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Comprehensive Evaluation of University Teachers' Teaching Quality under Fuzzy Environment

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Abstract

Teaching is one of the core works in universities, and the comprehensive evaluation on teachers' teaching quality has a vital significance to improve universities' teaching quality. In this paper, the problem of comprehensive evaluation on university teachers' teaching quality under fuzzy environment is studied. Concretely, a new evaluation system for teaching quality evaluation is established, and a fuzzy multi-attribute decision making method based on linguistic 2-tuple is presented to evaluate the teaching quality for all alternative university teachers. Finally, a numerical example is given to demonstrate the practicality and effectiveness of the proposed method.

Keywords

Teaching Quality; Comprehensive Evaluation; Fuzzy Multi-Attribute Decision Making Method; Linguistic 2-tuple

Introduction

With the deepening of education reform in the world, how to improve the education quality and train high quality talents, has become hot issues which should be concerned by the academical circles and society. The level of the university teaching quality decides the quality level of personnel training. Therefore, to improve the teaching quality is the inevitable requirement of training innovative talents with high quality in colleges and universities.

In the world, many universities have attached great importance to the improvement of teaching quality (Wei, 2012). To make full and accurate evaluation to the teachers' teaching quality, is a core work in the university human resources management and teaching management, which can let the university teaching and management decisions be close to the actual situation of the universities, and ensure that managers to solve the practical problems on the basis of scientific decision-making. It has a pivotal role on the long-term development of the universities.

In addition, to make scientific and reasonable comprehensive evaluation for teachers' teaching quality in colleges and universities plays a pivotal role for the university management decision-making of teachers and strategy decision of teachers' personal development. It has the functions of orientation, identification, improvement, motivation and management, which can be reflected in the following respects (Stronge, 2006; Wei, 2012). First, the comprehensive evaluation in time can regulate the behavior of teachers' teaching, make the teacher get comprehensive teaching feedback information, help teachers to summarize the experience and lesson in teaching, improve teaching work in time, and enhance the sense of responsibility and the dedication to work, so as to promote teachers to improve teaching methods, improve teaching quality and ensure teaching quality. Second, the comprehensive evaluation gives the guidance for the teachers' personal development. Finally, it can provide the basis of the inspection for teaching management in colleges and universities, and provide scientific basis for the decision-making management. Also, it helps to form and perfect the supervision mechanism of teaching quality, and finally achieves the purpose of improving teaching quality.

Generally, many complex factors reflect the teaching quality of university teachers. So it is important to establish a scientific and reasonable evaluation system for evaluating teachers' teaching quality, which can truly achieve the accurate evaluation for the teachers' teaching quality. In this paper, we present a new evaluation system for teaching quality evaluation from the aspects of teaching attitude, teaching appearance, teaching content, teaching methods and teaching effect, and then propose a fuzzy multi-attribute decision making method based on linguistic 2-tuple to evaluate the teaching quality for all alternative university teachers. Our contribution is thus to provide a theoretical basis and decision-making reference to help

the teaching management department make scientific decision in the comprehensive evaluation for the teachers' teaching quality under fuzzy environment.

The rest of the paper is organized as follows. Section 2 describes the problem and presents the evaluation system for teaching quality evaluation. Section 3 presents a fuzzy multi-attribute decision making method based on linguistic 2-tuple under a fuzzy environment. In section 4, we present a numerical application example to show the feasibility of the proposed decision method. Section 5 concludes the paper.

Evaluation System for Teaching Quality Evaluation

We now establish an evaluation system for evaluating the university teachers' teaching quality. In this paper, drawing from the existing related research, we take the following atrrtributes as the evaluation system into account.

A_1 Teaching attitude, which can be measured by the following aspects. (i) Be a model for others, care and strict with students, and listen to the students' opinions and suggestions; (ii) Give a class on time, have a class in strict accordance with the teaching progress, do not optionally switch classes; (iii) Do not reduce class hours, no absenteeism, do not late and leave early.

