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Comprehensive Evaluation Method to PE Teachers Based on TOPSIS

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Abstract: Comprehensive evaluation to PE teachers is an important issue in both theoretical and practical levels. For this reason, a comprehensive evaluation method is proposed to PE Teachers based on the TOPSIS. In this proposed approach, the multiple attribution decision making mathematics model of hierarchy TOPSIS is constructed and the entropy power process is adopted to solve index power coefficient. At final, the typical example indicates that this proposed approach is effective and feasible.

Key words: Comprehensive evaluation, PE teacher, TOPSIS

INTRODUCTION

Evaluation is to make judgments about the values of persons or things, namely, a process of making a value judgment on the quality, level, benefits and social meaning of evaluation objects through collecting data systematically according to a standard of value. Since the expansion of college enrolment in 1999, for a time the quality of education attracted attention. Star university teachers are a guarantee to the quality of education, while a scientific and reasonable evaluation system of university teachers plays an important role in teacher training and development. The primary purpose of this evaluation is to enhance the teaching level and the capacity of scientific research. Until 1990, four out of five colleges worldwide applied the students' evaluation of teaching. In universities, the teacher evaluation has become a common phenomenon, their individual performance and achievements in work are the evaluation basis and as a kind of value guidance, the evaluation results will encourage and guide the teachers towards the goal expected by administrators.

There are a variety of teacher evaluation methods. Based on the research status at home and abroad, there has not been a very perfect and non-controversial evaluation system which will promote the development of evaluation theory to a certain extent.

EVALUATION INDEX SYSTEM

According to the multi-objective and multi-criterion analysis principle, this evaluation system will establish a three-tiered judgment matrix evaluation system for PE teachers. The system contains seven evaluation indicators such as basic literacy, classroom teaching, teaching and research, sports competition, group activities, honors and rewards and academic writings. The first six ones are regarded as sssfirst-grade indicators according to which the second-grade and third-grade indicators are set and academic writings are set as an independent single evaluation item.

Basic literacy: The 21st century has set newer and higher demands on talents training. As educators, PE teachers should learn new knowledge and methods actively and consciously to keep pace with the times. Besides, morality should be put first in teaching, so PE teachers should continuously raise their own ideological and moral level, improve vocational ethics, enhance personality and ability and improve their psychological ability. They should develop multi-layer ethical education activities through scientific teaching methods to work on cultivating more high-leveled persons that meet the social development for our country. Its secondary indicators mainly contain ideological morality quality, vocational ethics quality, knowledge and comprehensive quality, personality and ability, psychological ability *et al*.

Classroom teaching: This indicator shows that the main responsibility of teachers is to impart knowledge and cultivate people. To make a good performance in each lesson is the pursuit of each conscientious teacher, so the evaluation on classroom teaching is an important means to promoting the development of students and teachers' profession and improving the quality of classroom teaching. As a result, it has become the basic element of modern teaching to make an effective and scientific classroom teaching evaluation. It is not only the precondition of a successful teaching but also the foundation of different education decisions. The classroom teaching of PE teachers is the key part of their teaching activities and its secondary indicators mainly contain teaching objective, teaching quality, teaching process and teaching effect.

Teaching and research: The evaluation on the teaching and research of PE teachers in this system is an important means to improving the quality of sports teaching. It can effectively raise the whole teaching level of PE teachers, thus set as the first-grade evaluation indicator with such secondary evaluation contents as teaching and research ability, teaching and research achievements *et al.*

Sports competition: Sports competition is an important feature of physical education, also a means to embodying a school's honor. It is a kind of competition played according to certain rules between persons or groups in their physical strength, skills or mentality, with sports items as contents and fighting for the win as the direct goal. It can effectively realize physical education objective through carrying out sports competition widely. As a first-grade evaluation indicator, its secondary evaluation contents mainly contain teaching training, participation, awards, *et al.*

Group activities: Group activities here refer to physical activities carried out in the university which take students as the main object and natural environment and sports facilities in the university as the material basis. It is a kind of conscious organized social activity that can enrich the campus cultural life and promote the campus civilization construction. As professional talents in group activities, PE teachers have played the key role in planning, organizing and implementing campus activities. Its secondary evaluation contents contain organization and implementation of group activities *et al.*

Honors and rewards: Winning honors and rewards itself is a kind of evaluation on teachers. As the credit and praise of some social group for the moral behavior of teachers, honors and rewards are special, qualitative and active evaluation of special organizations on special persons. As one evaluation indicator of the PE teacher evaluation system, it will make contributions to encouraging PE teachers to work more actively for physical education and its main evaluation contents contain awards items, levels and effect *et al.*

