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Comprehensive Evaluation Model of Professional Normal University Talents Based on FAHP-BP

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Abstract: In order to solve the problem of combination of qualitative and quantitative evaluation in the process of constructing the talent evaluation index system of vocational normal universities, based on the analysis of the principle of constructing the talent evaluation index system of vocational normal universities, this article puts forward a comprehensive evaluation model of vocational normal universities talent based on Fuzzy Analytic Hierarchy Process (FAHP) - BP neural network, and constructs a relatively complete comprehensive evaluation index system of vocational normal universities talents. The model can be used to evaluate teachers in all directions and at multiple levels, and provide an important basis for school human resources management. Experimental results show that the evaluation model has the highest 89.4% praise rate.

1. Introduction

With the deepening of education reform, the comprehensive quality of teachers is paid increasingly attention. In order to attract and retain excellent talents, schools must establish a scientific, reasonable, and effective comprehensive evaluation system for teachers. In order to improve the school-running level, vocational normal colleges must have a contingent of teachers with high quality, strong professional, and responsibility. But at present, the talent evaluation system of vocational normal colleges in China is still in the primary stage, and there are still some problems. This article adopts FAHP- BP neural network to evaluate teachers, which solves the problems of insufficient combination of qualitative and quantitative evaluation and lack of scientific and reasonable talent evaluation index system.

In recent years, many domestic and foreign experts and scholars have studied the application of FAHP and BP neural networks. For example, Chen Xiaofeng revealed the qualitative and quantitative differences between AHP (Analytic Hierarchy Process) and FAHP and determined the conditions and strategies for using FAHP instead of AHP [1]. NGUYEN Phi-Hung determined hotel service quality using Fuzzy Analytic Hierarchy Process (FAHP) and SERVQUAL methods. He showed that hotels should focus on sequential and organized priority factors to improve service quality, and this service quality evaluation method also helps to differentiate hotels [2]. Wright

Logan G introduced a hybrid in situ simulation algorithm called physics-aware training, which applies backpropagation to train controllable physical systems. Physically aware training combines the scalability of backpropagation with the automatic mitigation of defects and noise achievable by in-situ algorithms. Physical neural networks have the potential to perform machine learning faster and more energy efficiently than conventional electronic processors [3]. The above literature on the FAHP and BP neural network applications are very thorough.

This article adopts the method of combining FAHP and BP neural network to evaluate the teachers in vocational normal colleges. The concrete process is as follows: Firstly, the index system is decomposed into several interrelated factors according to the principles of science, rationality and feasibility, and then the hierarchical structure model is established; secondly, the fuzzy consistent matrix A is adopted and transformed into quantitative expression; finally, the fuzzy analysis BP neural network comprehensive evaluation model is established by using BP neural network and verified by actual data. In this article, FAHP method is used to determine the weight of each evaluation index, and then BP neural network is used to make the nonlinear mapping.

2. Construction Principle of Talent Evaluation Index System in Vocational Normal Universities

In the process of constructing the talent evaluation index system of vocational normal colleges, it should follow the scientific and guiding principles. Scientificalness means that the index system should reflect the aim and requirements of talent evaluation accurately, according with the actual situation, and have high reference value. The guiding principle means that the index system should guide the development of talent and reflect the aim and requirements of talent evaluation. Systematic principle means that the index system should reflect all kinds of elements and different aspects of talent evaluation, not only the advantages and disadvantages of talents in quantity, quality, and structure, but also the interrelation and function of various aspects. The principle of comprehensiveness means that the index system should fully reflect the requirements of talent evaluation in colleges and universities and all factors affecting talent evaluation. Operability means that the index system should be easy to operate and use.

2.1. Scientific Principle

Since the objective of talent evaluation in vocational normal colleges is to evaluate the talents comprehensively, the index system should reflect the objective and requirement of talent evaluation in colleges. For example, in the evaluation of professional teachers, emphasis shall be placed on the achievements of such teachers in subject construction and academic research; in the evaluation of management personnel, emphasis shall be placed on their organization and coordination ability, innovation ability and team spirit; in the evaluation of scientific research personnel, emphasis shall be placed on the quality and quantity of their scientific research achievements; in the evaluation of academic leaders, emphasis shall be placed on their contributions to subject construction and talent team construction [4].

