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A Teaching Quality Guarantee Model of Talents Training in Colleges and Universities Based on Grey Correlation Analysis

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Abstract

There are many things to consider in teaching activities of colleges and universities. Teaching quality guarantee involves complex system engineering. In order to address multi-attribute evaluation of teaching quality, this paper proposes a teaching quality guarantee model of talents training based on grey correlation analysis. A new type of teaching quality guarantee system of talent training is constructed and factor sets for guarantee analysis are confirmed. Then, the state sets of the teaching quality guarantee analysis and classical domains are discussed. A teaching quality guarantee model of talents training is established based on grey correlation analysis in order to obtain the grey correlation coefficient and the grey correlation degree. The teaching quality level of talent training is judged according to the grey correlation degree. Finally, a case is studied to verify the model.

Keywords: *teaching quality, talent training, grey correlation analysis, colleges and universities, model*

1. Introduction

As education reform in colleges and universities are gaining momentum, it raises new standards on teaching activities and teaching quality [1-3]. On the one hand, teaching activities should better fulfill the purpose the nurturing talents for the society. On the other hand, colleges and universities should enhance the teaching quality and the level of talent training. Thus, experts, scholars and leaders in the educational field analyze and discuss this problem from multiple perspectives and propose a series of methods and models for enhancing teaching quality, which plays an active role in guaranteeing teaching quality of talent training [4-8].

However, there are many things to consider in the teaching activities of colleges and universities. And teaching quality guarantee involves complex system engineering. In particular in the analysis of teaching quality of talents training, there is the necessity to deal with fuzzy uncertain information, which is unable to realize through traditional analysis methods or models. Therefore, based on previous research, this paper proposes a new type of teaching quality guarantee system of talent training and a teaching quality guarantee model based on grey correlation analysis [9-14]. Which category the teaching quality of the object under evaluation belongs to can be determined according to the grey correlation degree?

2. Teaching Quality Guarantee System of Talent Training

The key of guaranteeing teaching quality of talent training lies in the implementation of quality-oriented teaching mode. Basic conditions before the implementation of the teaching mode, key factors during the implementation and features of teaching indicators should be taken into account. Guided by the scientific principle, the objective principle, the comprehensive principle, the practical principle and the effective principle, this paper

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analyzes the three phases of teaching mode and constructs the teaching quality guarantee system of talent training, as shown in Table 1.

Table 1. Teaching Quality Guarantee System of Talent Training

Index system	Criteria layer	Index layer
Teaching quality guarantee system of talent training R	Basic conditions R_1	Rationality of teaching schedule r_{11}
		Completeness of syllabus and teaching plan r_{12}
		Orderliness of teaching plan r_{13}
		Professional knowledge r_{14}
	Key factors R_2	Abundance of teaching content r_{21}
		Diversity of teaching method r_{22}
		Scientific features of teaching method r_{23}
		Rationality of teaching ideal r_{24}
		Compliance of teaching attitude r_{25}
		Convergence of professional knowledge r_{26}
		Practical features of teaching mode r_{27}
	Achievement of teaching R_3	Integration of production and research r_{31}
		Number of reform project of quality-oriented education r_{32}
		Number of papers of quality-oriented education r_{33}
		Number of awards for educational reform r_{34}
		Teaching satisfaction r_{35}
		Overall quality of students r_{36}
		Qualified rate of students r_{37}

3. A Teaching Quality Guarantee Model of Talents Training Based On Grey Correlation Analysis

3.1. Constructing Factors Sets of Teaching Quality Guarantee for Grey Correlation Analysis

Factor sets for grey correlation analysis are constructed on the basis of teaching quality guarantee system of talent training. Indicators at each layer of the index system are the factors. Factor sets are constructed as followings:

The factor set in the first layer is R . There is:

$$R = \{R_1, R_2, R_3\}$$
(1)

Where R_1 , R_2 and R_3 are factor sets in the second layer. And they satisfy the following equation:

$$\begin{cases} R_1 = \{r_{11}, r_{12}, r_{13}, r_{14}\} \\ R_2 = \{r_{21}, r_{22}, r_{23}, r_{24}, r_{25}, r_{26}, r_{27}\} \\ R_3 = \{r_{31}, r_{32}, r_{33}, r_{34}, r_{35}, r_{36}, r_{37}\} \end{cases}$$
(2)

3.2. The Construction of State Sets of Teaching Quality Guarantee for Grey Correlation Analysis

State sets of teaching quality guarantee for grey correlation analysis are introduced to describe teaching quality, teaching ability and teaching level of talent training. They would reflect the evaluation result of the object under evaluation and the level of state of the object in effective measurement. This paper categories the level of state into five grades Lv_1 , Lv_2 , Lv_3 , Lv_4 and Lv_5 . So the state set Lv of the teaching quality guarantee for grey correlation analysis is expressed as:

$$Lv = \{Lv_1, Lv_2, Lv_3, Lv_4, Lv_5\}$$
(3)

Where Lv_1 refers to excellent, Lv_2 refers to good, Lv_3 refers to mediocre, Lv_4 refers to poor and Lv_5 refers to bad.

