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Model for evaluating the physical education teaching quality in universities and colleges under trapezoidal intuitionistic fuzzy environment

Dong-gen Zhong
Department of Physical Education, Jiangxi University of Finance and Economics, Nanchang, 330013, (CHINA)
E-mail: zdg55555@126.com

ABSTRACT

Entering the 21st century, with the rolling forward of information and the wave of globalization, various cultures continuously enter our country, making a fierce hit to traditional Chinese culture and, people's values, thinking and behavior are changing greatly, especially the college students who are walking in the forefront of the times at university campus, have a strong cultural sense of innovation and the ability to accept new things quickly. Meanwhile, the quality of the demand for talents is transferring from the "standardization" to diversified direction. Quality standards of the new developments of training personnel for colleges and universities have put forward new demands, and how to adapt to the times and the needs of self-development for college students, and how to construct the corresponding training objectives and quality standards has become the problem to be solved immediately in colleges and universities. In this paper, we have investigated the trapezoidal intuitionistic fuzzy MADM problem for evaluating the physical education teaching quality in universities and colleges. A modified GRA analysis method is proposed. Then, based on the traditional GRA method, calculation steps for solving trapezoidal intuitionistic fuzzy multiple attribute decision-making problems are given. Finally, an illustrative example about physical education teaching quality in universities and colleges evaluation is given to verify the developed approach and to demonstrate its practicality and effectiveness.

KEYWORDS

Multiple attribute decision making (MADM); Trapezoidal intuitionistic fuzzy information; GRA method; Physical education teaching quality.

INTRODUCTION

As one part of PE, physical education in the university is the highest and final stage of personnel training in China, and it is also the key to that[1-2]. With the changing from exam-oriented education to education for all-round development, personnel training in China demands that physical education in the university adds students' lifelong physical sense, ability and capability of adapting the society into the all-round developing goal in order to establish the student-centered teaching method, attach importance to the development of students characteristics, and cultivate students autonomic learning, self-exercise, independent thinking and innovation abilities[3-4]. Physical Education teachers are the core of Physical Education in China. The development of Physical Education relies on the development of Physical Education teachers, and it is also an event which has relation to personnel training and Physical Education enterprise of the whole country, meanwhile, people in the field of physical education in the university pay more attention to that[5]. Therefore, we must consider that whether the quality, quantity, levels and majors of physical education teachers in the university are adapted to the demands of the new physical education in the university, whether physical education teachers in the university can undertake the mission of carrying our innovation education and cultivating high-quality personnel. On the basis of analyzing the specialized quality structure of physical education teachers in the university, the thesis investigates and objectively evaluate the present situation of specialized qualities of physical education teachers in the university one Province, then proposes the suggestion of improving the teachers' specialized qualities, aiming at establishing clean goal for the teachers' specialized qualities and supplying the theory basis for normal schools cultivating teachers and the in-service physical education teachers in the university taking further education[6-7].

In this paper, we have investigated the trapezoidal intuitionistic fuzzy MADM problem for evaluating the physical education teaching quality in universities and colleges. Then, based on the traditional GRA method, calculation steps for solving trapezoidal intuitionistic fuzzy multiple attribute decision-making problems are given. Finally, an illustrative example about physical education teaching quality in universities and colleges evaluation is given to verify the developed approach and to demonstrate its practicality and effectiveness.

PRELIMINARIES

Atanassov[8-9] introduced the concept of intuitionistic fuzzy set (IFS), which is a generalization of the concept of fuzzy set[10]. The intuitionistic fuzzy set has received more and more attention since its appearance[11-13]. In the following, we shall introduce the concepts related to trapezoidal intuitionistic fuzzy numbers.

Definition 1. Let $\tilde{a}$ is an trapezoidal intuitionistic fuzzy number, its membership function is[14]:

$$\mu_{\tilde{a}}(x)=\begin{cases}\dfrac{x-a}{b-a}\mu_{\tilde{a}}, & a\le x<b;\\ \mu_{\tilde{a}}, b\le x\le c; & \\ \dfrac{d-x}{d-c}\mu_{\tilde{a}}, & c<x\le d;\\ 0, & others.\end{cases} \tag{1}$$

its non-membership function is:

