Research on Modern Higher Education 1, 02001 (2017)
DOI: 10.24104/rmhe/2017.01.02001

Research on humanistic quality training in vocational education based on AHP

Yu Li & Lei Yao
Sichuan Huaxin Modern Vocational College, Chengdu, Sichuan, China

ABSTRACT: With constant development of vocational colleges, for the satisfaction with demand of high-tech professionals in society, technical personnel are provided for constant development of society. The research of humanistic quality training in vocational college education also gains extensive attention. For the research of humanistic quality training in vocational education, this paper ranks rating for the influencing factors of humanistic quality based on AHP algorithm, and determines weights by the use of AHP, and then determines membership of each factor, in order to propose theoretical support for construction of rating models, and then conducts nonlinear fitting via neural network, and constructs an evaluation model with robustness and fairness by the use of its ability to strengthen classification, and finally provides a scientific basis for continuous improvement and development of humanistic quality training through verifying the practicality of model by actual cases.

Keywords: AHP; higher vocational education; humanistic quality; neural network

1 INTRODUCTION

In recent years, due to constant development of society, the demand on vocational college students is also increasing year by year, and promotes constant and flourished development of higher vocational school. Most researches of humanistic quality training are based on the theory, but analysis of the relevant data rarely obtains a process from quantitative analysis to qualitative analysis. Regarding the characteristics of humanistic quality training system in higher vocational education, this paper provides an effective reference and guidance for the establishment of humanistic quality training system through quantitative judgment on evaluation index of literature theory. AHP algorithm has a broad application in the field of evaluation and analysis, and can provide a theoretical basis for quantitative analysis on rating and qualitative issues, so that unquantifiable issues in education can be unified quantitative through the mathematical model [1]. AHP algorithm is a mature and stable algorithm, but the ambiguity of its evaluation index is often criticized, and the corresponding modeling is lack of flexibility, and even a failure. This paper proposes an idea to optimize model through combination with neural network and AHP algorithm, and constructs a good classifier [2]. This paper constructs an evaluation model with robustness and fairness through construction of college foreign teachers' teaching evaluation model based on AHP algorithm, and nonlinear fitting of neural network, and by the use of strong approximation ability of network.

2 MODELING

2.1 *AHP algorithm*

AHP can give a good support for decision of fuzzy qualitative issues, which is especially prominent in the efficiency in solving problems of failure to decouple mutually coupling variables [3]. Its modeling steps are divided into four steps, as shown in Figure 1.

Before developing solutions by the use of this method, there is a need to first systematically and hierarchically analyze information, construct a practical and effective model, and then decompose issues, and judge criterion according to logical framework and dominance relations between layers.

Construction of a judgment matrix based on AHP method is the basis for solving relations between various elements. Numerical value of the judgment matrix elements reflects the relative important relationship between influencing factors. To determine the

weight relationship between various indicators, there is a need to construct the corresponding judgment matrix at each layer [4].

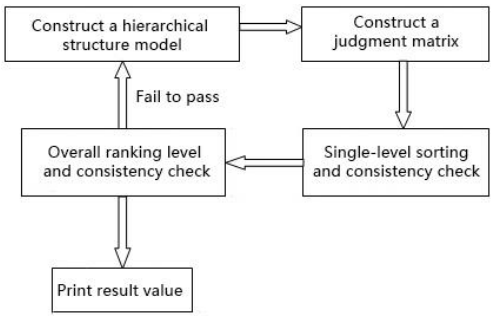

Figure 1. AHP algorithm flowchart

2.2 *Construction of quality evaluation system*

First, there is a need to determine various factors with greater influence in humanistic quality training; make classified statistic of relevant influencing factors, and respectively find the relationship between relevant factors. The composition of evaluation system has two levels: first level indicators are composed by four indicators - basic quality, humanistic spirit, moral quality and professional quality. The corresponding second level indicators are cultural cultivation, ideal ambition, humanistic thought, humanistic knowledge, moral sentiments, professional ethics, professional knowledge and professional practice, as shown in Figure 2.

