College Teachers Teaching Evaluation Model Based on AHP-DFS

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Abstract. To solve the problems encountered in the process of the college teachers teaching evaluation, Analytic Hierarchy Process（AHP）and Dynamic Fuzzy Sets (DFS) are introduced. AHP is used to reduce subjective interference in the teacher evaluation when the weights are determined, and DFS to obtain dynamic comprehensive evaluation results. The experimental results reveal not only the level of teachers teaching but the trend of every index and comprehensive levels of teachers.

Introduction

As the development of educational statistics and education measurement, research on teaching evaluation method has been paid more attention and optimized significantly [1,2,3]. At present, teaching evaluation systems of the domestic colleges usually utilize the weighted average to assess the result of comprehensive evaluation. But there is a serious problem that the dynamic fuzzy is ignored in traditional methods [4,5]. Different teacher may obtain the different results in the same evaluation .What is more; the results are not static and are open to change. Obviously, evaluation sets and indexes are fuzzy in teaching evaluation. It is not invariable for a teacher's teaching. The teaching developing process should be a curve to show dynamic changes. In order to correctly and timely reflect the trend of the teaching quality of colleges and give the correct judgments for teaching, a dynamic fuzzy comprehensive evaluation method is required to be introduced [6,7].

In this paper, the work was done as follow：（1）introducing the relative theories （2）constructing the teaching evaluation based on AHP and DFS algorithm （3） further illustrating the scientific and effectiveness of the algorithm by teaching evaluation index system of Guangxi Teacher College （GXTC）.

Relative theories

A. AHP

AHP which is proposed in 1977 by T.L.Satty, a U.S. operational research expert, is a qualitative, quantitative, systematic and hierarchical analytical method. When AHP is applied, a hierarchical model of the problem is constructed at first. Next, 1-9 and its reciprocal scaling method is utilized to quantize the qualitative description which was compared pairwise by experts. Finally, judgment matrix A is obtained.

$$A = (A_{ij})_{n*n}$$

aij that means the relative importance of ith and jth index is satisfy:

$$\frac{1}{9} \leq a_{ij} \leq 9$$

$$a_{ij=} \frac{1}{a_{ij}} \tag{1}$$

B. DFS

DFS is a method to express dynamic fuzzy data. In the method, the dynamic data is combined with theory of fuzzy sets to make further expansion and promotion [8-15].

Define 1: a domain on U mapping:

$$(\overleftarrow{A},\overrightarrow{A}):(\overleftarrow{U},\overrightarrow{U})\to[0,1]\times[\leftarrow,\to],(\overleftarrow{U},\overrightarrow{U})\Big|\to(\overleftarrow{A}(\overleftarrow{U}),\overrightarrow{A}(\overrightarrow{U}))$$

(2)

It is denoted with $(\overleftarrow{A},\overrightarrow{A})$ .And $(\overleftarrow{A},\overrightarrow{A})$ is called DFS in $(\overleftarrow{U},\overrightarrow{U})$. $\mu(\overleftarrow{A}(\overleftarrow{U}),\overrightarrow{A}(\overrightarrow{U}))$ is called the membership grade of to membership function to $(\overleftarrow{A},\overrightarrow{A})$.

There are many methods for expression of DFS. In this paper, the method is used as follow [8]:

If the domain U is a finite set $\{(\overleftarrow{u_1},\overrightarrow{u_1}),(\overleftarrow{u_2},\overrightarrow{u_2}),\cdots,(\overleftarrow{un},\overrightarrow{un})\}$, the commonly used dynamic fuzzy subset $(\overleftarrow{A},\overrightarrow{A})$ is expressed as follows:

$$(\overleftarrow{u1},\overrightarrow{u1})=\mu(\overleftarrow{A}(\overleftarrow{u_1}),\overrightarrow{A}(\overrightarrow{u_1}))/(\overleftarrow{u_1},\overrightarrow{u_1})+\mu(\overleftarrow{A}(\overleftarrow{u_2}),\overrightarrow{A}(\overrightarrow{u_2}))/(\overleftarrow{u_2},\overrightarrow{u_2})_+\cdots+\mu(\overleftarrow{A}(\overleftarrow{un}),\overrightarrow{A}(\overrightarrow{un}))/(\overleftarrow{un},\overrightarrow{un})$$

(3)

When two DFS operate, several operations of DFS are allowed in the domain U. They are considered the operation of membership function. Specific operation rules can be referred to 9 refs.

