A Preliminary Study on the Construction of Teaching Quality Evaluation System for Postgraduates in Local Colleges and Universities

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Abstract—**The key to improve the cultivation ability of postgraduates is to establish the computer-aided evaluation system. Also it takes students evaluation, peer evaluation, expert evaluation and self-evaluation into consideration. This paper is based on the methods of principal component analysis and fuzzy comprehensive evaluation, which is based on the analysis of data, such as the quality of postgraduate teaching and the single form of quality evaluation, and other means, supplemented by computer-aided evaluation system to establish a multi-subject, sustained, dynamic, scientific and efficient evaluation model set for promoting the comprehensive evaluation of quality evaluation system.**

Keywords—The quality of teaching; Evaluation model; Establishment; Innovation

I. INTRODUCTION

Now university teacher pay more attention to scientific research and ignore teaching, so it is difficult to improve teaching quality. So there is a great difference among teachers comprehensive quality. This paper intends to construct a three-dimensional teaching quality evaluation system, which can feedback teacher's weakness in teaching, so as to promote the quality of teaching.

The reform of the evaluation system aims to improving teachers teaching level and innovation abilities. It is suggested to cast off the early students' participation in evaluation. Meanwhile, it emphasizes the continuous evaluation. All of this is to make teacher have a full understanding of teaching [1].

II. THE IMPROVEMENT OF SINGLE STUDENT EVALUATION SYSTEM

Teaching quality optimization is a continuous dynamic process, the appropriate evaluation criteria and scientific evaluation methods can make teaching activities become a structured, systematic, spiral rise of the control process [2]. Exemplified by the Shandong University of Science and Technology, the original postgraduate teaching quality evaluation system only covers student evaluation. Although student evaluation has a certain effect on the quality of teaching, students are not completely rational subjects, they may be affected by knowledge, emotional factors and teaching service environment. The individual feelings mixed in the teacher evaluation will reduce the credibility and completeness of the teachers' evaluation conclusion [3].

In this paper, the existing graduate student evaluation system has been further adjusted and perfected to establish a comprehensive, multi-angle teaching quality evaluation system.

A. Principal component analysis is the key indicator of student evaluation

When graduate students evaluate teachers' teaching quality, they will get related indicators, and grade each question item by item. Taking Shandong University of Science and Technology as an example, this paper points out the several factors influencing the students' assessment, and the related data is shown in the following table:

TABLE I.   STUDENT COMMENTARY DATA DESCRIPTION AND IMPACT FACTOR TABLE

Ordinal number	Column number	Original data description	Impact factor
1	C	Be enthusiastic and careful about teaching and lectures	Teaching enthusiasm
2	D	Clear minded, standard mandarin, language specification	Lecture ideas
3	E	Help students learn and live Teaching content is diversified, and large amount of information	Words and deeds
4	F	Teaching content is substantial, and of large amount of information	Course Contents
5	G	Better organize classroom teaching or effective use of various teaching media	Organize the classroom
6	H	Use flexible teaching method and communicate with students	Flexible method
7	I	Teaching in accordance with their aptitude, pay attention to the cultivation of students' innovative ability	Teaching in accordance with their aptitude
8	J	Harmonious relationship between teachers and students, class and outside the study better	Relatively harmonious relationship
9	K	Explain the students' curiosity	Stimulate knowledge
10	L	Pay attention to the guidance of students' learning methods and the cultivation of ways of thinking	Cultivate thinking
11	M	Connect theory with practice, good at absorbing the cutting edge of the subject results	Subject frontier

By calculating the correlation coefficient matrix, the eigenvalues of the covariance matrix and the cumulative variance contribution of the principal components are obtained to compute the component matrix, as shown in the following table:

