Research Article

Neural Network-Based Approach for Evaluating College English Teaching Methodology

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Abstract

A fair and scientific method of evaluating collegiate English instruction is currently lacking. Traditional methods are commonly used to evaluate the quality of college English education in terms of the standard statistical analysis evaluation model. As the evaluation of English teaching is a nonlinear issue, the above strategies have achieved some good results but have certain limitations. They are not scientific and objective in the selection of evaluation indicators, or in the setting of evaluation index weights, and there is a certain degree of subjectivity. Artificial neural network (ANN) is widely used in massive fields due to its characteristics of nonlinear processing, adaptive learning, and high fault tolerance. As a kind of neural network, BP neural network has strong nonlinear mapping ability, so it is feasible and scientific to solve the nonlinear relationship of college English teaching evaluation (ETE). Therefore, in this work, we first designed an ETE system index. Then, a strategy of college ETE with BP network is designed, which can carry out high-performance modeling for the designed teaching evaluation index. In order to alleviate the issue of slow convergence speed for BP network and fall into local optimum, this work also combines particle swarm algorithm with BP network to further improve network performance. Massive experiments have proved the reliability and effectiveness of this work.

1. Introduction

All coursework revolves around the concept of teaching. The quality of a school’s teaching has a significant impact on the overall quality management of the institution. The quality of a school’s teachers can be used to determine the success of the institution. In order to better understand how well instructors are completing their goals, as well as how well the school as a whole is teaching, it is essential for school administrators and managers to evaluate teachers’ teaching quality. In addition, assessing the quality of instruction will be a significant effort in the future. Education institutions must assess and evaluate the quality of their teaching in order to ensure the continued high level of talent development in their programs. Therefore, evaluating the quality of teachers is an essential step in implementing reforms to improve student accomplishment while simultaneously raising the bar for instructors themselves. Given that teaching is both a spiritual and aesthetic activity, there is no one method that works for everyone in the field of education. Nonquantitative factors of teaching quality that are difficult to evaluate are sometimes included in teaching quality evaluation systems. This contributes to the difficulty and complexity of measuring the quality of education. Because the teaching and learning processes are linked, evaluating the quality of teachers is significantly more complex than evaluating the quality of products. Numerous factors influence the teaching process, which is a two-way street that involves both the teacher and his or her students. It is necessary to evaluate an increasing body of work to see how various factors influence the quality of training. One of the most pressing concerns facing education today is the development of an objective and equitable system for assessing the quality of instruction [1–5].

China’s higher education institutions are currently beset by inconsistencies and difficulties, and the quality of English
instruction falls short of satisfying the country’s expanding economic and social needs, as evidenced by the following statistics: Education in English should be developed in accordance with scientific principles, with a particular emphasis on improving the quality of instruction. Higher education institutions must reaffirm their commitment to fostering talent and ensuring that English language instruction is of the highest quality because English language instruction is the lifeblood of these organizations. Maintaining, harmonious, and healthy growth in college and university growth should be centered on increasing the quality of English instruction as a constant topic of discussion. The development of high-quality talents, as well as the continued reform of higher education and teaching, and the strengthening of the quality assurance system for higher education are all dependent on the provision of student-centered, social demand-focused English training. In addition to having significant practical implications, the concept of this method, which attempts to increase the quality of English instruction in higher education, is also appealing. As a result, it is critical that an evaluation system for the quality of college English instruction be devised as part of the evaluation process. The level of English instruction in colleges and universities in my country will have a direct impact on the quality of higher education in my country. The quality of English courses given by various departments and majors in colleges and universities, as well as the quality of their professors, can be used to determine the level of English instruction in those institutions. An educational plan that has been in place for over a century has found that the quality and level of the teaching team have an impact on how the school is directed, the quality of education and teaching, and the effectiveness of education reform [6–10].

The main contribution of the paper is the improvement of the school’s English education standard and the enhancement of teacher quality which are without a doubt two of the most important priorities in the new environment. Assessing how effectively English teachers are performing in their work with pupils of the language is one of the most effective strategies to increase educational standards. Developing an evaluation system for teaching quality that is founded on science and reason, while also taking into consideration the specific needs of academic institutions, is something that all colleges and universities are interested in doing. A new period of communist modernization has begun in China and with it comes a new set of challenges for the country’s English education system. There are a variety of approaches that can be used to improve the quality of English education, but improving the quality of instruction is the most crucial. College English classes can benefit from the use of a scientific evaluation system, which can help to improve the management of college and university education while also boosting academic standards [11–15].