Academic writings: Academic writings refer to theoretical articles describing research achievements obtained during the research on academic problems in some scientific field. They are a significant symbol to measure the academic level and research ability of teachers. The relevant evaluation contents contain academic study contents, level and achievements *et al.*

COMPREHENSIVE EVALUATION METHOD

For the MADM problem, let M = {1,2,…,m} and N = {1,2,…,n}, suppose that the decision scheme set is $U = \{u_i\}$, the attribute set $V = \{v_j\}$, the index weight set $W = \{w_j\}$, the decision matrix $A = (a_{ij})_{m\times n}$ ($i\in M$, $j\in N$), where a_{ij} is the value obtained from the measure by scheme u_i according to index v_j, w_j is the index weight to be determined and:

$$\sum_{j=1}^{n} w_j = 1$$

then the quadruple ⟨U, V, W, A⟩ constitutes the mathematical model of MADM.

The physical dimensions of various indexes in the attribute set may be different, thus the decision matrix should be normalized by following some rules before making a decision. There are several attribute types, including the benefit-type, cost-type, fixed-type and interval-type, of which the most commonly used types are the benefit-type and the cost-type. Suppose that I_1 and I_2 are respectively the subscript sets of the benefit-type and cost-type attributes and the normalized decision matrix can be written as $B = (b_{ij})_{m\times n}$, then the normalized formulas for the benefit-type and cost-type indexes are, respectively:

$$b_{ij} = \begin{cases} \dfrac{a_{ij} - a_{i\min}}{a_{i\max} - a_{i\min}}, & j \in I_1 \\ \dfrac{a_{i\max} - a_{ij}}{a_{i\max} - a_{i\min}}, & j \in I_2 \end{cases} \tag{1}$$

In which $a_{i\max} = \max_{i\in M}\{a_{ij}\}$ and $a_{i\max} = \max_{i\in M}\{a_{ij}\}$.

Determination of index weights by entropy method. The entropy H_j for the jth index v_j calculated by the normalized decision matrix $B = (b_{ij})_{m\times n}$ is:

$$H_j = -k\sum_{i=1}^{m}(\overline{b_{ij}}\ln\overline{b_{ij}}),\ j \in N \tag{2}$$

In here, $k = (\ln m)^{-1}$:

$$\overline{b_{ij}} = \frac{b_{ij}}{\sum_{i=1}^{m} b_{ij}}$$

and suppose that when $\overline{b_{ij}} = 0\,\overline{b_{ij}}\ln\overline{b_{ij}} = 0$. The entropy weight of the j^{th} index v_j calculated by H_j is:

$$w_j = \frac{1 - H_j}{n - \sum_{j=1}^{n} H_j},\ j \in N \tag{3}$$

After the index weight is determined, the weighted normalized decision matrix can be written as $C = (c_{ij})_{m\times n}$, its computational Equation is:

$$c_{ij} = w_j \times b_{ij},\ i\in M;\ j\in N \quad (4)$$

Nearness degree computing. Here, Suppose $\Phi^+ = (c^+_i)$ and $\Phi^- = (c^-_i)$ ($j\in N$) are, respectively the positive and negative ideal points, in which:

$$c_j^+ = \max_{i\in M} c_{ij} \quad (5)$$

$$c_j^- = \min_{i\in M} c_{ij} \quad (6)$$

Written as $\Psi^+ = (d^+_i)$, $\Psi^- = (d^-_i)$, ($i\in M$), where:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(c_{ij} - c_j^+)^2} \quad (7)$$

$$d_i^- = \sqrt{\sum_{j=1}^{n}(c_{ij} - c_j^-)^2} \quad (8)$$

d^+_i and d^-_i are, respectively the nearness degrees of scheme u_i to the positive ideal point Φ^+ and the negative ideal point Φ^-. Their physical meaning is that: the smaller d^+_i and d^-_i, the larger the degrees of similarity between scheme u_i and the positive and negative ideal points, respectively.

Calculation for comprehensive index values. Suppose that the vector of the comprehensive ranking index value for scheme u_i is $Z = (z_i)(i\in M)$, in which:

$$z_i = \frac{d_i^-}{d_i^- + d_i^+} \quad (9)$$

The schemes are sorted according to the comprehensive index values and the larger the comprehensive index values, the better the schemes.