TABLE II.   COMPOSITION MATRIX

Index	Ingredient					Index	Ingredient				
	1	2	3	4	5		1	2	3	4	5
Zscore(Teaching enthusiasm)	.251	.922	-.255	.205	-.004	Zscore(Teaching in accordance with their aptitude)	.201	.206	.851	-.082	.027
Zscore(Lecturing ideas)	.908	-.395	-.021	.410	.049	Zscore(Relatively harmonious relationship)	-.130	-.367	.155	-.080	.887
Zscore(Words and deeds)	.863	.287	.222	.181	.026	Zscore(To stimulate knowledge)	.127	.004	.953	-.259	-.030
Zscore(Course Contents)	-.094	.196	-.335	.958	-.058	Zscore(Cultivate thinking)	-.054	.267	-.049	.160	.939
Zscore(Organize the classroom)	.929	.195	-.066	.156	-.054	Zscore(Subject frontier)	.959	.037	.479	-.208	-.283
Zscore(Flexible method)	.351	.340	.869	-.028	.073	Extraction method: principal component. a. 5 ingredients have been extracted.					

According to the variance contribution rate of each principal component, the weight of each influencing factor in each key index is given as follows:

TABLE III. WEIGHT OF THE MAJOR INFLUENCING FACTORS IN KEY INDICATORS

Key indicators	Column number	The main influencing factor	Variance contribution rate	Weights
Basic quality	D	Lecturing ideas	0.908	0.249
	E	Words and deeds	0.863	0.235
	G	Organize the classroom	0.929	0.253
Teaching attitude	M	Subject frontier	0.959	0.263
	C	Teaching enthusiasm	0.922	1
Teaching method	H	Teaching enthusiasm	0.869	0.325
	I	Teaching in accordance with their aptitude	0.851	0.318
Teaching content	K	To stimulate knowledge	0.953	0.357
	F	Course Contents	0.958	1
Teaching and educating people	J	Relatively harmonious relationship	0.887	0.486
	L	Thinking training	0.939	0.514

B. Determining the Weight of Students' Evaluation of Teaching by Variation Coefficient Methods

In the evaluation index system, in general, the difference between the indicators of indicators and implementation is inverse proportional to the realization. Because these indicators can more fully reflect the difference between the evaluation units [4]. Therefore, it is necessary to determine the weight of the evaluation index of the graduate students through the coefficient of variation of the indicators and the variance of the indicators.

C. Linear weighting determines the student evaluation fee

Here, the score P_j (Define $j = 1, 2, \cdots, 64714$) consists of the first set of school students in the evaluation of each line (that is, each student effective score). Each line includes teaching attitude, teaching methods, teaching content and teaching and educating the five indicators of the value of (Define $j = 1, 2, \cdots, 64714$) [5].

By using the weight of each key indicators, students get assessment function as follows :

$$P_j = f(L_{1j}, L_{2j}, L_{3j}, L_{4j}, L_{5j}) = \sum_{i=1}^{5} W_i L_{ij}. \tag{1}$$

Log is the assessment score of the Line i in the No.i index, all the data in Line I are added up to Pj. Wj is the weight of No.i index , in accordance to $\Sigma = 1$.

D. Entropy Method to Determine the Correction Factor of Students' Evaluation of Teaching

When a student scores a teacher, if the variance exceeds 0.15, the greater the variance is, the more the reliability of the student's score is, so is the weight of the score. At the same time, if the score appears C or less (lowest score), then the score of the reference value is relatively large, and can be considered. Based on the above two considerations, the correction factor for each teacher's score can be amended.

According to the data entropy, the smaller the data is, the greater the variance of the score is, and the more the reliability

of the student score is, therefore the teacher corresponding weight gain becomes higher. In the score C or less (lowest score), then the score of the reference value is relatively large, a larger dynamic right can get.