One indicator at different levels of state has several classical domains. The relationship between the level of state of qualitative indicator and the classical domain is shown in Table 2.

Table 2. Level of State Of Qualitative Indicator and The Classical Domain

Grade	Lv_1	Lv_2	Lv_3	Lv_4	Lv_5
Classical domain	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
Classical domain	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6

For quantitative indicators, classical domains corresponding to the indicator at different levels of state usually have interval values, so the classical domain of indicator j at level Lv_i can be expressed as:

$$V_j(Lv_i) = \left[v_j^{lef}(Lv_i), v_j^{rig}(Lv_i)\right] \quad , \quad v_j^{lef}(Lv_i) \le v_j^{rig}(Lv_i)$$
(4)

3.3. Standardization of Indicators

For indicators of teaching quality with different scales, they need to be standardized to get unified measurement. Suppose the value of indicator j at level of state Lv_i is $V_j\left(Lv_i\right)=\left[v_j^{lef}\left(Lv_i\right),v_j^{rig}\left(Lv_i\right)\right]$, and $v_j^{lef}\left(Lv_i\right)\le v_j^{rig}\left(Lv_i\right)$. If indicator j is of effective-type, its standardized value $u_j\left(Lv_i\right)$ is:

$$u_j\left(Lv_i\right)=\left[u_j^{lef}\left(Lv_i\right),u_j^{rig}\left(Lv_i\right)\right]$$
$$=\left[\frac{v_j^{lef}\left(Lv_i\right)-inf\left(v_j^{lef}\left(Lv_i\right)\right)}{sup\left(v_j^{rig}\left(Lv_i\right)\right)-inf\left(v_j^{lef}\left(Lv_i\right)\right)},\frac{v_j^{rig}\left(Lv_i\right)-inf\left(v_j^{lef}\left(Lv_i\right)\right)}{sup\left(v_j^{rig}\left(Lv_i\right)\right)-inf\left(v_j^{lef}\left(Lv_i\right)\right)}\right]$$

(5)

In particular, if indicator j is an accurate value, its standardized value $u_j\left(Lv_i\right)$ is:

$$u_j\left(Lv_i\right)=\frac{V_j\left(Lv_i\right)-inf\left(V_j\left(Lv_i\right)\right)}{sup\left(V_j\left(Lv_i\right)\right)-inf\left(V_j\left(Lv_i\right)\right)}$$

(6)

If indicator j is of cost-type, its standardized value $u_j\left(Lv_i\right)$ is:

$$u_j\left(Lv_i\right)=\left[u_j^{lef}\left(Lv_i\right),u_j^{rig}\left(Lv_i\right)\right]$$
$$=\left[\frac{sup\left(v_j^{rig}\left(Lv_i\right)\right)-v_j^{lef}\left(Lv_i\right)}{sup\left(v_j^{rig}\left(Lv_i\right)\right)-inf\left(v_j^{lef}\left(Lv_i\right)\right)},\frac{sup\left(v_j^{rig}\left(Lv_i\right)\right)-v_j^{lef}\left(Lv_i\right)}{sup\left(v_j^{rig}\left(Lv_i\right)\right)-inf\left(v_j^{lef}\left(Lv_i\right)\right)}\right]$$

(7)

In particular, if indicator j is an accurate value, its standardized value $u_j\left(Lv_i\right)$ is:

$$u_j\left(Lv_i\right)=\frac{sup\left(V_j\left(Lv_i\right)\right)-V_j\left(Lv_i\right)}{sup\left(V_j\left(Lv_i\right)\right)-inf\left(V_j\left(Lv_i\right)\right)}$$

(8)

3.4. Weight of Indicators

AHP method proposed by Professor T.L. Saty is adopted to allocate weight to indicators of teaching quality. A 1-9 scale is used to score. Details are shown in Table 3.