A_2 Teaching appearance, which means that the teacher has passion and high spirit in class, and his lectures can regulate students' mood and make the topics atmosphere active.

A_3 Teaching content, which can be measured by the following aspects. (i) The teacher's lesson plans is wrote seriously, and the content is qualified; (ii) The teaching is right, clear and strong systemic; (iii) The analysis and exposition is accurate, and the heavy difficulty is outstanding and the problem of explaining is enlightening; (iv) The lesson is given by theory with practice, and is not only from the book; (v) The lesson can fully embody the frontier disciplines development, reflect the new trend of subject development and absorb the latest achievements of the disciplines.

A_4 Teaching methods, which refers to the following aspects, i.e., the teaching means is applied proper, the teacher can effective use of all kinds of advanced teaching tools, the class focuses on student ability training and encourages innovation, and the teaching method is flexible, vivid and effective.

A_5 Teaching effect, which means that the teaching have remarkable power which can arouse the enthusiasm of students in study, and let students accept and master knowledge better, and let students apply the course knowledge in the new curriculum better.

The above 5 attributes form the evaluation index system to evaluate the university teachers' teaching quality. In the practical evaluation decision, the expert group can synthetically consider the performance of multiple attributes and then give the evaluation values for each university teacher in the form of fuzzy linguistic variables "best, good, acceptable, poor, worst". Moreover, these attributes are all benefit type attributes, i.e., the higher the attribute value, the better is the teaching quality for the corresponding university teacher.

The Comprehensive Evaluation Method

The problem of comprehensive evaluation on university teachers' teaching quality can be described as follows.

Suppose that an expert group in one university wants to evaluate the teaching quality for m university teachers. The set of the alternative university teachers is denoted as $T = \{T_1, T_2, \mathrm{K}, T_m\}$. The above 5 attributes given in above section are used to evaluate the teaching quality of m university teachers. The set of evaluation attributes is denoted as $A = \{A_1, A_2, \mathrm{K}, A_5\}$, and the set of weights for these attrubutes is denoted as $w = \{w_1, w_2, \mathrm{K}, w_5\}$, which satisfies $0 \le w_j \le 1$ and $\sum_{j=1}^{5} w_j = 1$.

Suppose that the evaluation value for teacher i (i=1, 2, …, m) with respect to attribute A_j (j=1, 2, …,5) given by expert group is a fuzzy linguistic variable r_{ij} such as best, good, acceptable, poor and worst. The original decision matrix given by the expert group is denoted as $R = (r_{ij})_{i\times 5}$.

By considering the original decision matrix is formed by fuzzy linguistic variables, thus next we will present a fuzzy multi-attribute decision making method based on linguistic 2-tuple to evaluate the teaching quality of m university teachers according to the information in original decision matrix $R = (r_{ij})_{i\times 5}$.

Preliminaries

The 2-tuple linguistic representation model, proposed

by Herre-ra and Martínez in 2000. In this section, we first review some concepts of the 2-tuple.

Let $S=\{s_0,s_1,\mathrm{K},s_t\}$ be a linguistic term set with odd cardinality. Any label, s_i represents a possible the value for a linguistic variable, and it should satisfy the following characteristics (Herrera & Martí-nez, 2000; Wei, 2010; Wan, 2013; Park & Kwun, 2013):

(1) The set is ordered: $s_k \ge s_l$, if $k \ge l$;

(2) Max operator and Min operator. If $s_k > s_l$, then $\max(s_k,s_l)=s_k$, $\min(s_k,s_l)=s_l$.

In this paper, the five linguistic fuzzy variables, i.e., best, good, acceptable, poor and worst form a linguistic evaluation set $S=\{s_0,s_1,\mathrm{K},s_4\}$, where s_0 = Worst, s_1 = Poor, s_2 = Acceptable, s_3 = Good, and s_4 = Best.

Herrera and Martinez (2000) also defined the transformation function between the numeric values and 2-tuples, and the transformation function between the linguistic fuzzy variables and 2-tuples. They are shown in the following definitions.