1) Converts the raw data into a probability matrix

As the probability of one teaching quality indicator within the data entropy formula, the matrix (Xij) has to be normalized, so it can be treated as the 'probability' of teaching quality indicator [6], the calculation formula is as follows:

$$p_{ij} = \frac{X_{ij}}{\sum_{j=1}^{n} X_{ij}}. \tag{2}$$

where the pij is the probability of jth teacher at ith indicator, xij is the original data of the jth indicator of the ith teacher

2) Calculate the data entropy of ith indicator of teaching evaluation

The computation formula is as follows:

$$H_i = -k \sum_{j=1}^{n} p_{ij} In p_{ij}. \tag{3}$$

where K=1/inn, pij is the probability of jth teacher at the ith indicator3 Student correction factor

The term gi is the change rate of ith indicator's weight, that is, the correction factor of teaching assessment:

$$g_i = \frac{1 - H_i}{m - \sum_{i=1}^{m} H_i}. \tag{4}$$

where Hi, whose value can be obtained formula (6), is the data entropy of ith indicator. By the formula (4), we can see that, gi rises as H decreases, which indicates the teaching quality indicator transits more information and plays a better role in the process.

III. MULTI-FACTOR TEACHING EVALUATION SYSTEM DESIGN

First-level Fuzzy Comprehensive Evaluation is a multi-factor evaluation method using a single level. (And? Whereas?)The Fuzzy Comprehensive Evaluation firstly considers each single factor separately, and then make a comprehensive assessment of these results. We utilize students', colleagues', professionals' and self evaluation as factors, and give the comprehensive evaluation structure as follows:
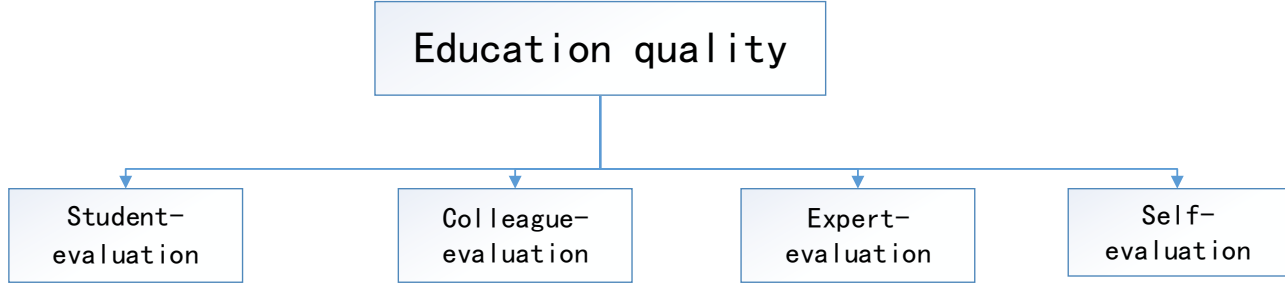

Fig. 1. Teaching quality evaluation system level evaluation structure diagram

A. *Multi-factor Fuzzy Comprehensive Evaluation*

1) *Determine the operators*

Firstly, Fuzzy Comprehensive Evaluation Model has the form as follows:

$$W \bullet R = W = \{w_1, w_2, \cdots, w_n\} \bullet \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} = (b_1, b_2, \cdots, b_m) \overset{\Delta}{=} B. \tag{5}$$

where B is the model comprehensive evaluation set, bj () is the evaluation indicator, and the symbol " within B=W"R is the operator, we choose weighted operator average model M (",") :

$$b_k = (w_1 \bullet r_{1k}) \oplus (w_2 \bullet r_{2k}) \oplus \cdots \oplus (w_n \bullet r_{nk}) = \min \left\{ 1, \sum_{j=1}^{n} \min(w_j, w_{jk}) \right\}. \tag{6}$$

(k=1, 2,..., p).