This work proposes a method for ETE with a neural network. First of all, this article designs a set of ETE indicators. Secondly, a BP network is established to model the evaluation indicators. Then, the particle swarm algorithm is combined with the BP network to solve the problems of the BP network. Finally, massive experiments have proved the validity and correctness of the English evaluation method proposed in this work.

2. Related Work
As can be seen from the development of foreign teaching evaluation, the United States has the most scientists in the world and the most Nobel Prize winners in the world. It can be seen that the educational system of the United States played a significant role; the perfect teaching evaluation system of colleges is the most powerful guarantee to give full play to higher education in colleges. Assessment teaching in the United States is characterized by diversification and systematization [16]. There are three main forms of educational evaluation in Russia. The first is to carry out teaching quality assessment in the whole country, which is called national assessment. The second is to conduct a separate self-assessment within the school. The third is socialist competition. The internal self-supervision system of colleges and universities is divided into school evaluation [17]. Teaching quality assessment in the UK includes not only school assessment but also professional assessment and disciplinary assessment, as well as their combination of assessment methods [18]. There are two most representative evaluations of teacher teaching quality in foreign countries: Babanski, the former Soviet-union educator, who established an evaluation index system named after him, mainly to form a variety of skills. Its content includes the skills to understand the subject knowledge, the ability to form the interest of the subject, and the understanding of the principles of educational psychology for students [19]. Literature divides teaching quality into media indicators and ultimate goals [20].

At present, colleges and universities in our country may adopt different evaluation methods for teachers’ teaching evaluation. Some colleges adopt the student evaluation method with students as the main evaluation body. Some colleges and universities adopt the way that experts give the evaluation index and evaluation standard. Some colleges and universities use peer evaluation and teachers’ self-evaluation to evaluate teachers’ teaching. No matter which evaluation method is adopted, the final evaluation result will be an important basis for teaching improvement. Quantitative evaluation is the main way to solve the evaluation problem at present. For example, the literature proposed fuzzy comprehensive evaluation as well as analytic hierarchy process to solve the impact of quantitative evaluation on evaluation results. To better achieve evaluation, we should try to get rid of such misunderstandings in the evaluation process. Current domestic universities mainly take advantage of massive data as support questionnaire form and use for network information as a support network evaluation form [21], two evaluation forms are after the baptism of time, in the time, and society will always be eliminated under the continuous development of utilization of the lower one, to take a more feasible way to evaluate teachers’ teaching. The two evaluation methods have their own strengths and weaknesses in the evaluation process. In investigation and research, we
found the following differences between them [22]. The questionnaire method, the concrete operation process, is very simple, but the need to complete the work in the process of operation, such as the need to invest more manpower and time to complete the questionnaire for data integration, is one of the most obvious problems in the process of integration of data due to the large amount, extremely easy to cause the error. Network evaluation can meet the current needs of universities and colleges. With the advantages of high-speed, fast, and convenient Internet, relevant evaluation information can be collected in the fastest time, data can be processed faster, and more comprehensive evaluation results can be obtained. ANNs have gone through four stages of development. The first stage was marked by the study of the structure and function of the human brain by literature [23]. The second stage is mainly marked by literature [24]. The third stage is marked by the revival of the book Parallel Distributed Processing written and published by literature [25].

3. Method

This section discusses all the ways and steps that were used to expand the recent study. Firstly, we explain the neural network which is the basic tool of paper. Secondly, we explain the teaching evaluation design based on neural networks. Thirdly, this section explains the BP neural network with a practical swarm.

3.1. Neural Network. The development of ANN has not yet been defined. According to American neural network scientists, a neural network is a computer system composed of multiple simple processing units that are connected to each other in some way [26].

ANN mainly has the following five characteristics:

1. **Memory Function.** It can make use of the existing information and learning rules in the network to restore the integrity of incomplete information through adaptive training.

2. **Nonlinear Mapping.** The problem can be approximated with arbitrary precision and the function relation can be established.

3. **Classification and Recognition.** The neural network can process the input samples by classification and recognition.