The model of college's teaching evaluation based on AHP-DFS

A. The Hierarchical Model of College's Teaching Evaluation

A college's teaching evaluation system is designed by the assessing department in the college. In fact, index system in college's teaching evaluation are not the same [16, 17].

In this paper, we refer to the teaching evaluation indexes of GXTC. The hierarchical model to judge the teaching quality is made up of 4 first-level indexes and 11 secondary indexes. Target layer shown on the left of TABLE Ⅰ is to judge the comprehensive quality of teaching. There are four factors to judge the quality of teaching on the middle of TABLE Ⅰ. The factors are expanded on indexes on the right of TABLE Ⅰ.

TABLE Ⅰ.The Teaching Evaluation Indexes of GXTC

B.Applying AHP of Scaling Method to Obtain Index Weight

Firstly, the experts don't need to evaluate the objects by giving concrete value, and they just mark the objects by 1~9 scaling method proposed by Staaty. Then a set of matrices can be obtained. One can attain the weight vector by examining the consistency and individually sorting the layer. It can be denoted as: $\omega(A)$ .The weight vector of third index layer for factor layer can be denoted as:

$\omega(B1)$, $\omega(B2)$, $\omega(B3)$ and $\omega(B4)$ respectively.

Teaching Quality Evaluation of College (A)	Teaching Attitudes (B1)	being a model for others(C1)
		imparting knowledge and cultivate people others(C2)
		basic teaching skill(C3)
		be a model for others(C4)
	Teaching Content (B2)	solving teaching difficulties(C5)
		linking theory with practice(C6)
		inspiring thought(C7)
	Teaching Method (B3)	Teaching method(C8)
	Teaching Effect (B4)	attraction(C9)
		enlightenment(C10)
		gains(C11)

C. Dynamic Fuzzy Evaluation of The Teaching Quality

Teaching evaluation system based on the Theory Dynamic Fuzzy is dynamically changed. It is critical for the representation of data in evaluation. And DFS will be use to represent the related data .

1) The evaluation factors set

It is evident from TABLE Ⅰ that the first layer, the evaluation factors set of the teaching evaluation indexes, can be denoted as $A=\{B1,B2,B3,B4\}$,and the second layer evaluation factors set as :

$B1=\{C1,C2,C3,C4\};B2=\{C5,C6,C7\};B3=\{C8\};B4=\{C9,C10,C11\}$.

2) The evaluation results set

The evaluation results set are made up of four grades. They will be represented as excellent (A), good (B), fair(C) and poor (D), which are dynamically changed.

The evaluation results set is denoted as: $B = \{(\overset{\leftarrow}{A},\vec{A}),(\overset{\leftarrow}{B},\vec{B}),(\overset{\leftarrow}{C},\vec{C}),(\overset{\leftarrow}{D},\vec{D})\}$ .In set B, $\overset{-}{A}$ means excellent, and its trends will be more excellent. Similarly, $\vec{A}$ means excellent, and the trend will be worse.

3) Comprehensive evaluation matrix

It is assumed that we evaluate *j*th index C*j* (j = 1, 2…,11) in B*i* (I = 1, 2, 3, 4) , then we can obtain a dynamic fuzzy vector relative to $(\overset{\leftarrow}{b}_k,\vec{b}_k)\epsilon B , (k = 1,2,3,4)$.

