



On-Line and Off-Line Teaching Research Based on BP Neural Network

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Abstract. In recent years, due to the influence of the new Crown Epidemic Situation Prevention and control, online teaching has become the mainstream teaching method during the epidemic situation in China. Under this background, a set of Scientific on-line teaching program is designed for the Middle Vocational Department of Guangdong Innovation and Technology Vocational College. Through the establishment of objective and subjective evaluation index system, using BP neural network as a teaching tool, the overall effect of online and offline teaching mode is compared. The results show that offline teaching is helpful to enhance students' practical ability and comprehensive analysis ability, and online teaching is helpful to improve their autonomous learning ability and classroom efficiency.

Keywords: Online Teaching · Offline Teaching · Evaluation Index System · BP Neural Network

1 Introduction

In late December 2019, there was an outbreak of the new crown disease. [7] The Ministry of Education has decided to postpone the start of the school year to coincide with the epidemic prevention work. At the same time, in order to ensure the normal operation of teaching and learning, the Ministry of Education has directed the deployment of various schools to make use of the network platform [8] to carry out online teaching, which will become the mainstream teaching method in 2020.

During the outbreak, 265 million school children took online courses, the Ministry of Education launched 22 online courses and 24,000 online courses, more than online education applications have an average daily active population of tens of millions. However, compared with the traditional teaching method, the online teaching plan is still in the exploration period, the assessment method is the same, the assessment content is relatively scattered, and the teaching evaluation system lacks objectivity and standardization. Most of the existing research on the mixed online and offline teaching mode is qualitative analysis of the combination of online and offline teaching, which lacks universality. Based on MOOC, Gitee, learning pass, PTA, Tencent classroom, Mu classroom and other platforms, this paper designs a perfect online teaching program and evaluation index system. At the same time, using the BP neural network model, taking the data structure course as an example, taking the real student score and the student score as the

Table 1. Evaluation index weight.

Objective evaluation index	Subjective evaluation index	Weight (%)
Learning initiative (X1)	Autonomous Learning Ability(Y1)	10
Classroom attendance (X2)	Learning attitude (Y2)	10
Experimental report (X3)	practical ability (Y3)	10
Usual test (X4)	Listening efficiency (Y4)	20
Final examination (X5)	Comprehensive analysis ability (Y5)	50
Comprehensive achievements (X6)	Overall teaching effect (Y6)	100

support, exploring the advantages and disadvantages of the two teaching models, and combining the advantages of the two models, summing up the improvement plan of the hybrid teaching model.

2 Evaluation Index System Construction

Evaluation Index system is composed of objective evaluation index and subjective evaluation index, the two index systems have one-to-one mapping relationship. Based on the importance of the evaluation index, the weight of each index is pre-set, as shown in Table 1, where index x_6 (y₆) is a synthesis of the first five indexes, so the weight is 100%.

3 Design of Online Teaching Plan

According to the objective evaluation indicators in Table 1, combined with the actual online teaching resources, taking the data structure course as an example, the following teaching plan is formulated, as shown in Table 2.

4 Comparative Analysis of Online and Offline Teaching Effects at an Objective Level

4.1 Initial Data Selection

After one semester of online teaching of the data structure course, the teacher gives the scores of each indicator and multiplies them with the corresponding weights of the indicators in Table 2. Some scores are shown in Table 3. The sample is 64 students from the Secondary Vocational Department of Guangdong Innovation and Technology Vocational College.

Table 2. Online teaching plan.

