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Analysis on the Competence Characteristics of Counselors Based on AHP and Neural Network

Lisha WU[a,1]
[a] *Chongqing Three Gorges Vocational College, Wanzhou, 404100, China*

Abstract. In order to solve the problems of unscientific evaluation process and untimely feedback of evaluation results in the performance evaluation system of college counselors, a competency analysis model based on AHP and neural network is proposed. Based on the analysis and research of relevant knowledge and needs, we established the competency characteristics evaluation system of counselors through factor analysis and expert survey, and quantified the assessment factors of qualitative analysis by mathematical methods. Then, through AHP, the effective weight of each index is determined, and the output results are used as samples to be trained and tested in BP neural network, and the final evaluation score of the counselor's ability is obtained. The empirical analysis shows that the scheme has high precision of matching model and training speed, which provides a new model for the competency evaluation of college counselors.

Keywords. competence characteristics; counselors; AHP; BP neural network; index system

1. Introduction

College counselors have become an important part of the team of college teachers, and have become a profession familiar to both the country and students' parents. How to build a good team of college counselors, how to improve the competency of college counselors, and how to make them go on a professional, professional, expert road to better play their role has become a problem that has to be considered [1]. Competency method is a method widely used in human resource management. At present, the research of Chinese scholars on competency is mainly limited to the field of organization and management. How to introduce competency research into the field of education to build a model of college counselors and provide objective basis for the selection, training and assessment of college counselors is a pioneering work of great significance [2]. College counselors are the grass-roots implementers of college students' ideological and political education, and an indispensable force to ensure the sustainable, healthy and rapid development of higher education. At present, there is very little research on the establishment of competency models in human resource management in universities, especially in the special industry of counselors. According to the competency evaluation indicators, conducting closed-loop management throughout the entire process of counselor selection, mid-term training, and post assessment, effectively improving the ability and level of the counselor team, and promoting the overall construction of the counselor team, is currently a research

[1] Corresponding Author: Lisha WU; Chongqing Three Gorges Vocational College, Wanzhou, 404100, China; liushichuanren123@163.com

hotspot in university student management work. Therefore, exploring the construction of counselor competency model and its application in the construction of counselor team undoubtedly has important practical significance and broad application background.

This paper first discusses the basic concepts and application status of AHP, neural network and competency model. On this basis, combined with the actual needs of college student management and teacher performance management, the paper establishes an evaluation system for the competency characteristics of counselors, and initially gives the main indicators of the influencing factors of the comprehensive ability of counselors. Then, in view of the defects and deficiencies of AHP in the analysis process, it is proposed to use BP neural network to simulate AHP thinking mode, and perform model training and accurate matching experiments based on AHP and BP neural network. Through the empirical analysis of the counselor scoring data provided by a university, the improved hierarchical analysis method can be used to normalize the data and feed it back to the BP neural network as input to output the final objective evaluation score. The experimental results show that this scheme has good training speed and matching accuracy, and can indirectly improve the awareness and comprehensive working ability of counselors.

2. Related Work

2.1 Basic Steps of AHP

The idea of AHP is to judge the importance of different schemes, criteria and objectives to obtain the weight of different schemes' importance, so as to provide basis for decision-making. The basis of AHP is scoring method: determine indicators, score indicators of different schemes, and determine weights for indicators. It is used to handle the evaluation of unknown data. Analytic Hierarchy Process (AHP) decomposes the problem into constituent factors, and assembles the factors according to their associations, influences and affiliations, forming a multi-level analytical structure model. Thus, the problem can finally be summed up as the determination of the relative important weight value of the lowest level (plans, measures, etc. for decision-making) relative to the highest level (overall goal) or the arrangement of the relative advantages and disadvantages.

The operation steps of AHP are depicted as follows:

Step 1: Establish a hierarchical structure and determine the target layer, criteria layer and scheme layer;

Step 2: Construct a judgment matrix by comparing two factors.

Step 3: Calculate eigenvalue and eigenvector for consistency check and weight calculation at the same level

Step 4: Calculate the weight ranking and consistency check of the scheme layer to the target layer.