4. **Optimization Calculation.**

5. **Strong Knowledge Processing Ability.**

3.2. Teaching Evaluation Design Based on Neural Network. The following are the mathematical formulas used in the BP neural network training process:

\[
    x_i = \frac{x_{\text{max}} - x_i}{x_{\text{max}} - x_{\text{min}}},
\]

where \(x_i\) is the input component of \(i\)-th neuron component before pretreatment. \(x_{\text{min}}\) and \(x_{\text{max}}\) are minimum and maximum values.

\[
    h_i(k) = \sum w_{i} x_i(k) - b_h,
\]

where \(k\) is the number of \(k\)-th sample, \(h\) is the number of hidden layers, \(w_{i} \) refers to the connection weight of the nerve cell of \(i\)-th input layer as well as \(h\)-th hidden layer, and \(b_h\) refers to the threshold.

\[
    f(x) = \frac{1}{1 + e^{-x}} ,
\]

where \(x\) refers to the hidden layer input value and \(f(x)\) is the output function.

\[
    y_{io} = \prod_{h=1}^{P} w_{ih} h_{o} (k) - b_{o},
\]

\[
    y_{o} (k) = f \left( y_{o} (k) \right),
\]

where \(w_{ih}\) is the connection weight between the \(h\)-th neuron in the innermost hidden layer and the \(o\)-th output neuron cell, \(y_{io}(k)\) is the output function of the \(k\)-th data sample, \(b_{o}\) is the threshold value of the \(o\)-th neuron cell on the output layer, and \(h_{o}\) is the value of the \(h\)-th neuron.

\[
    E^i_j = 0.5 \left( \sum_{p} \left[ y_{i}^p - y_{ip}^p \right]^2 \right),
\]

\[
    \delta_j^{(2)} (k) = \left( T_j^p - y_{ip}^p \right) \right) \right) \times \left( 1 - y_{ip}^p \right),
\]

\[
    \delta_j^{(1)} (k) = \sum_{i=1}^{m} \left[ w_{ij}^{(2)} \times \delta_j^{(2)} (k) \right] \times y_{il} \times \left( 1 - y_{il} \right),
\]

\[
    E = \frac{\sum_{i=1}^{k} E^i_j}{k},
\]

\[
    w_{ji}^{(2)} = w_{ji}^{(2)} + \eta \times \sum_{i=1}^{k} \left[ \delta_j^{(2)} (i) \times y_{il} \right],
\]

\[
    w_{ji}^{(1)} = w_{ji}^{(1)} + \eta \times \sum_{i=1}^{k} \left[ \delta_j^{(1)} (i) \times x_i \right],
\]

3.3. BP Neural Network with Particle Swarm. Scientists led by Liu and Zhang [27] suggested the BP network, or back-propagation network, in 1986. Error backpropagation is used to train a multilevel feed-forward network. An input-output mode mapping can be learned and stored without the mathematical equations explaining the mappings being revealed in advance. In order to minimize the sum of squares of error, it employs the quickest descent approach, which uses backpropagation to update weights and thresholds. The input, hidden, and output layers of the BP network model are all included.

The main idea of the BP network is as follows: assume that the input sample is \(P_1, P_2, \ldots, P_n\), target sample is \(T_1, T_2, \ldots, T_m\), and the network output is \(A_1, A_2, \ldots, A_n\). When there is an error between output and target output, the error is propagated back to adjust the weight, and the output and the target sample are close so that the error reaches the minimum value, and the weight adjustment is finished. The structure of the BP network is illustrated in Figure 1.
The core of particle swarm optimization is to find and traverse the optimal particles in the solution space. Here, the dimension of solution space is set as \( D \), where the number of distributed particle swarm is \( S \). The particle I in the particle swarm is expressed as follows:

\[
X_i = (x_{i1}, x_{i2}, \ldots, x_{id}); \quad (i = 1, 2, \ldots, S; d = 1, 2, \ldots, D).
\]  