There are 11 second-level indexes in the teaching quality evaluation system. And 11*4 matrixes named R will be generated after constructing the dynamic fuzzy vector named Rj:

$$R = \begin{matrix} (\overset{\leftarrow}{r}_{111},\vec{r}_{111}) & (\overset{\leftarrow}{r}_{112},\vec{r}_{112}) & (\overset{\leftarrow}{r}_{113},\vec{r}_{113}) & (\overset{\leftarrow}{r}_{114},\vec{r}_{114}) \\ (\overset{\leftarrow}{r}_{121},\vec{r}_{121}) & (\overset{\leftarrow}{r}_{122},\vec{r}_{122}) & (\overset{\leftarrow}{r}_{123},\vec{r}_{123}) & (\overset{\leftarrow}{r}_{124},\vec{r}_{124}) \\ \dots & \dots & \dots & \dots \\ (\overset{\leftarrow}{r}_{4111},\vec{r}_{4111}) & (\overset{\leftarrow}{r}_{4112},\vec{r}_{4112}) & (\overset{\leftarrow}{r}_{4113},\vec{r}_{4113}) & (\overset{\leftarrow}{r}_{4114},\vec{r}_{4114}) \end{matrix}$$

R is the comprehensive evaluation matrix. In the matrix, very row means the result which has been generated from the evaluation of every index. The whole matrix contains all information that shows relationship between the evaluation result set B and the evaluation factor set A.

4) Dynamic fuzzy evaluation of an index

The method for dynamic fuzzy evaluation of an index is shown below:

For an index Cj (j=1,2,…,11) ,it is assumed that there are $(\overset{\leftarrow}{k1},\overset{\rightarrow}{k1}),(\overset{\leftarrow}{k2},\overset{\rightarrow}{k2}),(\overset{\leftarrow}{k3},\overset{\rightarrow}{k3}),(\overset{\leftarrow}{k4},\overset{\rightarrow}{k4})$ users who evaluate results are $(\overset{\leftarrow}{b1},\overset{\rightarrow}{b1}),(\overset{\leftarrow}{b2},\overset{\rightarrow}{b2}),(\overset{\leftarrow}{b3},\overset{\rightarrow}{b3}),(\overset{\leftarrow}{b4},\overset{\rightarrow}{b4})$. The indexes belonging to each evaluation level of membership degree are $(\overset{\leftarrow}{r}_{ijk},\vec{r}_{ijk})$.

$$(\overset{\leftarrow}{r}_{ijk},\vec{r}_{ijk}) = (\overset{\leftarrow}{ki}\Big/\sum_{i=1}^{4}ki , \vec{k}_i\Big/\sum_{i=1}^{4}ki) \tag{4}$$

In equation (4), $\sum_{i=1}^{4}ki$ represents the valid users, and dynamic fuzzy evaluation of an index can be represented as follow: $Sj = (\overset{\leftarrow}{r}_{ij1},\vec{r}_{ij1}),(\overset{\leftarrow}{r}_{ij2},\vec{r}_{ij2}),(\overset{\leftarrow}{r}_{ij3},\vec{r}_{ij3}),(\overset{\leftarrow}{r}_{ij4},\vec{r}_{ij4})$.

Next, evaluation results are converted to values. Assuming that the score of Evaluation sets are column vectors C=（95,85,75,65）T,then C combined synthetically operated with S .And the results are listed below:

$$Qi = \omega(Bi)S \circ C \tag{5}$$

$$Qi = \begin{cases} \vec{Q}, \overset{\leftarrow}{Q} < \vec{Q} \\ \overset{\leftarrow}{Q}, \overset{\leftarrow}{Q} > \vec{Q} \end{cases} \tag{6}$$

"∘ "is a compound operator. There are many model of the operation method for "∘ ". In this paper, "∘ "means sum product . Equation 6 expresses the direction of value.

In general speaking, not only can fuzzy dynamic evaluation objectively reflect the fuzzy degree of different index, but above all, make predictions about the development of teacher teaching. Applying it in the teacher teaching evaluation, one can obtain more precise results to be referred to in teaching.