2.2 Competency Model

Competency refers to the potential and deep-seated characteristics of individuals who can distinguish excellent performance from average performance in a job. It can be motivation, traits, self-image, attitudes or values, knowledge, cognitive or behavioral

skills in a certain field - any individual characteristics that can be reliably measured or counted, and can significantly distinguish excellent performance from general performance. We describe competency as an iceberg floating on the water, as shown in Figure 1. The part above the water represents the characteristics of shallow layer, which is relatively easy to improve and develop; The underwater part represents the deep competency, which is difficult to evaluate and improve [4]. The latter is the key factor determining people's behavior and performance.

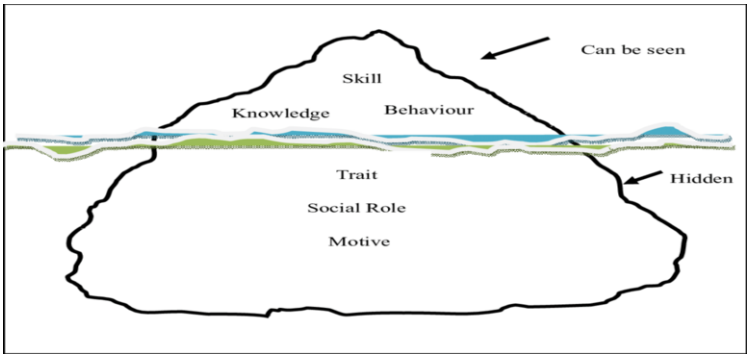

Figure 1. Iceberg model of generalized competency.

2.3 Principle of Neural Network

BP neural network can be divided into two parts, back-propagation and neural network BP network can learn and store a large number of input-output mode mapping relations without revealing the mathematical equations describing the mapping relations in advance. Its learning rule is to use the steepest descent method to continuously adjust the network weight and threshold through backpropagation, to minimize the total square error of the network. Its main characteristics are: the signal is forward propagation, and the error is back propagation [3]. The basic principle of BP network model to process information is that the input signal X_i acts on the output node through the intermediate node (hidden point). After non-linear transformation, the output signal Y_k is generated. Each sample of network training includes the input vector X and the expected output t, and the deviation between the network output Y and the expected output t. By adjusting the connection strength between the input node and the hidden layer node to W_{ij}, the connection strength between the hidden layer node and the output node T_{ik}, and the threshold, the error decreases along the gradient direction. After repeated learning training, Determine the network parameters (weights and thresholds) corresponding to the minimum error, and the training will stop. At this time, the trained neural network can input information to similar samples.

3. Experimental Study on Analysis on The Competence Characteristics of Counselors Based on AHP and Neural Network

3.1 Competency Characteristics Evaluation System of Counselors

Counselors refer to school public officials who are engaged in the ideological and political education of students, daily management of students, employment guidance, mental health and student party and league building. Each instructor generally manages one or more classes [5,6]. The competency model of college counselors defines the knowledge, skills, abilities and other relevant characteristics required for counselors to achieve high performance in their work, which is used to solve the problems of counselor appointment, training development, performance evaluation, etc. To determine the relevant competency indicators, combined with the existing research on the competency evaluation of counselors, as well as expert interviews and other methods, the competency evaluation indicators of counselors are summarized as shown in Table 1. The indicator system includes 4 primary indicators and 14 secondary indicators in total. To comprehensively improve the quality of ideological and political education for college students, the school of Economics and Management has launched a plan to improve the quality and ability of counselors.

Table 1. Competence characteristics indicator system of counselors

1st level index	2nd level index
Knowledge	Educational knowledge
	Education and Psychology
	Management
Skills	Emergency capacity
	Learning ability
	Teamwork ability
	Communication skills
Quality	Dedication
	Professional identity
	Responsibility
	Moral cultivation
Personality	Affinity
	Self-confidence
	Initiative

3.2 Model Training Based on AHP and BP Neural Network

AHP is widely used in the evaluation of information systems in communication industry. However, in the practical application of AHP method, due to the influence of the size of the selected expert group and the differences in the academic background of the members of the expert group, the evaluation data has a certain subjectivity, which needs to be constantly improved to further improve the scientificity of the method. Nonlinear mapping capability: BP neural network essentially realizes a mapping function from input to output. Mathematical theory proves that the three-layer neural network can approximate any nonlinear continuous function with any accuracy, and can be used for AHP thinking mode simulation and improvement. The power function is taken as the activation function of hidden layer neurons, and combined with the idea of pseudo inverse matrix, the output weights of neurons are determined in advance, and a polynomial neural network model is established. Follow the existing neural network scheme to establish own task, and only modify the neural configuration of data input

and loss function. Finally, determine whether to adjust again according to the actual training situation.