Definition 1. Let $S=\{s_0,s_1,\mathrm{K},s_t\}$ be a known linguistic evaluation set, and $\beta\in[0,t]$ be a real number which is a value supporting the result of a symbolic aggregation operation, then $\beta\in[0,t]$ can be transformed into an equivalent linguistic 2-tuple by the following function Δ:

$$\Delta:[0,t]\to S\times[-0.5,0.5),\ \Delta(\beta)=(s_k,a_k),$$

where

$$\begin{cases} k=round(\beta) \\ a_k=\beta-k, \quad a_k\in[-0.5,0.5) \end{cases}$$

and "round" is the usual rounding operation. Conversely, for a known linguistic 2-tuple (s_k,a_k), there is an inverse function Δ^{-1} such that from a 2-tuple (s_k,a_k) it returns its equivalent numerical value $\beta\in[0,t]$, i.e.,

$$\Delta^{-1}:S\times[-0.5,0.5)\to[0,t],$$

$$\Delta^{-1}(s_k,a_k)=k+a_k=\beta.$$

From Definition 1, we can conclude that the conversion of a linguistic variable into a linguistic 2-tuple consists of adding a value 0 as symbolic translation:

$$\theta(s_k)=(s_k,0),\ s_k\in S. \tag{1}$$

Moreover, Herrera and Martínez (2000), Zhang (2013) defined the comparison of linguistic information represented by 2-tuples.

Definition 2. Let (s_k,a_k) and (s_l,a_l) be two linguistic 2-tuples, with each one representing a counting of information, then: If $k>l$, then $(s_k,a_k)>(s_l,a_l)$. If $k=l$, then (i) If $a_k=a_l$, then $(s_k,a_k)=(s_l,a_l)$; (ii) If $a_k<a_l$, then $(s_k,a_k)<(s_l,a_l)$. (iii) If $a_k>a_l$, then $(s_k,a_k)>(s_l,a_l)$.

In order to aggregate multiple 2-tuples, Herrera et al. (2005) defined the following weighted averaging (*TWA)* operator.

Definition 3. Let (s_1,a_1), (s_2,a_2), …, (s_n,a_n) be n linguistic 2-tuples, then the 2-tuple weighted averaging (*TWA)* operator is defined as

$$\begin{aligned} &TWA_W((s_1,a_1),(s_2,a_2),\mathrm{K},(s_n,a_n)) \\ &=\Delta\left(\sum_{j=1}^{n} w_j\Delta^{-1}(s_j,a_j)\right) \end{aligned} \tag{4}$$

where $w=\{w_1,w_2,\mathrm{K},w_n\}$ is the weight vector of 2-tuples (s_j,a_j), $j=1,2,\mathrm{K},n$, such that $0\le w_j\le 1$ and $\sum_{j=1}^{n} w_j=1$.

The Decision Method Based on 2-tuple

Based on above 2-tuple linguistic representation model, now we present a fuzzy multi-attribute group decision making method to evaluate the teaching quality of alternative university teachers. The detailed decision steps are given as follows.

Step 1: The expert group gives the evaluation ratings for *m* alternative university teachers, and the original decision matrix $R=(r_{ij})_{i\times 5}$ is found.

Step 2: Use the transformation method given by (1) to transform the original decision matrix $R=(r_{ij})_{i\times 5}$ into linguistic 2-tuple decision matrix $\tilde{R}=((r_{ij},0))_{i\times 5}$.

Step 3: Use the *TWA* operator given in Definition 3 to aggregate all evaluation values under 5 evaluation attributes in matrix $\tilde{R}$ into one comprehensive evaluation value r_i of the alternative teacher T_i (*i*=1, 2, …, *m*), i.e.,

$$\begin{aligned} r_i&=(s_i,a_i) \\ &=TWA_W((r_{i1},0),(r_{i2},0),\mathrm{K},(r_{i5},0))=\Delta\left(\sum_{j=1}^{5} w_j\Delta^{-1}(r_{ij},0)\right), \end{aligned}$$

where $w=\{w_1,w_2,\mathrm{K},w_5\}$ is the weight vector of 5

evaluation attributes which satisfies $0 \le w_j \le 1$ and $\sum_{j=1}^{13} w_j = 1$.