General steps of general TOPSIS. Based on the above analysis, the solving steps of TOPSIS ranking model are listed as follows:

- **Step 1:** Suppose that there is a MADM problem and its decision matrix is $A = (a_{ij})_{m\times n}$, then the normalized decision matrix $B = (b_{ij})_{m\times n}$ is obtained by Mukhopadhyay *et al.* (2009)
- **Step 2:** The index weights w_j are calculated by Marano *et al.* (2009) and Zhou *et al.* (2009) and the weighted normalized decision matrix $C = (c_{ij})_{m\times n}$ by Whittaker *et al.* (2009)
- **Step 3:** The positive ideal point $\Phi^+ = (c^+_i)$and the negative one $\Phi^- = (c^-_i)$ are solved by Chung *et al.* (2009) and Martin (2009) and the nearness degrees of scheme u_i to $C^+$and C^- by Kimbrough *et al.* (2008) and Vilcot and Billaut (2008)
- **Step 4:** The comprehensive ranking index value z_i of scheme u_i is solved by Kun *et al.* (2004) and determine the relative merits of the schemes using the values of z_i

Solving steps of hierarchy TOPSIS. If there are too many indexes (generally more than 10) in the attribute set and meanwhile the indexes can be clustered based on certain rules, in order to avoid the problem of being hard to assign weights due to too many indexes, we can classify the indexes and then calculate the comprehensive index values of schemes under each type of index by the calculation methods discussed in the previous for each kind of index set, take various comprehensive index values as the values obtained from the measure by scheme ui according to index vi and repeat the above procedure until finally the comprehensive ranking index value of scheme sets is obtained.

RESULTS

Selection of scheme sets and attributes index values: Four PE teachers were selected as the schemes to be evaluated. The scheme set is $U = \{u_1, u_1, u_2, u_3, u_4\}$. The attribute set are listed in Table 1.

Calculation for hierarchy comprehensive index values: For attribute v_4, its decision matrix obtained by Table 1 is:

Table 1: Attribute set

First level indexes	Second level indexes
Basic literacy	Ideological morality quality
	Vocational ethics quality
	Knowledge and comprehensive quality
	Personality and ability
	Psychological ability
Classroom teaching	Teaching objective
	Teaching quality
	Teaching process
Teaching effect	
Teaching and research	Teaching and research ability
	Teaching and research achievements
Sports competition	Contain teaching training
	Participation
	Awards
Group activities	Organization of group activities
	Implementation of group activities
Honors and rewards	Awards items
	Awards levels
	Awards effects
Academic writings	Academic paper contents
	Academic paper level
	Academic paper achievements

$$A_1 = \begin{pmatrix} 13 & 148 & 950 \\ 6.5 & 24 & 626 \\ 8 & 190 & 850 \\ 11.5 & 148 & 1000 \end{pmatrix}$$

In which, the subscript 1 represents that for the hierarchy attribute v_4, the meanings of the subscripts below are similar. V^4_1, V^4_1, V^4_2, V^4_3 and V^4_4 are the benefit-type indexes, then the normalized decision matrix obtained by Mukhopadhyay *et al*. (2009) is:

$$B_1 = \begin{pmatrix} 1 & 0.75 & 0.87 \\ 0 & 0 & 0 \\ 0.23 & 1 & 0.60 \\ 0.77 & 0.75 & 1 \end{pmatrix}$$

The weight set of various attributes obtained by Zhou *et al*. (2009) and Whittaker *et al*. (2009) is $W_4 = \{0.41, 0.29, 0.30\}$ and its weighted normalized decision matrix obtained by Chung *et al*. (2009) is:

$$C_1 = \begin{pmatrix} 0.41 & 0.22 & 0.26 \\ 0 & 0 & 0 \\ 0.09 & 0.29 & 0.18 \\ 0.32 & 0.22 & 0.30 \end{pmatrix}$$

The positive and negative ideal points obtained by Martin (2009) and Kimbrough *et al*. (2008) are, respectively $\Phi^+_1 = (0.41, 0.29, 0.30)$ and $\Phi^-_1 = (0, 0, 0)$. By Vilcot and Billaut (2008) and Kun *et al*. (2004), the nearness degrees of scheme u_1 to the positive ideal point Φ^+_1 and the negative one Φ^-_1 are, respectively $\Psi^+_1 = (0.08, 0.58, 0.34, 0.11)$ and $\Psi^-_1 = (0.53, 0, 0.35, 0.49)$. By the set of comprehensive ranking index values for scheme u_1 is $Z_1 = (0.87, 0, 0.51, 0.82)$. The computational processes for other attributes are similar with the above procedure.

CONCLUSION

Main contributions of this study include: A comprehensive evaluation method is proposed to PE Teachers based on the TOPSIS. In this proposed approach, the multiple attribution decision making mathematics model of hierarchy TOPSIS is constructed and the entropy power process is adopted to solve index power coefficient. The typical example indicates that this proposed approach is effective and feasible.

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