All particles iterate to change their speed and position. The iteration rule is expressed by the following two formulas:

\[
\begin{align*}
\dot{x}_{id}^{k+1} &= \omega \dot{x}_{id}^k + c_1 r_1 (p_{id}^k - x_{id}^k) + c_2 r_2 (g_{id}^k - x_{id}^k), \\
x_{id}^{k+1} &= x_{id}^k + \dot{x}_{id}^{k+1},
\end{align*}
\]  

where the number of iterations of particle swarm is represented by \( K \), and the acceleration factors of particle swarm motion are represented by \( c_1 \) and \( c_2 \), respectively. In order to reflect the randomness of particle movement, \( r_1 \) and \( r_2 \) are used to modify its running speed, and the inertia of particle swarm motion is represented by the parameter \( \omega \). The update of the particle’s speed and position depends on the following:

1. The speed and position at the previous time
2. The tendency to get closer to the optimal position to avoid local minima
3. The speed and position are adjusted at any time due to information exchange among particle swarm members. In this way, PSO can quickly locate the optimal solution of the solution space. These characteristics help to optimize the performance of neural networks.

4. Experiments and Discussion

In this portion, methods are practically applied to give verified results. Firstly, we gather data and evaluate all the indicators. We take a sample from data for teaching evaluation. We give a questionnaire to people and collect feedback. Further, we evaluate the network training and data normalization. Also, we analyze for PSO and, at the end, compare with other methods to elaborate its advantages and benefits.

4.1. Evaluation Indicators and Datasets. Several factors influence the quality of English classroom instruction, including students’ past English learning, classroom setting, subject matter difficulty, teacher competency, and attitude toward instruction, as well as the preferences of those who evaluate students’ performance in English. The following evaluation criteria are based on the features of college English instruction and the demands of students as illustrated in Table 1.

In this work, we use two self-made ETE datasets, named EEA and EEB, respectively. Each dataset contains a different number of samples, and the specific distribution is shown in Table 2. The evaluation metrics applied in this work are precision and recall.

4.2. Evaluation Procedures. Collecting Data and Obtaining Sample Data. The collection of sample data is a key step in teaching evaluation. First of all, sufficient samples should be selected in combination with a detailed questionnaire survey and expert interview, including evaluation data and the evaluation value of each indicator. Only sufficient samples can ensure the accuracy of neural network training and evaluation. The collected sample data is utilized as the data source for the neural network.
Data Preprocessing. The collected data must be preprocessed. If these data are directly input into the neural network, the weighted data will be amplified after the accumulator, and the neural network convergence is difficult. Combined with the data features selected in this study, and considering that Sigmoid (nonlinear function of neurons) is introduced into the neural network hierarchy to achieve activation, therefore, in order to prevent the function from acting on the flat region within its value range, normalized preprocessing is adopted to map collected data to a fixed interval.

Training in the Network to Make Sure of Knowing the Number of Layers in the BP Neural Network. The three-layer BP network can finish the mapping since the research reveals that the neural network with a hidden layer can approach any continuous function arbitrarily. Finally, the neural network with a three-layer structure used in this paper presents the foundation for scrutinizing training. The network layer’s node count can be found here. There are five nodes in the hidden layer when using the Kolmogorov algorithm. Using the particle swarm optimization approach, we can improve the standard neural network method and train the BP network so that we can get the best weight and threshold value for the neural network. We determine the adaptive learning rate. The optimized neural network was preliminarily trained at several different speeds, and the error sum of square values after training at different speeds were statistically compared. If this value can be rapidly reduced, it proves that the selected learning rate is ideal. If this value decreases slowly or there is an intolerable oscillation, the learning rate is not appropriate. If the learning rate is high, this system will lose stability; if the learning rate is small, the convergence rate will be too slow. Through repeated experiments and comprehensive comparison, combined with the conclusion that the learning rate is in the range of [0.01,0.7], the learning rate is located at 0.6.

4.3. Evaluation for Network Training. In neural networks, it is very important to evaluate the convergence of network training. Only when the model can achieve performance convergence on the training set can it be used in further testing applications of the network. To evaluate the convergence of the designed network, we analyze the loss during the network training process. The change trend for training loss is illustrated in Figure 2.

It can be seen that, whether it is on the EEA data set or the EEB data set, the training loss of the neural network designed for ETE in this paper is gradually decreasing. When the training epoch is 60, the training loss basically does not decrease, indicating that the network at this time has reached the convergence state and achieved the expected effect. This can also show that the network designed in this paper is reasonable and feasible and laid the foundation for further follow-up experiments.