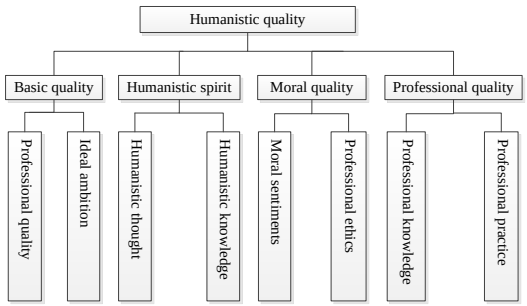

Figure 2. The construction of humanistic quality evaluation model

Important influencing factors of humanistic quality training are mainly the above four aspects, so the factors of determining judgment are integrated with the target layer (evaluation system of humanistic quality training), criterion (basic quality, humanistic spirit, moral quality, professional quality), property (cultural cultivation, ideal ambition, humanistic thought, humanistic knowledge, moral sentiments, professional ethics, professional knowledge, professional practice). Evaluation rating is:

$$X = \{x_1, x_2, x_3, x_4, x_5\}$$
$$= \{\text{best, better, good, worst, worse, bad}\}$$

Steps of constructing the judgment matrix of element relationships according to three scale judging method are as follows.

Three scale comparison matrix: $A=(a_{ij})_{n\times n}$:

$$a_{ij} = \begin{cases} 2 & i \text{ element is more important than } j \text{ element} \\ 1 & i \text{ element is equally important to } j \text{ element} \\ 0 & i \text{ element is less important than } j \text{ element} \end{cases}$$

Moreover, $a_{ij}=1$, that is, the comparative result of the element itself is 1.

Then, the sum of each row of elements based on three scale comparison matrix is:

$$r_i = \sum_{j=1}^{n} a_{ij} \; ; i=1,2,3,\ldots,n \tag{1}$$

The maximum value $r_{\max}$ and minimum value $r_{\min}$ of the sum of elements can be found out from r_i , in order to obtain the comparison elements of matrix base points corresponding to $r_{\max}$ and $r_{\min}$, and then the comparison elements of matrix base points are respectively compared by the judgment scale of 1-3, and the relative importance degree of the comparison elements of matrix base points is b_m, which is the comparison scale of base point elements. The direct comparison matrix is changed into the indirect judgment matrix by mathematical changes [5]. Changing method is as follows:

$$d_{ij} = \begin{cases} \dfrac{r_i - r_j}{r_{\max} - r_{\min}}(b_m - 1) + 1 & r_i - r_j \geq 0 \\ 1 \Big/ \left[\dfrac{r_j - r_i}{r_{\max} - r_{\min}}(b_m - 1) + 1\right] & r_i - r_j < 0 \end{cases}$$

Indirect judgment matrix obtained has the following properties:

$$\begin{cases} 1/b_m \leq d_{ij} \leq 1 & d_{ij} < 1 \\ 1 \leq d_{ij} \leq b_m & d_{ij} \geq 1 \end{cases}$$

That is, numerical range of d_{ij} is the scale of $1-b_m$.

$$d_{ij} = 1/d_{ji}$$

That is, changed indirect matrix still has reciprocal nature between symmetry elements of the matrix:

$b_m = 3$, that is the scale of 3.

This paper adopts the root method to solve issues of ranking weight of n elements (A_1, A_2,…, A_n) under multi-indicator C_k, obtaining the judgment matrix A.

After solving, the characteristic root of the judgment matrix A is $AW=\lambda_{max}W$; after normalization processing, the characteristic root W obtained can be used as elements of A_1, A_2,…, A_n for ranking weights under the indicator C_k. In equations, λ_{max} exists and solely exists, so W can be represented by a positive component, which is also exists and solely exists. To check consistency of the judgment matrix, the consistency indicator is represented by the average difference between characteristic values CI, obtaining:

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

When $CI = 0$, that is, $\lambda_{max} = n$, the judgment matrix is identical, so it is called as complete consistency; when $CI > 0$, the value of CI is compared with the randomness index RI.

When the random consistency ratio is:

$$CR = CI / RI \leq 0.1$$

The matrix has better consistency.

When the random consistency ratio is:

$$CR = CI / RI > 0.1$$

The matrix does not have good consistency, and then the matrix is changed into the judgment matrix, until having better consistency.

For the matrix of 1 -10 order, the consistency index of judgment matrix is shown in Table 1.

Table 1. Consistency index of judgment matrix of 1-10 order

Order	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

2.3 *Neural network algorithm*

BP neural network is a multilayer feedforward bionic algorithm. The algorithm has two major features: the first feature is forward pass of information; the second feature is back propagation of error. There is no interaction between neurons, and the change of numerical value has an inherited effect, which is recycled until reaching the desired error, and training a proportional gravity domain matrix that is in line with expectation.