Index number	Index composition	Teaching program
X1 (10%)	Preview before class (5%)	MOOC platform automatically records the viewing video duration
	Classroom interaction (5%)	Actively answer the questions raised by the teacher in class and record them manually
X2 (10%)	Classroom attendance (5%)	Tencent classroom platform automatically records online time
	Random inspection (5%)	The teacher randomly checks the roll call
X3 (10%)	Experimental report (10%)	Finish the experiment report and the teacher will grade it
X4 (20%)	In class detection (10%)	The teacher releases the questions in real time and records the results in class
	Chapter test (10%)	Complete the chapter test within a limited time, and record the results on the platform
X5 (50%)	final exam (50%)	Conduct the final examination based on the platform and record the results

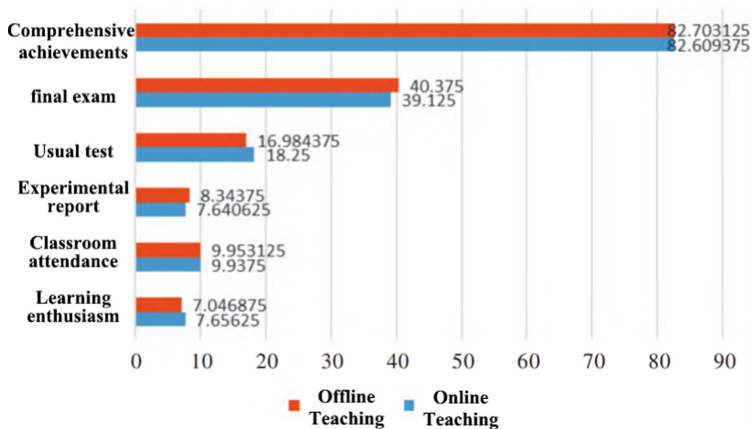
Table 3. Part of the results of online teaching.

Sample number	X1	X2	X3	X4	X5	X6
1	9	10	8	18	48	93
2	9	10	7	19	36	80
3	6	10	8	19	48	91
4	8	10	7	17	41	83
5	6	10	6	18	37	77
6	6	9	9	18	33	75
7	7	10	8	19	41	85
8	10	10	8	19	42	89
...

In order to ensure the comparability of online and offline teaching, the data structure course taught by the same teacher was selected, and the sample was 64 students who adopted offline teaching in the previous session. The corresponding scores are shown in Table 4.

Table 4. Part of the results of offline teaching

Sample number	X1	X2	X3	X4	X5	X6
1	8	10	8	16	38	80
2	6	10	8	19	45	88
3	7	10	9	17	41	84
4	7	10	7	17	48	89
5	5	10	8	15	37	75
6	9	10	8	18	33	78
7	8	10	9	16	33	76
8	7	10	9	19	48	93
...

**Fig. 1.** Average performance of objective indicators.

4.2 Analysis and Comparison of Objective Evaluation Indicators

Calculate the average scores of students in various indicators during online and offline teaching, as shown in Fig. 1. It can be seen that online teaching has an advantage in usual tests and learning enthusiasm, offline teaching is excellent in experimental reports and final exams, and has a slight advantage in classroom attendance and comprehensive scores.

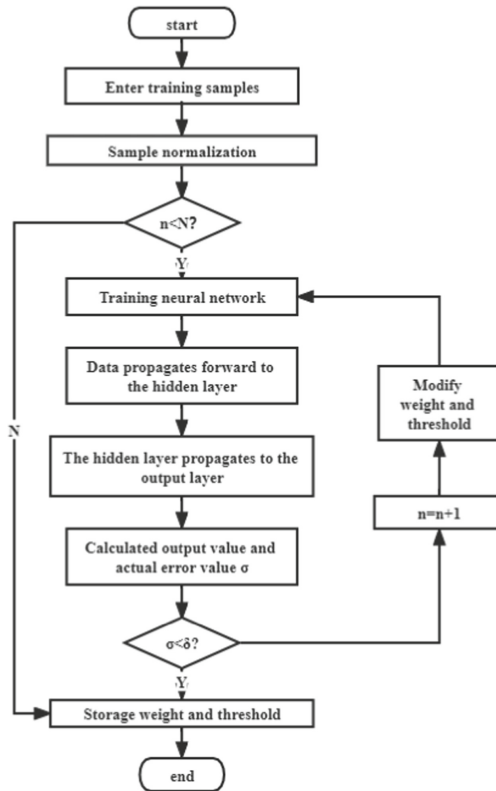


Fig. 2. Flow of BP neural network.