2) *Analysis for the evaluation result vector*

For analysis of Fuzzy Evaluation result, the Principle of Maximum Membership, Maximum Proximity Principle and Weighted Average Principle are commonly used. We apply Fuzzy Vector Uniformization and Multi-level Fuzzy Comprehensive Evaluation here. For there are too many factors in teaching quality evaluation, we have to make Multi-level Fuzzy Evaluation here to separate the factor domain(indicator) into S sets according to certain property [7].

$$X = \bigcup_{j=1}^{n} X_j. \tag{7}$$

where j=1, 2,...,s, and Xj={}. Consider Xj as a comprehensive factor, the membership matrix, as the single-factor evaluation result of Xj, is as follows:

$$\tilde{R} = \begin{bmatrix} \tilde{B}_1 \\ \tilde{B}_2 \\ \vdots \\ \tilde{B}_S \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1p} \\ r_{21} & r_{22} & \cdots & r_{2p} \\ \vdots & \vdots & & \vdots \\ r_{s1} & r_{s2} & \cdots & r_{sp} \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1p} \\ r_{21} & r_{22} & \cdots & r_{2p} \\ \vdots & \vdots & & \vdots \\ r_{s1} & r_{s2} & \cdots & r_{sp} \end{bmatrix}. \tag{8}$$

Given the the fuzzy weight vector of comprehensive factors B, we have the Two-level Fuzzy Comprehensive Evaluation Model as follows:

$$W \circ \tilde{R} = (w_1, w_2, \cdots, w_s) \circ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1p} \\ r_{21} & r_{22} & \cdots & r_{2p} \\ \vdots & \vdots & & \vdots \\ r_{s1} & r_{s2} & \cdots & r_{sp} \end{bmatrix} = (b_1, b_2, \cdots, b_p) \overset{\Delta}{=} \tilde{B}. \tag{9}$$

B. The improvement of the other index system

We can improve the teaching quality evaluation system from the three aspects of peer evaluation, expert evaluation and self-evaluation, so that the whole evaluation model system is more reasonable. For each type of evaluation being in accordance with the above model for processing, we can improve the evaluation system accordingly.

C. Gray Correlation Determines Weight and Total Score Function

Based on the fuzzy comprehensive evaluation, the gray comprehensive analysis is used to determine the weight of each layer of fuzzy comprehensive evaluation. In this way, the fuzzy comprehensive evaluation method is established based on gray relational degree [8].

According to the above calculation data, we can reach four layers of evaluation indicators of the weight. As shown in the following table:

TABLE IV.   WEIGHT OF FOUR LAYERS OF INDICATORS

Index	Student evaluation	Colleague evaluation	Expert evaluation	Self-evaluation
proportion	0.313	0.332	0.217	0.138

The analysis shows that in the evaluation of teaching quality of teachers in colleges and universities, colleagues and students have the most contact with teachers, so their evaluations have more reference value, corresponding to the above weight, which shows that the weight setting meets the actual situation in daily life.

Firstly, we denote the total grade of teachers in the college as Gradei (i=1,2,...,323), and denote the students', colloges', professionals' and self assessments as wi (i=1,2,...,4) respectively, whose values have been given by table 11. As the result, we obtain the total grade of ith teacher by following equation:

$$Grade_i = F(Grade(Stu)_i, Grade(Tea)_i, Grade(Exp)_i, Grade(Sel)_i) = \sum_{j=1}^{4} \omega_j Grade_{ij}. \tag{10}$$

where wi is the weight before jth one-level indicator, and satisfies $\Sigma w_j = 1$, Grade(Stu)i is the students' evaluation, Grade(Tea)i is the colleagues' evaluation, Grade (Exp) i is the professionals' evaluation, and the Grade(Sel)i is the self-assessment of the ith teacher [9].

Obviously the formula utilize the weight of different one-level indicators, and efficiently combines these four indicators, making the joint effect to teaching quality.IV, The improvement of the teaching evaluation system.