Step 4: Use the comparison methods given by Definition 2 to rank the oder for comprehensive evaluation value r_i (i=1, 2, …, m).

Step 5: Rank the teaching quality for all alternative university teachers according to the values of 2-tuple $r_i = (s_i, a_i)$ (i=1, 2, …, m). The greater the value of $y_i = (s_i, a_i)$, the better is the teaching quality for alternative teacher i.

An Application Example

We now give a decision example to demonstrate the effectiveness of this method. Suppose that an expert group in one university wants to evaluate the teaching quality for five university teachers. The above five evaluation attributes, Teaching attitude (A_1), Teaching appearance (A_2), Teaching content (A_3), Teaching methods (A_4) and Teaching effect (A_5) are used to evaluate the teaching quality, and the set of weights for these attrubutes are denoted as w=(0.1, 0.1, 0.3, 0.3, 0.2). The original decision matrix $R = (r_{ij})_{5\times5}$ given by the expert group is shown in Table 1.

TABLE 1 ORIGINAL DECISION MATRIX R

Teacher	A_1	A_2	A_3	A_4	A_5
T_1	s_3	s_2	s_3	s_4	s_2
T_2	s_4	s_3	s_3	s_4	s_4
T_3	s_3	s_4	s_4	s_3	s_3
T_4	s_4	s_3	s_3	s_3	s_2
T_5	s_4	s_4	s_3	s_2	s_4

The following steps are involved to evaluate the teaching quality of five teachers.

(1) Transform the original decision matrix $R = (r_{ij})_{5\times5}$ into linguistic 2-tuple decision matrix $\tilde{R} = ((r_{ij}, 0))_{5\times5}$ as follows.

TABLE 2 LINGUISTIC 2-TUPLE DECISION MATRIX $\tilde{R}$

Teacher	A_1	A_2	A_3	A_4	A_5
T_1	(s_3, 0)	(s_2, 0)	(s_3, 0)	(s_4, 0)	(s_2, 0)
T_2	(s_4, 0)	(s_3, 0)	(s_3, 0)	(s_4, 0)	(s_4, 0)
T_3	(s_3, 0)	(s_4, 0)	(s_4, 0)	(s_3, 0)	(s_3, 0)
T_4	(s_4, 0)	(s_3, 0)	(s_3, 0)	(s_3, 0)	(s_2, 0)
T_5	(s_4, 0)	(s_4, 0)	(s_3, 0)	(s_2, 0)	(s_4, 0)

(2) Use the *TWA* operator to aggregate all evaluation values under five evaluation attributes in matrix $\tilde{R}$ into comprehensive evaluation value r_i (i=1, 2, 3, 4, 5), the computation results are as follows.

$$r_1 = (s_3, 0),\ r_2 = (s_4, -0.4),\ r_3 = (s_3, 0.4),$$
$$r_4 = (s_3, -0.1),\ r_5 = (s_3, 0.1).$$

(3) Rank the teaching quality of all alternative teachers in accordance with the 2-tuple $r_i = (s_i, a_i)$ (i=1, 2, 3, 4, 5). Since $r_2 > r_3 > r_5 > r_1 > r_4$, the optimal and worse order of teaching quality for five alternative teachers is B_2 f B_3 f B_5 f B_1 f B_4.

Conclusions

In this paper, we present a new evaluation system, and propose a fuzzy multi-attribute group decision making method based on linguistic 2-tuple to evaluate the teaching quality of university teachers under fuzzy information environment. The application example shows that our method can effectively avoid the loss and distortion of information in the process of information gathering, and the comprehensive evaluation results have definite and specific meanings. Also, it is simple in computing and easy to carry out in computers. Therefore, it has a good theoretic value and applied value in practice.

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