5 Comparative Analysis of Subjective Level Based on BP Neural Network

5.1 Basic Principles of BP Neural Network

BP (Back Propagation) neural network is a multi-layer feedforward neural network trained according to the error back propagation algorithm [1][2], which is widely used in system evaluation in various fields [3][4][5][6]. BP neural network training includes two processes of forward propagation and back propagation [9][10][11]. During forward propagation, the input signal is propagated to the hidden layer [12]. According to the preset weights and thresholds, the signal is propagated to the output layer through layer-by-layer transmission in the hidden layer, generating the predicted output value, and obtaining the output value and the expected value. error between. Then, the error is back-propagated back to the nodes of each level step by step, in order to obtain a smaller error, the weights and thresholds are adjusted, which is the back-propagation of the error. Set the number of iterations, repeat the training within this number of times, select the weight and threshold corresponding to the minimum error generated during the training, and the training is over. The detailed process is shown in Fig. 2.

5.2 Basic Steps of BP Neural Network

A 3-layer BP neural network structure is used.

5.2.1 Data Collection

Collect initial sample data, determine the number of nodes in the input layer and output layer, and the expected value.

5.2.2 Parameter Setting

The number of nodes in the input layer and the output layer is determined by the actual problem, and there is no rigid requirement for the selection of the hidden layer. The number l of the hidden layer nodes is calculated by using the empirical formula (1), which is expressed as:

$$l = \sqrt{m + n} + a \quad (1)$$

In the formula, m is the number of nodes in the input layer, n is the number of nodes in the output layer, and a is an adjustment constant between 1 and 10. The activation function selects the activation function used by the newff function in MATLAB by default, which is a tansig (double S) type. The learning rate, and the number of samples in the training and test sets are determined by trial and error.

5.2.3 BP Algorithm Implementation

MATLAB software is used for simulation experiments, and the steps are as follows:

(1) Use formula (2) to perform forward normalization on the data.

$$x'_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}} \quad (2)$$

(2) Create a forward neural network and train the neural network.

(3) Output the final prediction result.

5.3 Case Analysis

5.3.1 Data Collection

A score sheet was distributed to 64 students, and they were scored based on the subjective indicators in Table 1. The scoring interval was [0, 10]. The larger the value, the better the online teaching effect of the indicator was than the offline teaching. 5 is the benchmark. The final values are shown in Table 5.

Table 5. Part of subjective evaluation index data.

Sample number	Y1	Y2	Y3	Y4	Y5	Y6
1	5	5	4	7	6	5.8
2	6	5	3	6	3	4.1
3	6	4	3	6	5	5
4	4	5	5	5	4	4.4
5	5	5	4	7	5	5.3
6	5	5	6	4	6	5.4
7	7	6	5	8	5	5.9
8	8	5	4	7	4	5.1
...

5.3.2 Parameter Setting

Take Y1 to Y5 as the 5 input layer indicators, and Y6 is obtained by weighting the first five indicators as the expected value of the output layer. The number of nodes in the input layer is 5, and the number of nodes in the output layer is 1. According to formula (1), the number of nodes in the hidden layer is selected as 4. After repeated tests and comparative analysis, it is found that the training effect is the best when the number of iterations is 1000. At the same time, the learning rate is set to 0.01, the number of training set samples is set to 54, and the number of test set samples is set to 10.

5.3.3 BP Algorithm Implementation

MATLAB software is used for simulation experiments, and the predicted and actual values of the comprehensive scores of the test set are obtained as shown in Fig. 3. In the figure, R2 is the coefficient of determination, which reflects the degree of correlation between the indicators. The closer the value is to 1, the higher the correlation and the better the fit; the closer it is to 0, the lower the correlation and the worse the fit. The coefficient of determination of the prediction results of the BP neural network in this paper is as high as 99.795%, indicating that the prediction results have a high degree of fit and have reference value. Of the 10 test samples, 60% had a composite score lower than 5. It can be seen that at the subjective level, students believe that the overall effect of offline teaching is better than online teaching.