1) Establish a more comprehensive and objective evaluation model

We modify the old students' evaluation method, including 'student evaluation', 'teaching attitude', 'teaching method', 'content of courses', and 'impart knowledge and educate people' into the students' teaching evaluation system. The modified structure is as.
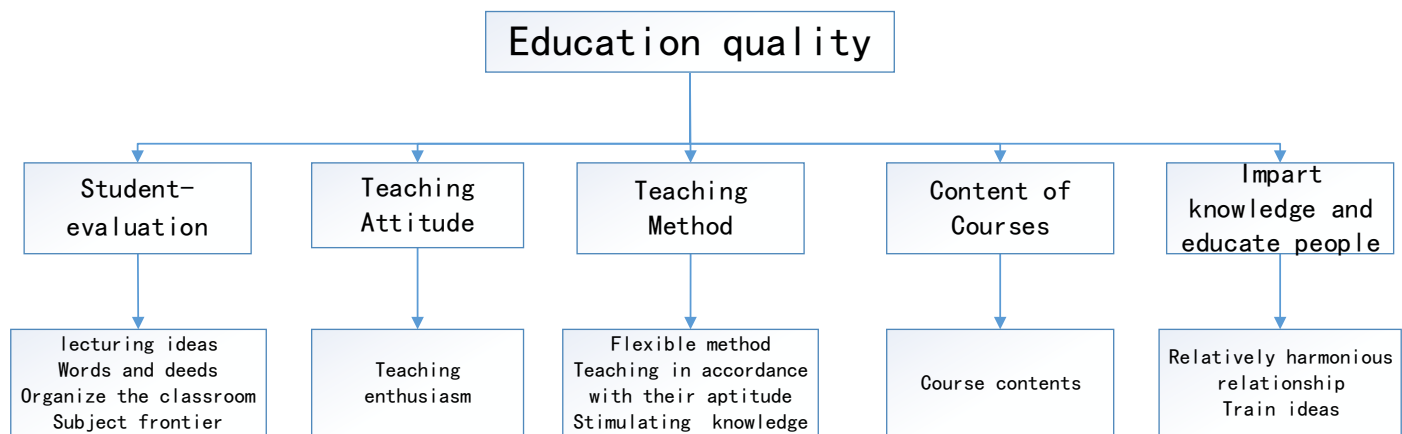
Fig. 2.   Students' two-story structure

In order to attract graduates to participate into evaluation, we adapt multi-factor students' teaching-evaluation model. Based on the tech of the Principle Component Analysis (PCA), and further take the effect of different population and different student's evaluation, the model becomes more reasonable.

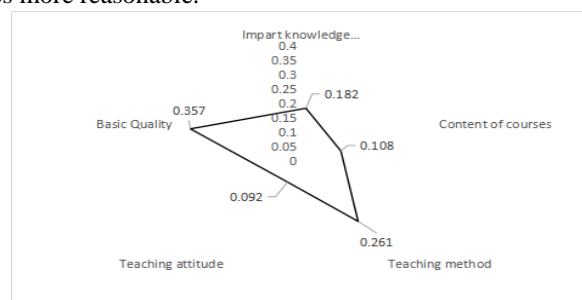According to the measurement, we weight the five vital indicators as the following spider chart:

Fig. 3.   Indicator weight radar map

2)   Establish a more three-dimensional evaluation system that is comprehensive, transparent and scientific