2.2. Directive Principle

The construction of talent evaluation index system in vocational normal colleges should fully consider the needs of school orientation, subject and specialty construction, faculty construction, and talent training. At the same time, each second-level college and department should combine its own development needs, focus on the school's development goals, and the requirements of various disciplines and majors, start from the school's development strategy, and build its own talent

evaluation index system according to the school's talent evaluation system. For example, for teachers, in addition to completing teaching and research, they also need to complete curriculum design, textbook compilation, teaching, research, and other work; for students, in addition to completing their studies, they also need to master certain social practice skills and guide students to start their own businesses; and for administrators, in addition to completing their daily administrative work, they also need to undertake school research tasks. Therefore, when constructing the index system, it should fully consider the needs and differences of all aspects from the school development strategy to build a practical talent evaluation index system [5].

3. Fuzzy Analytic Hierarchy Process

Fuzzy Analytic Hierarchy Process (FAHP) is a qualitative and quantitative decision-making method proposed by American scholars in the 1980s [6]. The fuzzy consistent matrix and fuzzy complementary matrix are obtained by decomposing the fuzzy relational matrix reasonably, and the relative importance of each factor to the target is calculated according to the relative importance of each element [7]. The basic steps are as follows: (1) to compare the factors in the target system and establish the corresponding judgment matrix; (2) to calculate the weights of each factor through the expert scoring method; (3) to compare the weights of each factor with the corresponding target weights and obtain the weights of each factor relative to the target; (4) to normalize the weights and convert them into the matrix form, and then calculate the comprehensive evaluation vector; (5) to judge all evaluation objects by using the fuzzy comprehensive evaluation method.

3.1. Establish Hierarchical Hierarchy

Hierarchical structure is the basis of fuzzy comprehensive evaluation. In designing the talent evaluation index system of vocational normal universities, it should comprehensively consider the objectives, requirements, professional development ability, and professional development ability of teachers. On this basis, the factors are divided into two groups according to certain criteria, namely, target layer A and criterion layer B. Level A consists of four factors: teaching level, scientific research ability, management ability, and innovation ability.

Using 1-9 scale method to quantify the scoring results of experts, the weight of each index is obtained. The weight of each index may be determined by the method of scoring by experts. The first level is the target level, the second level is the criterion level, and the third level is the indicator level. In establishing the objective system, the order of the relative importance of the factors in the objective system, that is, the order of the relative importance of the factors at the first level to the factors at the second level, shall be determined firstly, and then the order of the importance of the evaluation indicators relative to the factors in the objective system shall be determined [8].

3.2. Fuzzy Comprehensive Evaluation

Fuzzy comprehensive evaluation method is to use the method of fuzzy mathematics to make a comprehensive and objective judgment on the evaluated object by combining qualitative and quantitative evaluation. This method integrates subjective and objective factors, makes up for the shortcomings of the traditional single method, and realizes the combination of quantitative and qualitative methods. From the point of view of fuzzy mathematics, it can establish quantitative and qualitative relations under uncertain conditions and can evaluate various things comprehensively. When the fuzzy comprehensive evaluation method evaluates talent, it mainly includes three methods: analytic hierarchy process, entropy method, and fuzzy comprehensive evaluation. Among them, AHP is mainly used to determine the relationship between the various factors, while entropy

method and fuzzy comprehensive evaluation are based on the actual situation of the evaluated objects, the experts give a weight coefficient, and finally use fuzzy comprehensive evaluation method to conduct the comprehensive evaluation of talent [9].

4. BP Neural Network

BP neural network is a feedforward neural network based on error back-propagation algorithm, which has multilayer structure. Its structure is shown in Figure 1.

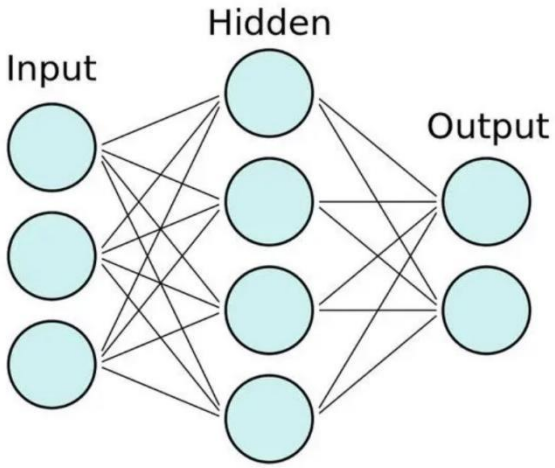

Figure 1: BP neural network structure diagram

BP neural network is composed of an input layer, hidden layer, and output layer. The number of neuron connections in each layer is the product of errors between input and output. There are two neurons in the hidden layer and one neuron in the output layer, which connects to the output layer and the input layer, respectively. In network training, there is a nonlinear mapping between input and output. The network can accomplish two tasks: one is to map the input data to the output layer; the other is to map the output data to the input layer [10]. The BP neural network is generally calculated as Formula (1).

$$a_i = \sum Q_{ij} a_j \tag{1}$$

In formula (1), Q_{ij} is the weight coefficient. BP neural network training algorithm is divided into three steps: learning algorithm, training, and testing. Learning algorithm is based on the characteristics of neural network, select the appropriate learning algorithm to construct the neural network model. The aim of BP neural network training algorithm is to construct an ideal neural network model with the least parameters, so that it can approach the actual problem with the expected precision [11].