Back-propagation neural network is essentially a nonlinear function, independent variable is an input value of the network, and dependent variable is an output value of the network, thereby constructing a function relationship from n dimension to m dimension.

Training network can make data become standard, and the network more intelligent. [6] Training steps are as follows:

First step: to initialize the network. To determine the node number at the typing layer of algorithm (n), node number at the hidden layer (l) and node number at the printing layer (m) according to the typing and printing matrix (X, Y); to initialize the connection proportion at the typing layer and printing layer (ω_{ij} and ω_{jk}), domain at the hidden layer (a), domain at the printing layer (b) and give the acquired rate and agitation function [6].

Second step: to output the hidden layer. To determine the node number at the typing layer (n), connection proportion at the hidden layer (ω_{ij}) and domain (a) according to the matrix (X, Y), thereby calculating the output at the hidden layer (H).

$$H_j = f(\sum_{i=1}^{n} \omega_{ij} x_i - a_j), \quad j = 1,2,\cdots,l \tag{2}$$

In Formula (2), l is node number at the hidden layer; f is agitation function.

Third step: to output the printing layer. To output H, connection proportion ω_{jk} and domain b at the hidden layer, and calculate the predicted output of bionic algorithm (O).

$$O_k = \sum_{1}^{l} H_j \omega_{jk} - b_k, \quad k = 1,2,\cdots,m \tag{3}$$

Fourth step: to calculate error. To calculate the prediction error (e) according to printing O obtained by prediction and predicted printing Y.

$$e_k = Y_k - O_k, \quad k = 1,2,\cdots,m \tag{4}$$

Fifth step: to update proportion. To update the connection proportion of algorithm (w_{ij}, w_{jk}) according to the prediction error (e).

$$w_{ij} = w_{ij} + \eta H_j (1 - H_j) x(i) \sum_{k=1}^{m} w_{jk} e_k,$$
$$j = 1,2,\cdots,n \quad j = 1,2,\cdots,l \tag{5}$$

In Formula (5), η is learning rate.

Sixth step: To update domain. To update domain (a,b) according to the prediction error of algorithm (e).

$$\mathrm{a}_j = a_j + \eta H_j (1 - H_j) \sum_{k=1}^{m} w_{jk} e_k$$
$$j = 1,2,\cdots,l \; b_k = b_k + e_k \quad k = 1,2,\cdots l \tag{6}$$

Seventh step: to determine whether finished, return to the second step if not up to standard.

3 MODEL SOLUTION

In the process of humanistic quality training, there are many influencing factors of humanistic quality, which are coupled to each other, and unable to be quantitatively described by given analytical formula, but the evaluation indicators can be sampled through construction of questionnaire forms, and physically and

chemically analyzed by the data set [7]. The evaluation ranking is given to the influencing factors of humanistic quality based on the statistical data, in order to determine a ranking model of influencing factors. Later, the neural network is constructed to obtain an evaluation model through non-linear fitting, with indicator as the input matrix, and rating as the output variable. AHP diagram is shown in Figure 3.

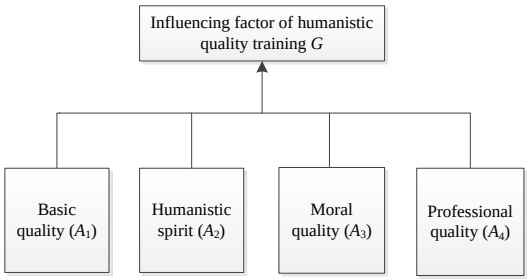

Figure 3. AHP diagram

The influencing factors of humanistic quality training are decomposed into issues of composition of multiple influencing elements, and these elements are at different levels of hierarchical relations of objectives based on the composition of basic quality, humanistic spirit, moral quality and professional quality, thereby constructing a membership between each influencing factor and general objectives. The judgment matrix is constructed by the use of statistical data (see Table 2).