In order to obtain a more three-dimensional and objective evaluation system, there will be student evaluation, peer evaluation, expert evaluation and self-evaluation and other factors to join, so as to improve the entire teaching quality evaluation system [10], get the following architecture diagram:
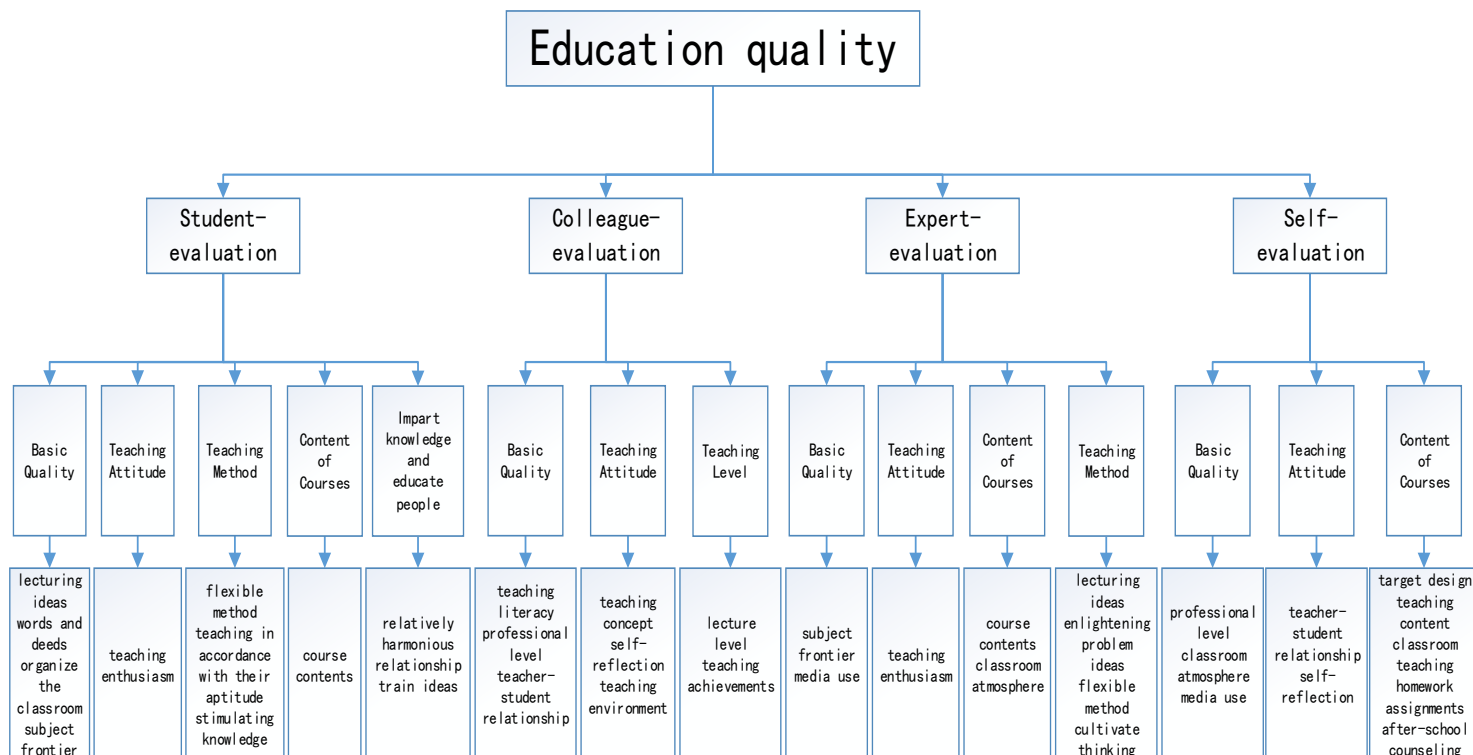
Fig. 4. Overall teaching quality evaluation system structure chart

We take a lot of JQUERY and AJAX technology into consideration in fuzzy comprehensive evaluation method so as to make the teacher and student experience more effective. Make full use of convenient network resources, experience the student-teacher interactive platform, and run the orthodox educational management system for a seamless connection, using the same basic CSS style and habits, we provide an example for the functional expansion of educational administration system in the future. The teaching quality evaluation model, through the analysis of large data analysis and data mining, is established, based on the principal component analysis method, the variance coefficient method, the TOPSIS method, the entropy method as well as the fuzzy comprehensive evaluation method.

IV. CONCLUSION

The preparation work of the evaluation system has an important influence on the evaluation result, which requires the evaluation subject to clarify the importance of this evaluation to the teachers before evaluation. It pays more attention to the response of both sides and helps teachers improve teaching quality through communication. After the implementation of the evaluation system, teacher will pay more attention to teaching quality and assessment criteria. Through the modification of the subject and the evaluation method, the comprehensive quality of teacher and the classroom effect on students have been greatly improved. The evaluation system combined the credit system reform, and the joint software company redeveloped, we realize the complete connection between the original teaching management information system and newly one. Software companies, on this model, plans to develop teaching quality evaluation system that is more suitable for teachers in the institutions and universities so as to widely make the evaluation system into application.

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