The collected data are normalized. Normalization refers to the normalization of data in a certain way to make it suitable for other formulas or functions. The common methods of normalization are normal distribution, exponential distribution, lognormal distribution, Fisher information matrix, and sigmoid function. In this article, the exponential distribution is used as the normalization method, and the data are normalized in [- 1,1] range. The mean square error (MSE) for calculating the sample data is shown in formula (2).

$$MSE\left(\hat{\delta}\right) = e\left(\hat{\delta} - \delta\right)^2 \tag{2}$$

In formula (2), δ indicates the true value of the parameter. In the calculation of MSE, we should pay attention to the normalization of the sample data before calculation. The normalized data were trained according to the set method. This article sets the mean square error of the sample data as 0.0001 (1-x), that is, the average value of each sample during the training process, so for the training sample (x = 1), the average value of the training sample (x = 2) is 2, and so on. BP neural network structure is generally divided into input layer, hidden layer, and output layer.The input layer has an input value and an output value; the hidden layer is composed of a plurality of hidden layer neurons; the output layer has two output values of x and y; there is a number c of hidden layer connections between the hidden layer and the output layer (here c = 1); there is a transfer function sigmoid function connecting the weight matrix wc and the output weight matrix wb between the hidden layer and the output layer.

Firstly, the number of input and output nodes and the number of implicit layer nodes are determined, and then the input and output nodes are normalized. The BP neural network is composed of an input layer, a hidden layer, and an output layer, and the input and output nodes are connected by a transfer function sigmoid function, of which the sigmoid function is the most basic one, as shown in formula (3).

$$sigmoid = x_0 x_i + y_1 y_2 \tag{3}$$

In formula (3), x_0 is the output value of the neuron; x_i is the input value of the neuron. Train the model and test it. Input the selected data into the trained network for testing, and the result is consistent with the actual situation. It can be seen that the trained BP neural network can be used to evaluate the talents of vocational normal colleges, and achieve the goal of combining qualitative and quantitative indexes [12].The comprehensive evaluation model of talent in vocational normal universities has certain practicability and generality.

5. Model Building

1) Analytical Hierarchy Process (AHP). Analytic Hierarchy Process (AHP) is a comprehensive evaluation method combining qualitative and quantitative analysis. The method comprehensively considers the relative importance of each index in the index system and realizes the combination of qualitative evaluation and quantitative evaluation. The main steps are as follows: Firstly, the weight of each level in the talent evaluation index system is determined by AHP method, then the weight of each level is quantified by fuzzy theory, finally, the final evaluation result is obtained by fuzzy comprehensive evaluation. Therefore, based on the analytic hierarchy process, this article adopts fuzzy comprehensive evaluation to construct the comprehensive evaluation index system of professional normal universities [13].

2) BP neural network. BP neural network is a nonlinear function approximation method, which can deal with complex systems with nonlinear relations. Its basic principle is to build a mathematical model consisting of a large number of input variables (output variables) and train them to approach the nonlinear function of input variables. The basic operation process is as follows: first, the input and output variables of BP neural network model are determined; secondly, the input and output variables are sent to BP neural network after certain processing; finally, the trained BP neural network is used for training and testing [14].

3) Simulation experiments. First, the collected teacher-related data is input into the BP neural network for training; then, the trained BP neural network is used to make a comprehensive evaluation of the teacher; finally, the obtained results are compared with the actual results [15].

4) Model application. Taking a teacher's comprehensive evaluation in a vocational normal university as an example, this article uses the model to evaluate the teacher's comprehensive

evaluation and obtains good results.

6. Research Experiment of Talent Evaluation Model Based on FAHP-BP

This article carries out a research experiment of university talent evaluation model based on FAHP-BP, which selects tutor evaluation (Figure 2) and student evaluation (Figure 3) as evaluation indicators.