The basic idea is to calculate the distance between the test sample and each training sample in each cycle. In order to add random rows, after each round of training, the data in the training set should be scrambled. However, this for loop will actually take up a lot of resources in Python. Similarly, we can use vectorization to calculate all m samples at once to improve our computing speed. Repeat this process until the error requirement or the maximum number of hidden neurons is reached. The training algorithm is implemented by NEWRB function in MATLAB.

4. Empirical Analysis

4.1 Data Acquisition and Judgment Matrix Construction

According to the competency factors of college counselors obtained from the previous analysis and research, a questionnaire is designed and a 5-point evaluation method is adopted. According to the different specific division of labor of the respondents, all teachers and students in charge are investigated, and students are sampled. The scoring standard of counselor performance assessment is to introduce a competitive mechanism, fully mobilize the enthusiasm and creativity of counselors, establish a good school atmosphere, class atmosphere, and style of study, and score the importance of various competency elements that excellent counselors should have. After personal self-evaluation, organizational evaluation, student evaluation, student work department evaluation, and assessment leadership, the required initial data are finally obtained, and the initial judgment matrix is summarized as shown in Table 2.

Table 2. Initial judgement table

B_1	C_{11}	C_{12}	C_{13}	C_{14}	Weight
C_{11}	1	1/2	1	1/3	0.1152
C_{12}	2	1	2	1/2	0.2058
C_{13}	1	1/2	1	1/3	0.3412
C_{14}	3	2	3	1	0.3389

In the process of data standardization, firstly, the membership function of fuzzy mathematics is used to normalize the evaluation index, and the learning sample mode is composed of the endpoint value and intermediate value of the membership function, which is trained by BP back-propagation algorithm; Then, the neural network structure is determined and the weights are initialized: according to the system input and output sequence (X, Y), the number of nodes in the network input layer n, the number of nodes in the hidden layer l, and the number of nodes in the output layer m are determined, and the connection weights between the neurons in the input layer, the hidden layer, and the output layer are initialized. With enough samples of the network, the structure of the network is adjusted by a certain algorithm to make the output of the network conform to the expected value; Fourth, compare the real output results with the expected output results. The random initial parameters used to train BP neural networks are indeed random, and during the training process, these parameters and weights will be corrected in the same general direction. We use BP neural network to fit the curve, find the linear rule between the input value and the output value, then during

the training process, the fitting curve will constantly adjust its parameters and weights until it meets one of several preset conditions and the training stops.

4.2 Preliminary Determination of Index Weight

(1) Compute the multiply of the elemetns of each line in the matrix as $\mathrm{M} = \prod_{j=1}^{n} a_{ij}$;

(2) Compute the n_{th} P_i of M as $P_i = \sqrt[n]{\mathrm{M}}$;

(3) Normalize vector $P = (P_1, P_2, ..., P_n)^T$ as $W_i = \frac{P_i}{\sum_{i=1}^{n} P_i}$ and $W = (W_1, W_2, ..., W_n)^T$ is the expected feature vector, where $W_1, W_2, ..., W_n$ are the weight of each index in the same layer.

(4) Compute the competency evaluation system of college counselors as follows:

$P_1 = \sqrt[4]{1 * (1/2) * (1/3) * (1/4)} = 0.537$

Similarly, we have $P_2 = 0.535$, $P_3 = 1.442$, $P_4 = 2.063$.

The above results are normalized to compute the weights as:

$$W_1 = \frac{0.537}{0.537 + 0.535 + 1.442 + 2.063} = 0.12$$

Similarly, we have $W_2 = 0.16$, $W_3 = 0.28$, $W_4 = 0.64$

Then we can know the weight ranking vector of competency evaluation system for college counselors.