Table3. Scoring Of Weight

Explanation	Judgment value	
	$A\rightarrow B$	$B\rightarrow A$
A is as important as B	1	1
A is more important than B	3	1/3
A is a little more important than B	5	1/5
A is much more important than B	7	1/7

A is extremely more important than B	9	1/9
The importance of A to B lies in between	2,4,6,8	1/2,1/4,1/6,1/8

The judgment matrix $\boldsymbol{T}$ is constructed according to scores in Table 3.

$$\boldsymbol{T}=\begin{bmatrix} t_{11} & t_{12} & \cdots & t_{1N} \\ t_{21} & t_{22} & \cdots & t_{2N} \\ \vdots & \vdots & \cdots & \vdots \\ t_{N1} & t_{N2} & \cdots & t_{NN} \end{bmatrix}$$
(9)

Based on judgment matrix $\boldsymbol{T}$, we can get the maximum eigenvalue $\lambda_{max}(\boldsymbol{T})$ and its corresponding character vector ζ, there is:

$$\zeta=(\zeta_1,\zeta_2,\cdots,\zeta_N)$$
(10)

Character vectors are standardized and the weight w_j of indicator j is obtained. There is:

$$w_j=\zeta_j/\sum_{j=1}^{N}\zeta_j$$
(11)

The value of RI can be obtained from the table. If the judgment matrix accords with the requirement of the consistency indicator, namely,

$$\begin{cases} CR=CI/RI\le 0.10 \\ CI=\left(\lambda_{max}(\boldsymbol{T})-N\right)/(N-1) \end{cases}$$

Then there forms the weight sequence W:

$$W=(w_1,w_2,\cdots,w_N)$$
(12)

3.5. Grey Correlation Analysis of Teaching Quality Guarantee and the Realization Of The Algorithm

Suppose the value of indicator j in factor sets of object under evaluation P is $u_j(P)=\left[u_j^{lef}(P),u_j^{rig}(P)\right]$, the grey distance $D_{ij}^{\otimes}(P)$ of the most frequent level of state of indicator j is:

$$D_{ij}^{\otimes}(P)=\left(\left|u_j^{lef}(P)-u_j^{lef}(Lv_i)\right|^G+\left|u_j^{rig}(P)-u_j^{rig}(Lv_i)\right|^G\right)^{\frac{1}{G}}/2^{\frac{1}{G}}$$
(13)

In general, there is $G=1$ or $G=2$. When $G=1$, $D_{ij}^{\otimes}(P)$ is the Hamming distance. When $G=2$, it is the Euclidean distance.

$$D_{ij}^{\otimes}(P)=\left(\left|u_j^{lef}(P)-u_j^{lef}(Lv_i)\right|+\left|u_j^{rig}(P)-u_j^{rig}(Lv_i)\right|\right)/2$$

(14)

In this paper, $G=1$, which means the grey distance $D_{ij}^{\otimes}(P)$ is the Hamming distance.

$$\xi_{ij}^{\otimes}(P)=\frac{\min_i \min_j D_{ij}^{\otimes}(P)+\beta \max_i \max_j D_{ij}^{\otimes}(P)}{D_{ij}^{\otimes}(P)+\beta \max_i \max_j D_{ij}^{\otimes}(P)}$$

(15)

So grey correlation coefficient $\xi_{ij}^{\otimes}(P)$ between indicator j of teaching quality guarantee of object under evaluation P and the most frequent level of state Lv_i teaching quality guarantee is:

$$\rho_i^{\otimes}(P)=\sum_{j=1}^{n}\left(w_j * \xi_{ij}^{\otimes}(P)\right)$$

(16)

If the weight is considered, the weighed grey correlation degree $\rho_i^{\otimes}(P)$ between indicator j of teaching quality guarantee of object under evaluation P and the most frequent level of state Lv_i teaching quality guarantee is:

According to the grey correlation degree $\rho_i^{\otimes}(P)$, the closeness between object under evaluation P and the most frequent level of state of teaching quality guarantee can be figured out. The bigger the grey correlation degree is, the closer the two is. And vice versa. If there is:

$$\rho_0^{\otimes}(P)=max\left(\rho_1^{\otimes}(P),\rho_2^{\otimes}(P),\cdots,\rho_m^{\otimes}(P)\right)=\rho_k^{\otimes}(P)$$

(17)

It means the level of state of teaching quality of object under evaluation P is at Lv_k

4. The Model and the Algorithm

This paper takes stage assessment of newly recruited teachers of a key university implementing talent training as the example to test the teaching quality guarantee model of talents training based on grey correlation analysis. After summarizing and analyzing data handed in by newly recruited teachers, and based on feedbacks from assessment experts, supervisors and students, the performance of newly recruited teachers is available to see, as shown in Table 4.