4.4. Evaluation for Data Normalization. In this work, the data normalization strategy is used to process the input features. To verify the effectiveness and feasibility of this strategy, a comparative experiment was carried out in this work to compare the performance when data normalization is not used and the performance when data normalization is used. The experimental results are illustrated in Figure 3.

It can be seen that the best performance can be obtained when using data normalization. Compared with the performance of English teaching quality evaluation when data normalization is not embedded, the use of data normalization can achieve performance improvements of 1.2% precision and 2.4% recall on the EEA dataset. At the same time, it can obtain the performance improvement of 1.4% precision and 2.1% recall on the EEB dataset. This verifies the validity and reliability of the data normalization strategy.

4.5. Evaluation for PSO. In this work, the PSO strategy is used to optimize the BP network. To verify the effectiveness and feasibility of this strategy, a comparative experiment is carried out in this work to compare the performance when the PSO strategy is not used and the performance when the
PSO strategy is used. The experimental results are illustrated in Figure 4.

The best performance can be obtained when using the PSO strategy. Compared with the performance of English teaching quality evaluation when PSO strategy is not embedded, the use of PSO strategy can achieve the performance improvements of 1.7% precision and 2.7% recall on the EEA dataset. At the same time, it can obtain the performance improvement of 2.1% precision and 2.6% recall on the EEB dataset. This verifies the validity and reliability of the PSO strategy.

4.6. Evaluation for the Hidden Layer. The number of hidden layer nodes can be varied in the neural network described in this article. Comparative studies are carried out to investigate the impact of different node counts on network assessment performance and to determine the ideal number of hidden layer nodes for a given network. As you can see in Table 3, we get some interesting results.

As can be seen, the network performance will vary based on the number of nodes in the hidden layer that are present. Having the greatest number of nodes, 5, as opposed to any other number, results in the best performance. In the beginning, as the number of nodes increases, the network performance gradually improves until it reaches its maximum. However, as the number of nodes increases, the overall performance of the network will deteriorate over time.

4.7. Comparison with Other Methods. To verify the effectiveness of the designed method designed, this work compares our method and other methods. The methods compared include decision tree (DT), logistics regression (LR), SVM, KNN, and SVM. The experimental results are illustrated in Table 4.

It can be seen that, compared with other methods, our method can obtain the best performance in evaluating English teaching. Compared with the best method SVM
listed in Table 4, the method designed in this work can obtain the performance improvement of 1.1% precision and 1.5% recall on the EEA dataset. At the same time, this method can obtain the performance improvement of 1.6% precision and 1.4% recall on the EEB dataset. These data further prove the effectiveness of our method.

| Table 4: Comparison with other methods. |
|------------------|------------------|------------------|------------------|------------------|
| Method | EEA | EEB | EEA | EEB |
| | Precision | Recall | Precision | Recall |
| DT | 85.7 | 82.1 | 92.5 | 90.8 |
| LR | 88.4 | 83.2 | 94.0 | 92.3 |
| KNN | 92.5 | 90.1 | 94.8 | 93.1 |
| SVM | 94.3 | 92.2 | 95.1 | 93.5 |
| Ours | 95.4 | 93.7 | 96.7 | 94.9 |

| Figure 4: Evaluation for PSO. |

5. Conclusions

Using ANNs, recent improvements have made it feasible to improve the ability of the network to recognize patterns, in addition to performing autonomous prediction tasks. Under the belief that a nonlinear process model is being employed, any nonlinear link can be approximated with any degree of accuracy without the need to master data. College ETE is essential for improving the overall quality of English instruction, the overall quality of teachers, and the learning outcomes for students in higher education. The productivity of collegiate English instruction is assessed through the use of high-dimensional, nonlinear relations. Teachers are evaluated in a variety of ways, and this study proposes a neural network-based model for evaluating teaching performance in the classroom. First, this work has designed a set of indicators for the evaluation of English teaching, including a total of 14 detailed indicators. Second, this work is based on the BP network to achieve high-performance modeling of evaluation indicators. This model can effectively deal with high-dimensional nonlinear characteristics. Third, this work combines particle swarm algorithm and BP network to further improve the performance of the ETE network. It can effectively alleviate the problems of slow training speed and easy falling into local optimum. Fourth, a comprehensive and systematic experiment has been carried out for this work, and the results prove that the designed method is feasible and effective and can be used for high-quality evaluation of English teaching.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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