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{\sum_{j=1}^{n} a_{ij} W_j}{W_i} = 4.0526$$

$$CI = \frac{\lambda_{max} - n}{n - 1} = 0.01681$$

When $n = 4$, by table look-up we have $RI = 0.9$, $CR = \frac{CI}{RI} < 1$, the consistency of judgment matrix passes. Thus, the weight of each 1st index can be determined.

4.3 Neural Network Evaluation

The formula derivation of forward propagation and backward propagation of a simple three-layer neural network is established. Generally, when learning, a batch of data will be sent to the learner, first forward propagation and then backward propagation. The output layer corresponds to the AHP target index, and the number of neurons in the hidden layer is 6. First, standardize the values of each competency index, and then divide the processed data into two parts. The weights between the input signal and neurons are stable and can maximally conform to the trained learning samples. The training times are 100, and the target curve of the training process is shown in Figure 2. It can be seen from figure 2 that the error between each output result of the model and the model output expectation, that is, the stability of the model, reflects the predicted

fluctuation After training. Input the weight data calculated by AHP to the trained BP network to obtain the corresponding competency evaluation results of counselors, as shown in table 3. It can be seen that if the actual output of the BP output layer is inconsistent with the expected output, it will turn to the error back propagation. The output error is transmitted back to the input layer layer by layer through the hidden layer in some form, and the error is distributed to all neurons of each layer to obtain the error signal of each layer. The maximum relative error between the output value of the training sample network and the expected value obtained by the BP network is less than 4%, and the maximum relative error between the output value of the test sample network and the expected value is 3%. This scheme can be programmed to form a calculation tool, and when encountering similar evaluation problems, it can be directly run to obtain the demand results and comparison results.

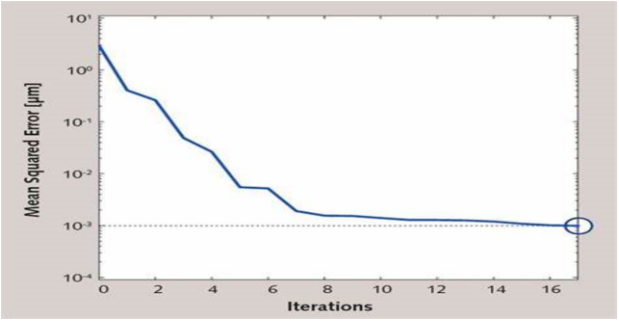

Figure 2. BP neural network training process.

Table 3. Final output results

NO.	1	2	3	4	5
Training result	0.8512	0.6844	0.5276	0.6988	0.5711
Expected result	0.8515	0.6843	0.5277	0.6984	0.5723
Relative error(%)	0.03	0.01	0.01	0.04	0.12
NO.	6	7	8	9	10
Training result	0.8219	0.7391	0.5685	0.5018	0.7105
Expected result	0.8208	0.7394	0.5662	0.5024	0.7108
Relative error(%)	0.11	0.03	0.23	0.06	0.03
…	...	...	...	...	...

To sum up, the scheme proposed in this paper with AHP-BP neural network not only integrates the competency hierarchical model related to other disciplines into the model training through AHP, effectively improving the training speed and accuracy, but also effectively avoids the problem of data normalization and sparse destruction, and further obtains a more scientific and more objective method in the research on the precise matching of college counselor positions, which can effectively help colleges and universities solve the problem of college counselor positions, so it provides suggestions when matching problems accurately.

5. Conclusion

This paper aims to provide a scientific method for the quantification of the competency evaluation of college counselors' professional and technical posts. We combine AHP

and BP neural network tools to construct, train and simulate the predictive power and generalization ability of evaluation models. Firstly, the model determines the competency characteristic index system of counselors through investigation and analysis. Then, AHP method is used to determine the indicators at all levels and their weights, and as the input of BP neural network, the importance of each factor is ranked and described according to the weight value. The case analysis results show that the scheme provides a scientific measurement tool for further evaluating the overall competency level of counselors, and also provides decision-making basis for the self-development of individual counselors and the development of counselors' teams, to achieve intelligent comprehensive evaluation of counselors' post competency.

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