Table 4. Performance of Newly Recruited Teachers

Criteria layer	Index layer	Performance
R_1	r_{11}	0.80-0.90
	r_{12}	0.80-0.90
	r_{13}	0.70-0.80
	r_{14}	0.80-0.90
R_2	r_{21}	0.70-0.80
	r_{22}	0.60-0.70
	r_{23}	0.80-0.90
	r_{24}	0.70-0.80
	r_{25}	0.80-0.90
	r_{26}	0.60-0.70
	r_{27}	0.70-0.80
R_3	r_{31}	0.50-0.60
	r_{32}	1
	r_{33}	3
	r_{34}	1
	r_{35}	0.85
	r_{36}	0.80-0.90
	r_{37}	0.80-0.90

Considering opinions from experts and leaders, the classical domains of different levels of state is constructed as shown in Table 5.

Table 5. State Sets and Classical Domain

Criteria layer	Index layer	Classical domain				
		Lv_1			Lv_1	
R_1	r_{11}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{12}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{13}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{14}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
R_2	r_{21}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{22}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{23}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{24}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{25}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6

	r_{26}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{27}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
R_3	r_{31}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{32}	3	2	1	0.5	0
	r_{33}	5	4	3	2	1
	r_{34}	3	2	1	1	0
	r_{35}	90-100	80-90	70-80	60-70	0-60
	r_{36}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6
	r_{37}	0.9-1.0	0.8-0.9	0.7-0.8	0.6-0.7	0-0.6

After standardization of the abovementioned data, we can get the grey correlation coefficient (See Table 6) and the grey correlation degree (See Table 7) through calculation.

Table 6. Grey Correlation Coefficient

Criteria layer	Weight	Index layer	Weight	Grey correlation coefficient				
				Lv_1				
R_1	0.162	r_{11}	0.265	0.733	1.000	0.733	0.579	0.355
		r_{12}	0.265	0.733	1.000	0.733	0.579	0.355
		r_{13}	0.220	0.579	0.733	1.000	0.733	0.379
		r_{14}	0.250	0.733	1.000	0.733	0.579	0.355
R_2	0.529	r_{21}	0.168	0.579	0.733	1.000	0.733	0.379
		r_{22}	0.106	0.478	0.579	0.733	1.000	0.440
		r_{23}	0.159	0.733	1.000	0.733	0.579	0.355
		r_{24}	0.150	0.579	0.733	1.000	0.733	0.379
		r_{25}	0.142	0.733	1.000	0.733	0.579	0.355
		r_{26}	0.142	0.478	0.579	0.733	1.000	0.440
		r_{27}	0.133	0.579	0.733	1.000	0.733	0.379

R_3	0.309	r_{31}	0.137	0.454	0.526	0.625	0.769	0.571
		r_{32}	0.118	0.425	0.500	1.000	0.742	0.500
		r_{33}	0.098	0.500	0.800	1.000	0.500	0.333
		r_{34}	0.137	0.333	0.500	1.000	1.000	0.500
		r_{35}	0.167	0.769	1.000	0.769	0.625	0.377
		r_{36}	0.186	0.769	1.000	0.769	0.625	0.377
		r_{37}	0.157	0.769	1.000	0.769	0.625	0.377

Table7. Grey Correlation Degree

	Grey correlation degree				
	Lv_1	Lv_2	Lv_3	Lv_4	Lv_5
R_1	0.6991	0.9413	0.7917	0.6129	0.3603
R_2	0.6003	0.7752	0.8534	0.7529	0.3870
R_3	0.5992	0.7880	0.8308	0.6977	0.4306
Comprehensive correlation degree	0.6160	0.8061	0.8364	0.6206	0.3961

5. Conclusion

This paper discusses the evaluation of teaching quality of talent training in colleges and universities and proposes a teaching quality guarantee model of talents training based on grey correlation analysis. A new type of teaching quality guarantee system is constructed on the basis of different phases of teaching mode implementation, which supports the framework for the evaluation of teaching quality and enhances the reliability of the evaluation. The grey correlation coefficient and the grey correlation degree between indicators and levels of state are obtained based on grey correlation analysis. And teaching quality of the object under evaluation is confirmed according to the grey correlation degree. What's more, the model has clear physical definitions, easy to compute and easy to achieve on the computer.

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