Table 2. Statistics table of judgement matrix

G	A_1	A_2	A_3	A_4
A_1	2	0	0	0
A_2	1	2	0	0
A_3	1	2	2	0
A_4	1	1	1	2

To solve three scale judgment matrix of A_1,A_2,A_3,A_4 related to G, steps are as follows:

Calculated from the above table, $r_{\max}$=6.9, $r_{\min}$=1, b_m=6.1. The indirect judgment matrix of the evaluation model obtained from three scale judgment matrix is:

$$A=\begin{bmatrix} 1 & 3/8 & 3/13 & 1/6 \\ 8/3 & 1 & 3/8 & 3/13 \\ 13/3 & 8/3 & 1 & 3/8 \\ 6 & 13/3 & 8/3 & 1 \end{bmatrix}$$

Calculated from Table 2, the maximum eigenvalue, λ = 4.013, its weight vector is w = (0.0192, 0.1256, 0.3419, 0.4413)^T. Due to $\lambda_{\max}$ = 4.013 > 4, the consistency check is given to eigenvalues.

$$CI=\frac{\lambda_{\max}-n}{n-1}=0.0289$$

$$RI=0.905,$$

$$CR=\frac{CI}{RI}=0.0654<0.10,$$ indicating that Table 2 can pass the consistency check, so the weight vector of A_1, A_2, A_3, A_4 related to G is (0.1598, 0.2262, 0.2078, 0.4062)^T. The results are shown in Table 3:

Table 3. Quality weight coefficient vectors solved by four elements

Four elements	Basic quality	Humanistic spirit	Moral quality	Professional quality
Weight	0.1989	0.3231	0.3178	0.1602

After measuring elements based on AHP, the humanistic spirit, moral quality and basic quality have the largest influence on the humanistic quality training. As mentioned above, AHP algorithm can conduct quantitative analysis of ambiguity problems, in order to quantify problems, but the construction of models requires the algorithm with good generalization ability and strong robustness. This paper constructs the neural network for nonlinear approximation of the humanistic quality training model based on the algorithm evaluation results of AHP.

Assuming that the humanistic spirit, moral quality and basic quality are three input variables, an output variable is set as a vector sequence {1, 2, 3, 4, 5} to be rating results, the number of neurons in the intermediate layer is 9. Figures in sequence represent the rating results. The final rating results obtained from network training are shown in Figure 4.

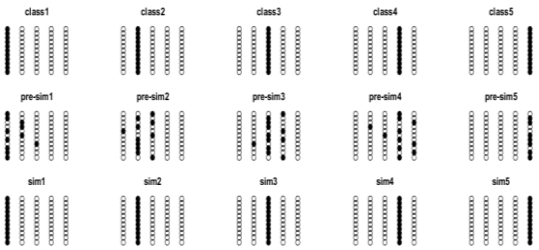

Figure 4. Rating results

The second row is prediction of original data. It shows that, the rating matrix is sparse and scattered, but the neural network digs out rules through its strong nonlinear approximation ability for correct rating.

4 CONCLUSION

The research of this paper has an important practical significance on the improvement and application for scientific and reasonable evaluation of the quality of vocational humanistic quality training. This paper

ranks rating for the influencing factors based on AHP algorithm. Regarding the features of humanistic quality training system, the mathematical modeling method solves quantitative judgment between evaluation indicators, and the establishment of humanistic quality training provides an effective reference and guidance. Later, this paper conducts nonlinear fitting via neural network based on AHP algorithm, and constructs an evaluation model with robustness and fairness by the use of its ability to strengthen classification, and finally verifies the practicality of model by actual cases, and rates each factor, obtaining important factors and non-important factors, so that modeling is more convincing. The results show that the system and method constructed in this paper is feasible and effective in solving practical problems.

ACKNOWLEDGEMENT

This paper is supported by the Research of Current Situation and Implementation Approach of Humanistic Quality Education in Higher Vocational Colleges (No. ky2016001z).

REFERENCES

[1] Qingyu Hu. 2010. *A Multi-level Fuzzy Evaluation of Students' Comprehensive Qualities Based on AHP*. North China Electric Power University.

[2] Zhefang Wang. 2013. Satisfaction model building of higher education and empirical analysis. *Chinese Securities and Futures*, (4): 275-276.

[3] Kyoung-jae Kim, Hyunchul Ahn. 2012. Simultaneous optimization of artificial neural networks for financial forecasting. *Applied Intelligence*. (4).

[4] Xianfeng Zeng. 2014. Research on the current situation and promotion strategy of legal vocational college students' satisfaction. *Education*, (6): 45.

[5] Chunyou Jing. 2006. On humanistic quality education of science and technology college students. *Northeast Normal University*, 10.

[6] Jie Zhao. 2005. Research on the evaluation of college students' comprehensive qualities based on AHP. *Science and Technology and Engineering*, 5(7).

[7] Yinan Su. 2009. Computational Intelligence and Software Engineering, *CISE 2009*, Dec.11- 13. pp: 1-4.