5) Teaching quality comprehensive evaluation

Comprehensive teaching evaluation result which will provide clues about the evaluation at the end of year comes from evaluation of every index. And the result is obtained from sum product.

$$Q = \omega(A) \circ Q_i^T \tag{7}$$

According to these analyses, the model of teaching quality evaluation based on

AHP-DFS can be deduced easily. The model is made up of four sections. The four sections are confirming index weight, representing data with DFS, constructing comprehensive evaluation matrix and obtaining single and comprehensive evaluation, as shown in Fig.1.
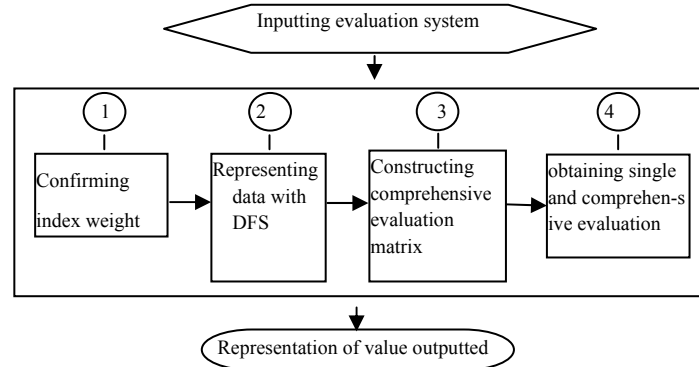

Figure1. The model of teaching quality evaluation.

The experiments and analysis

To verify the validity of our proposed algorithm, we evaluated the teaching quality of a teacher with the algorithm. The experimental data were collected from evaluation by one hundred students to a teacher with the teaching evaluation indexes of GXTC.The results are shown in TABLE II.

Applying the model shown in Fig 1, every weight vector is obtained respectively. The weight vectors of factor layer relative to target layer are obtained: $\omega(A) = (0.06, 0.13, 0.23, 0.58)$,The weight vectors of index layer relative to factor layer are obtained: $\omega(B1) = (0.08, 0.13, 0.59, 0.2)$, $\omega(B2) = (0.08, 0.22, 0.7)$, $\omega(B3) = (1)$, $\omega(B4) = (0.09, 0.28, 0.63)$.

TABLE II. Teaching Quality Evaluation

	$\overleftarrow{A}$	$\overrightarrow{A}$	$\overleftarrow{B}$	$\overrightarrow{B}$	$\overleftarrow{C}$	$\overrightarrow{C}$	$\overleftarrow{D}$	$\overrightarrow{D}$
C1	0.22	0.4	0.03	0.35	0	0	0	0
C2	0.2	0.35	0.08	0.37	0	0	0	0
C3	0.25	0.3	0.05	0.4	0	0	0	0
C4	0.21	0.45	0.09	0.25	0	0	0	0
C5	0.12	0.45	0.09	0.33	0	0.01	0	0
C6	0.24	0.38	0.12	0.22	0.01	0.3	0	0
C7	0.11	0.35	0.15	0.23	0.09	0.07	0	0
C8	0.2	0.3	0.15	0.28	0.02	0.05	0	0
C9	0.29	0.28	0.12	0.3	0	0.01	0	0
C10	0.2	0.28	0.1	0.25	0.08	0.09	0	0
C11	0.1	0.48	0.12	0.3	0	0	0	0

Comprehensive evaluation matrix R can be obtained by TABLE II and equation (4).

$$
R = \begin{matrix}
0.22 & 0.4 & 0.03 & 0.35 & 0 & 0 & 0 & 0 \\
0.2 & 0.35 & 0.08 & 0.37 & 0 & 0 & 0 & 0 \\
0.25 & 0.3 & 0.05 & 0.4 & 0 & 0 & 0 & 0 \\
0.21 & 0.45 & 0.09 & 0.25 & 0 & 0 & 0 & 0 \\
0.12 & 0.45 & 0.09 & 0.33 & 0 & 0.01 & 0 & 0 \\
0.24 & 0.38 & 0.12 & 0.22 & 0.01 & 0.3 & 0 & 0 \\
0.11 & 0.35 & 0.15 & 0.23 & 0.09 & 0.07 & 0 & 0 \\
0.2 & 0.3 & 0.15 & 0.28 & 0.02 & 0.05 & 0 & 0 \\
0.29 & 0.28 & 0.12 & 0.3 & 0 & 0.01 & 0 & 0 \\
0.2 & 0.28 & 0.1 & 0.25 & 0.08 & 0.09 & 0 & 0 \\
0.1 & 0.48 & 0.12 & 0.3 & 0 & 0 & 0 & 0
\end{matrix}
$$

Qi can be obtained with module 4 combining equation (5) and equation (6).

$$Q_i = \overline{90.7} \quad \overline{93.2} \quad \overline{89.3} \quad \overline{90}$$

The score of teachers' teaching attitude is 90.7 and will be better. The score of teaching content organization is 93.2 and will be, too. Teaching methods scored 89.3 doses not reach optimal, but will be better. Teaching effect is scored 90 and has a tendency to be better.