5.3.4 Comparative Analysis of Subjective Evaluation Indicators

Starting from a single indicator, analyze the advantages and disadvantages of online and offline teaching in all aspects, and the average score of each indicator is shown in Fig. 4. It can be seen from the figure that the online teaching mode has obvious effects on the improvement of students’ autonomous learning ability and listening efficiency; the offline teaching mode has obvious effects on the improvement of students’ practical

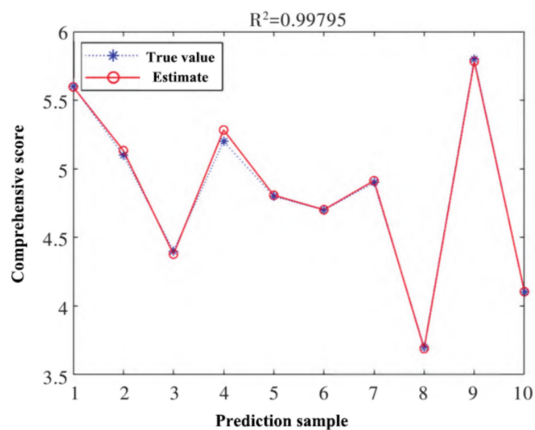


Fig. 3. Comprehensive score.

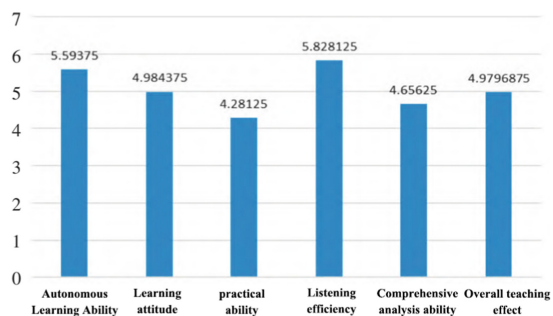


Fig. 4. Average score of subjective evaluation indicators.

ability and comprehensive analysis ability; the two modes have obvious effects on students' learning attitude and overall teaching. The difference in the improvement effect is not obvious, but the offline teaching is slightly better than the online teaching.

6 Conclusion

In the online teaching mode, students perform well in the indicators of autonomous learning ability and listening efficiency. This is because online teaching adds the step of pre-class preview compared to offline teaching, and the use of online high-quality teaching resources enables students to cultivate autonomous learning, Good habits of active learning. In the classroom discussion session, online teaching can interact with students in real time through silent discussion methods such as bullet screens and group chats, mobilizing their enthusiasm and activity. In the in-class testing session, teachers can use the online teaching platform to release questions in real time for testing, so as to deepen students' memory of this part of the knowledge points and improve the efficiency of listening to the class.

In the offline teaching mode, students performed well in the indicators of the experimental report (practical ability) and the final exam (comprehensive analysis ability). This is because the offline teaching experimental class has on-site guidance from teachers, which can quickly and accurately solve the problems in the experiment. In addition, students can sit in the center of the classroom and study without distraction, forming a virtuous cycle of learning.

In comparison, the performance of students in the two modes in terms of classroom attendance (learning attitude) and comprehensive performance (overall teaching effect) indicators is not much different, but the classroom attendance indicators of online teaching may be affected by occasional network problems. The influence of force majeure factors such as power outages and platform system bugs. Offline teaching can pay attention to the learning status of each student, has a good collective learning atmosphere, and is slightly better than online teaching in terms of overall teaching effect. However, due to the supervisory role played by the teacher, the difference between the two is not obvious. According to the above conclusions, combined with the mapping relationship in Table 1, it is believed that online and offline teaching have different influences on students' subjective and objective indicators.

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