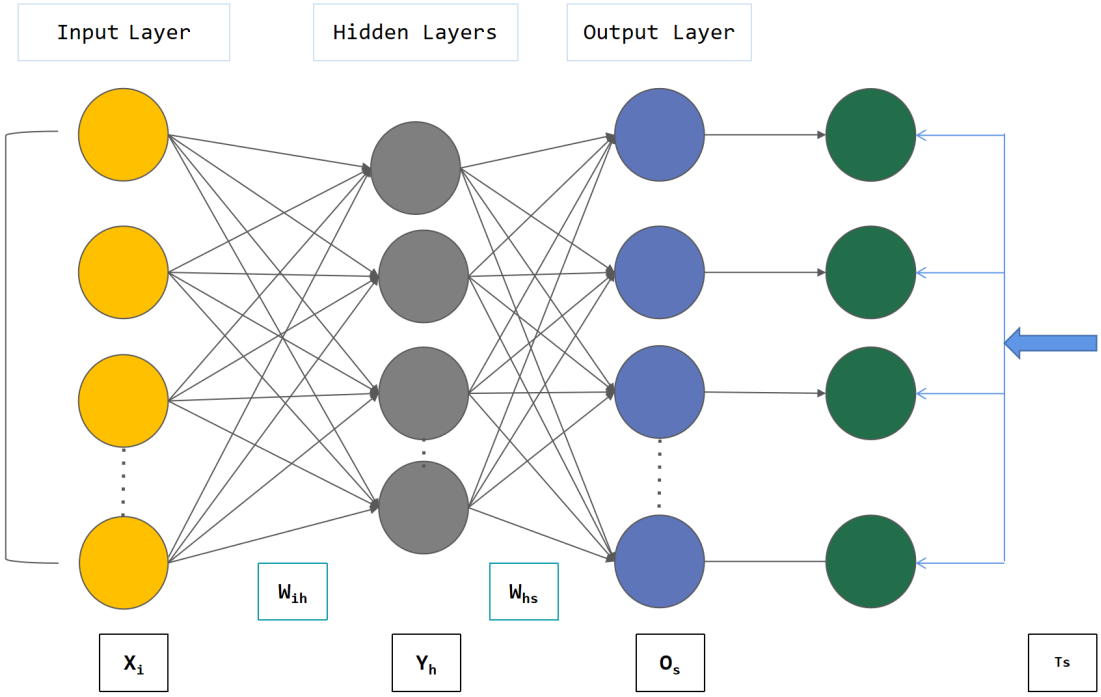

Fig 1: BP Neural Network Structure

2.2.2. BP Learning Algorithm

The essence of the BP algorithm is to use the sum of the squares of the network error as the objective function, and to obtain the minimum value of the objective function according to the gradient approaches. The BP algorithm takes the principle of error correction as the basic principle, and uses the gradient descent method to adjust and modify the connection weights of the network through the backpropagation of the error output by the network, and the purpose is to minimize the error.

a. Initialize network and learn parameters

The initialization parameters include the connection weights between the network input layer and hidden layer which recorded as Wih, connection weights from hidden layer to output layer credited as W_{hs}, threshold of hidden layer neurons which recorded as θh and threshold of output layer neurons that credited as θs. These parameters can be initialized with random numbers between [-1, 1]. In addition to the above parameters, it is usually necessary to specify parameters such as learning rate and error limit value.

b. Input training samples

The input vector (X) and the expected output vector (T) constitute two parts of the BP neural network sample. The transfer function of the hidden layer is f and the transfer function of the output layer is g.

c. Calculate the response value of the hidden layer and output layer

The output of the neurons in the hidden layer is obtained as equation (1) below.

$$y_h = f\left(\sum_{i=1}^{n} w_{ih} \cdot x_i + \theta h\right) \quad (1)$$

The output of the neurons in the output layer is obtained as equation (2) below.

$$O_s = g\left(\sum_{h=1}^{n} w_{hs} \cdot y_h + \theta s\right) \quad (2)$$

d. Calculate the error of the neural network (e)

In the BP learning algorithm, the error function can be defined by whether the network output generated by a single sample is consistent with the expected response output. It is shown as follow.

$$e = \frac{1}{2}\sum_{S}^{n}(T_S - O_S) \quad (3)$$

3. Design of Teaching Quality Evaluation Model Based on BP Neural Network

3.1. Evaluation system construction

Compared with the previous evaluation system, the system constructed in this paper has made some innovations. In order to build an evaluation system suitable for mixed teaching model, this article divides the whole teaching process into three links: curriculum construction, teaching process and after-class effect, and determines the evaluation indicators for the online and offline links of different links. The teaching evaluation system constructed on the basis of this principle includes three first-level indicators and eleven second-level indicators, which is shown as table 1 below.