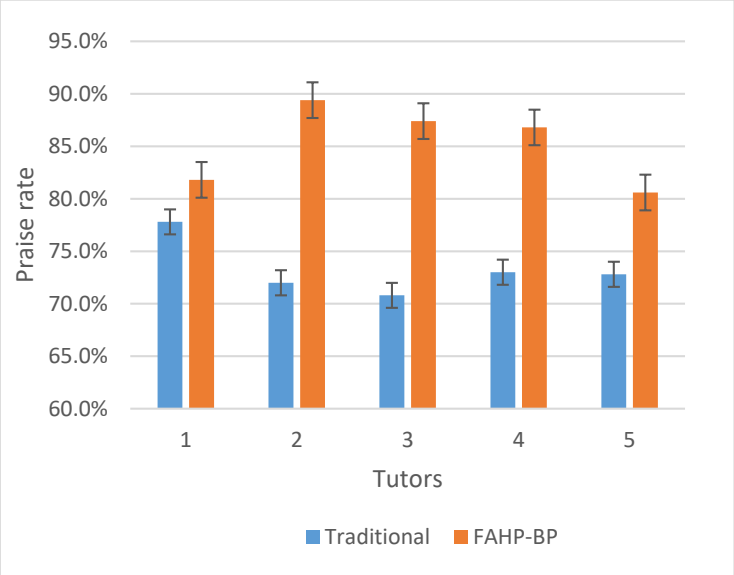

Figure 2: Mentor evaluation

As can be seen from Figure 2, in the evaluation model based on the traditional method, the evaluation of the mentor has a maximum of 77.8% and a minimum of 70.8%, with a calculated average of 73.28%; in the evaluation model based on FAHP-BP, the evaluation of the mentor has a maximum of 89.4% and a minimum of 80.6%, with a calculated average of 85.20%. Therefore, it can be concluded that the FAHP-BP model can improve the evaluation rate of tutors, which means that the teaching level of tutors is gradually increasing.

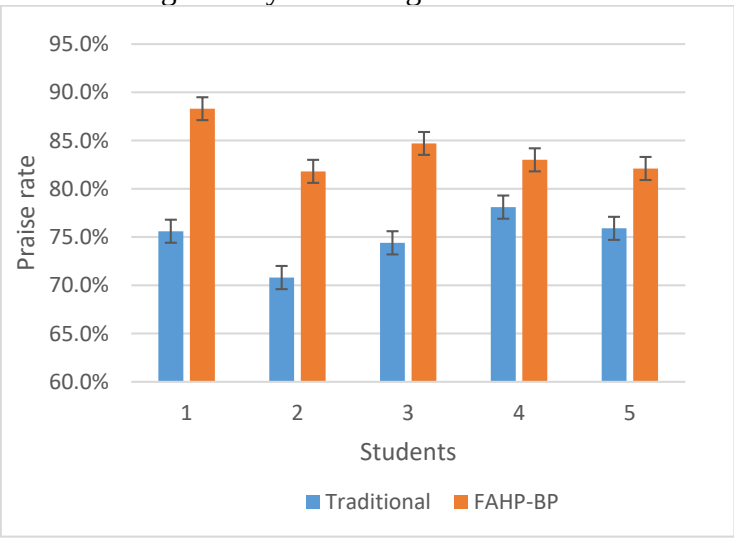

Figure 3: Student assessment

As can be seen from Figure 3, in the evaluation model based on the traditional method, the

student evaluation has a maximum rate of 78.1%, a minimum rate of 70.8%, and a calculated average rate of 74.96%; in the evaluation model based on FAHP-BP, the student evaluation has a maximum rate of 88.3%, a minimum rate of 81.8% and a calculated average rate of 83.98%. It can be concluded that the FAHP-BP model can improve the rate of student evaluation, which means that students' learning ability is also gradually improving.

Finally, a questionnaire survey based on FAHP-BP is carried out in a university, and the result is shown in Table 1.

Table 1: Questionnaire

	Very poor	Poor	General	Good	Very good
Teaching level	4%	6%	40%	25%	25%
Learning ability	7%	8%	38%	27%	20%

As can be seen from Table 1, about 50% of the students and tutors in the university rated the teaching level and learning ability of the model as "good" or above, while the proportion rated as "bad" or below was less than 15%. It can be seen that the talent evaluation model based on FAHP-BP in colleges and universities has obtained a higher evaluation in colleges and universities, which can promote the promotion in the future.

7. Conclusions

Taking a teacher in a vocational normal university as an example, this article constructs a complete talent evaluation index system by combining the fuzzy analytic hierarchy process with BP neural network. The fuzzy analytic hierarchy process is used to evaluate the system, and a more accurate result is obtained. Through the combination of fuzzy analytic hierarchy process and BP neural network, teachers can be evaluated in an all-round and multilevel way, thus providing an important basis for human resources management. The model can effectively solve the problem of the combination of qualitative and quantitative evaluation in the talent evaluation of vocational normal colleges and has better practicability.

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