$Q = \overline{90.3}$ can be derived from indexes. It is shown that the organization of teaching content earns the highest scores in the four indexes and will be better. Teaching methods are scored lowest but

will be better too. From the result, one can suggest the teacher evaluated to improve his teaching methods. Finally he will really do.

Conclusions

The method proposed in this paper is the evaluation of the teaching quality based on the dynamic fuzzy sets. According to dynamic and fuzzy teaching quality evaluation factors, this paper clarifies how to create dynamic fuzzy sets and analyze the dynamic fuzzy evaluation results. Meanwhile it also plays a valuable role in exploring better teaching quality evaluation methods.

Teaching quality is the lifeblood of college survival and development, and improving the teaching quality is the eternal theme of teaching management. To establish teaching quality monitoring system is an important measure to guarantee improvement of the teaching quality. And the teaching quality evaluation is an effective way to improve the teaching quality. By reasonable teaching evaluation, the teaching management department can scientifically and comprehensively learn teachers' teaching situation. So that teachers can identify gaps and take measures to further facilitate the teaching.

References

[1] Hou GuangWen. Overview of Education Evaluation.HeBei:HeBei Education Press,1999

[2] WuGang. Modern education evaluation basis.Shanghai:XueLin Press,1996,28.

[3] Douwe,Beijaard and Nico Verloop, "Practical Knowledge, Studies in Educational Evaluation," Assessing Teachers,1996, Vol. 22. No. 3, pp. 275-286.

[4] Shen WeiXing, "The University Teaching Quality Evaluation Item System,"ShangHai:DongHua University, 2003.

[5] Liu Yao, "Quantizing Assessment about Teacher's Business,"China Higher Education Evaluation,1998,2,62-64.

[6] Tamar Levine, "Stability and change in curriculum evaluation," Studies in educational evaluation,2002,28:1-33.

[7] Curry,Stacie,"Portrolto-Based Teacher Assessment,"Thrust for Educational Leadership, 2000, 29 (3) : 34-37.

[8] Li Fanzhang, " The Limit of Dynamic Fuzzy Data Sets Sequence and Its Property," Computer Engineering, 2001, 27 (3):90-92.

[9] Li Fanzhang,"The Dynamic Fuzzy Data Operation and Its Model," Computer Engineering, 2001, 27(3):100-102.

[10]Dai WenHui, "Method of Data Categorizing Based on Dynamic Fuzzy Lattice and Its Applications in Human Resource Management," SuZhou:SuZhou University,2008.

[11]Hofmeister P et a1, "Reduction of complexity in scenario analysis by means of dynamic fuzzy data analysis,"OR SPEKTRUM, 2000, 22 (3):403-420.

[12]Li Fanzhang and Zheng Jialiang, "Research on a Dynamic Fuzzy Data Model,"Journal of Computer Research and Development,1998,35(8):714-718.

[13]CAO SG,REES NW, " Identification of dynamic fuzzy models," Fuzzy Sets and Systems,1995. 74(3):307-320.

[14]CAO SG and BEES Nw.Feng G, "Analysis and design of fuzzy control systems using dynamic fuzzy-state space models," IEEE Transactions on Fuzzy System,1999. 7 (2):192-200.

[15]Liu Hongmei and Li Fanzhang, "Application and Research of DFL in E-commerce," Computer Engineering,2007.33(2):133-176.

[16]Robert A and Rothberg, Marilyn Fenner, "Teacher Perceptions of Teacher Assessment," Clearing House.1991,64(6):272-274.

[17]Jiang Manyun and Lei Mingqiang, "Setting up the Concept of Evaluating the Quality Education,"Shanghai Research on Education,1998,5:21-38.