Table 1: Teaching Quality Evaluation System

First grade indexes	Second grade indexes	Indicator meaning
Evaluation of curriculum construction I1	Resources for teaching I11	Teaching resources such as teaching calendars, lesson plans, and courseware are perfect and can be continuously updated
	Design of instruction I12	(1) Allocation of online and offline teaching hours; (2) cross-complementarity of online and offline teaching content; (3) The connection of online and offline teaching activities
	Arrangement of teaching content I13	(1) Clear expression: Measurable, quantifiable and measurable degree of achievement; (2)The teaching content is reasonable, complete and sustainable
	Teaching platform I14	(1) The platform is convenient and fast to operate; Stable operation; (2) Real-time monitoring, feedback, statistics; (3) Convenient interaction between teachers and students; Various; (4) Support testing, assessment, live broadcast and other functions; (5) It is conducive to the personalized design of teachers
Evaluation of the teaching implementation process I2	Student performance in online sessions I21	Course learning, video viewing hours; Student discussion and effective posting
	Teacher performance in online sessions I22	(1) the number of posts posted by teachers; (2) the number of times the teacher answered questions; (3) Teacher Q&A coverage;
	Student performance in offline sessions I23	the number of times students ask or answer questions; Students' in-class test scores;
	Teacher performance in offline sessions I24	the number of questions asked by the teacher;Classroom activities organized by teachers;
Evaluation of teaching effect I3	Students ' Acceptance of Knowledge Points I31	Online and offline test scores;
	Improvement of student's self-ability I32	The ability to identify problems, analyze problems, and solve problems;
	cultivation of students' professional qualities I33	

First grade indexes	Second grade indexes	Indicator meaning
		Professional beliefs, professional attitudes

3.2. Establishing a BP neural network model

The first step in building a BP neural network is to determine the number of each layer. Then, adjust the BP network structure and establish the initial parameters, and then the neural network starts training.

3.2.1. Design of input layer.

There are 11 secondary indicators in teaching quality evaluation system as shown in table 1, so that the number of nodes in input layer is 11.

3.2.2. Design of output layer

The output layer exhibits the results of evaluation. According to the evaluation grade established above, the number od nodes of output is set to 1.

3.2.3. Design of hidden layers

In order to better fit the model and improve the accuracy of the evaluation, the number of hidden layers is determined to be 2 through MATLAB multiple training.

3.2.4. Design of the number of hidden neurons

At present, a relatively common method to determine the optimal number of hidden layer nodes is the trial and error method, the following formula is used to determine the number of hidden layer nodes.

$$m = \sqrt{n + l} + a \tag{4}$$

The m in the equation means the node number of hidden layer, n represents node number of input layer and l is the number of nodes of output layer, meanwhile, a is a constant between 1 and 10. In this article, the node number of hidden layer is 5.

3.3. Model training

This paper establishes a teaching quality evaluation system that adapts to the characteristics of blended teaching. The supervisors, teachers and students jointly score the teaching effect according to the indicators in the evaluation system, and use the BP neural network to train in MATLAB many times in order to obtain objective research results.

4. Experimental Results and Discussion

In this paper, 80 valid data were obtained, 70 of which were used as the training sample set, and the remaining 10 were used as the test sample set. In addition to teachers and students scoring the teaching quality, a team of 5 supervisors made an objective score on the evaluation indicators of teaching quality. Use the supervisor's evaluation as the expected result and compare it with the sample set results.

Since the input of the secondary index is a ten-point system, if the original data is directly applied without any transformation, the result may fall outside the effective processing range of the neuron due to the absolute value of the original value being too large. Even if the absolute value of each original data is not too large, it is possible that because a certain component is too large, the impact on the network is much greater than that of other components, so that other components lose their ability to regulate the network. Therefore, it is necessary to normalize the input samples of the neural network. The sigmoid function is used in the neural network, and the input should be normalized to [0, 1].

Training time for 5000 times in MATLAB, obtained the relationship between input indicators and output results as shown below named table 2.

Table 2: Output results of test sample set

Sample Serial Number	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Actual valur	Predictive value	Correlation coefficient
1	0.52	0.8	0.45	0.2	0.62	0.4	0.57	0.70	0.75	0.55	0.8	0.58	0.52	
2	0.71	0.72	0.65	0.66	0.60	0.58	0.62	0.70	0.74	0.67	0.64	0.64	0.67	
3	0.70	0.72	0.55	0.65	0.68	0.72	0.60	0.70	0.65	0.57	0.61	0.65	0.65	
4	0.71	0.72	0.65	0.66	0.60	0.58	0.62	0.70	0.74	0.67	0.64	0.67	0.66	
5	0.74	0.81	0.56	0.58	0.63	0.65	0.75	0.58	0.71	0.70	0.68	0.68	0.69	0.97253
6	0.65	0.81	0.73	0.50	0.75	0.60	0.65	0.70	0.80	0.80	0.70	0.72	0.74	
7	0.54	0.71	0.67	0.63	0.71	0.64	.0.67	0.63	0.80	0.65	0.67	0.72	0.75	
8	0.83	0.75	0.85	0.83	0.76	0.74	0.68	0.70	0.79	0.68	0.83	0.76	0.76	
9	0.70	0.88	0.80	0.81	0.75	0.80	0.88	0.85	0.82	0.87	0.80	0.84	0.84	
10	0.87	0.91	0.88	0.91	0.85	0.84	0.94	0.93	0.84	0.88	0.90	0.90	0.91	

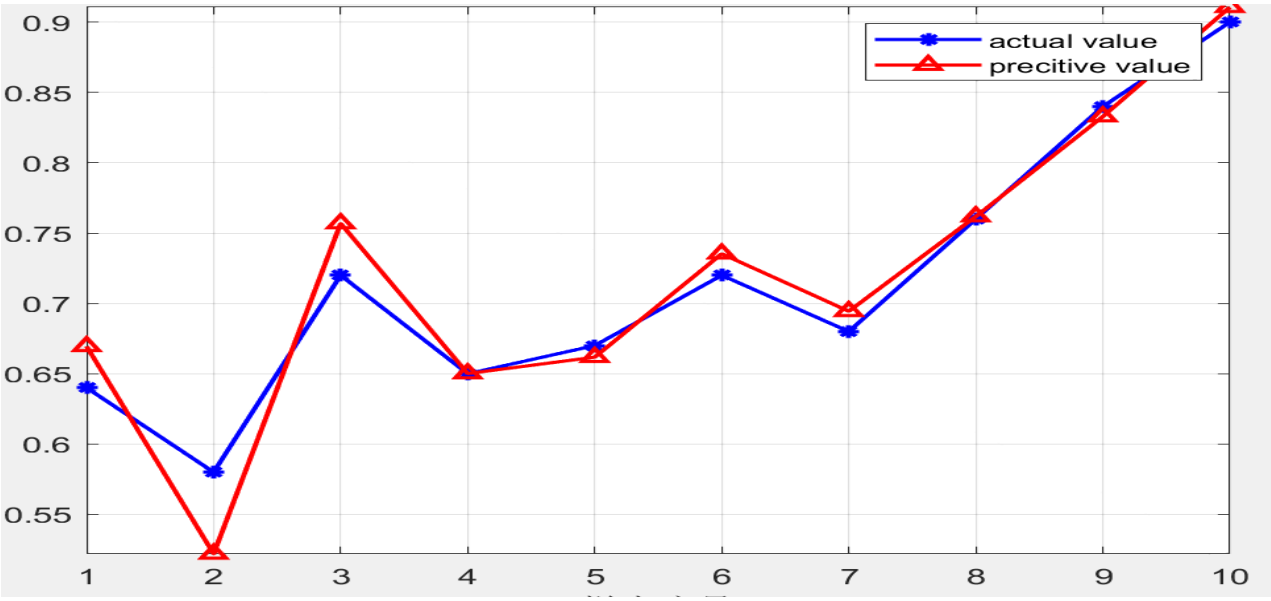

Fig 2: Comparison between predicted value and actual value

Table 2 shows that the correlation coefficient between the predicted value and the real value is 0.9253, which means that the training accuracy and prediction accuracy of the blended teaching quality evaluation model based on BP neural network have met the requirements. In addition, it can be seen from the results of the sample set in figure 2 that the model has a high degree of fitting, indicating that the model is a reasonable, feasible, and high-precision prediction model. The BP network model can basically replace experts' grasp of each weight, and objectively judge the scores of each index system.

This model provides a convenient, accurate, reliable, and teaching evaluation method for blended teaching in colleges and universities. Through the characteristics of BP neural network's high self-organization, self-adaptation and self-learning ability, it effectively weakens the influence of human factors in the determination of index weights. In addition, the construction process of the model can easily realize the dynamic update of the weight value, which can reflect the weight change of each evaluation standard in time.

5. Conclusion

The BP neural network model based on the new teaching evaluation system proposed in this paper can not only evaluate the comprehensive situation of teaching effect, but also judge only a single factor, which improves the effectiveness of the evaluation. Empirical research shows that the use of BP neural network to

establish a mixed teaching quality evaluation model in colleges and universities can effectively solve the dilemma faced by the current teaching quality evaluation.

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