$$\nu_{\tilde{a}}(x)=\begin{cases}\dfrac{b-x+\nu_{\tilde{a}}(x-a_1)}{b-a_1}, & a_1\le x<b;\\ \nu_{\tilde{a}}, b\le x\le c; & \\ \dfrac{x-c+\nu_{\tilde{a}}(d_1-x)}{d_1-c}, & c<x\le d_1;\\ 0, & \text{others.}\end{cases} \tag{2}$$

where $0 \le \mu_{\tilde{a}} \le 1; 0 \le \nu_{\tilde{a}} \le 1$ and $\mu_{\tilde{a}} + \nu_{\tilde{a}} \le 1; a,b,c,d \in R$. Then $\tilde{a} = \left\langle \left(\left[a,b,c,d \right]; \mu_{\tilde{a}} \right), \left(\left[a_1,b,c,d_1 \right]; \nu_{\tilde{a}} \right) \right\rangle$ is called a trapezoidal intuitionistic fuzzy number. For convenience, let $\tilde{a} = \left(\left[a,b,c,d \right]; \mu_{\tilde{a}}, \nu_{\tilde{a}} \right)$.

Definition 2[15]. For a normalized trapezoidal intuitionistic fuzzy decision making matrix $\tilde{R} = \left(\tilde{r}_{ij} \right)_{m \times n} = \left(\left[a_{ij}, b_{ij}, c_{ij}, d_{ij} \right]; \mu_{ij}, \nu_{ij} \right)_{m \times n}$, where $0 \le a_{ij} \le b_{ij} \le c_{ij} \le d_{ij} \le 1$, $0 \le \mu_{ij}, \nu_{ij} \le 1, 0 \le \mu_{ij} + \nu_{ij} \le 1$, the trapezoidal intuitionistic fuzzy positive ideal solution is defined as follows:

$$\tilde{r}^+ = \left(\left[a^+, b^+, c^+, d^+ \right]; \mu^+, \nu^+ \right) = \left(\left[1,1,1,1 \right]; 1, 0 \right) \tag{3}$$

Definition 3[14,16]. Let $\tilde{a}_1 = \left(\left[a_1, b_1, c_1, d_1 \right]; \mu_{\tilde{a}_1}, \nu_{\tilde{a}_1} \right)$ and $\tilde{a}_2 = \left(\left[a_2, b_2, c_2, d_2 \right]; \mu_{\tilde{a}_2}, \nu_{\tilde{a}_2} \right)$ be two trapezoidal intuitionistic fuzzy number, then the normalized Hamming distance between $\tilde{a}_1$ and $\tilde{a}_2$ is defined as follows:

$$\begin{aligned} d\left(\tilde{a}_1, \tilde{a}_2 \right) = \frac{1}{8} \Big(& \left| \left(1 + \mu_{\tilde{a}_1} - \nu_{\tilde{a}_1} \right) a_1 - \left(1 + \mu_{\tilde{a}_2} - \nu_{\tilde{a}_2} \right) a_2 \right| + \left| \left(1 + \mu_{\tilde{a}_1} - \nu_{\tilde{a}_1} \right) b_1 - \left(1 + \mu_{\tilde{a}_2} - \nu_{\tilde{a}_2} \right) b_2 \right| + \\ & \left| \left(1 + \mu_{\tilde{a}_1} - \nu_{\tilde{a}_1} \right) c_1 - \left(1 + \mu_{\tilde{a}_2} - \nu_{\tilde{a}_2} \right) c_2 \right| + \left| \left(1 + \mu_{\tilde{a}_1} - \nu_{\tilde{a}_1} \right) d_1 - \left(1 + \mu_{\tilde{a}_2} - \nu_{\tilde{a}_2} \right) d_2 \right| \Big) \end{aligned} \tag{4}$$

MODEL FOR EVALUATING THE PHYSICAL EDUCATION TEACHING QUALITY IN UNIVERSITIES AND COLLEGES UNDER TRAPEZOIDAL INTUITIONISTIC FUZZY ENVIRONMENT

In this section, we have investigated the trapezoidal intuitionistic fuzzy MADM problem for evaluating the physical education teaching quality in universities and colleges with incompletely known weight information. Let $A = \left\{ A_1, A_2, \cdots, A_m \right\}$ be a discrete set of alternatives. Let $G = \left\{ G_1, G_2, \cdots, G_n \right\}$ be a set of attributes. The information about attribute weights is incompletely known. Suppose that $\tilde{R} = \left(\tilde{r}_{ij} \right)_{m \times n} = \left(\left[a_{ij}, b_{ij}, c_{ij}, d_{ij} \right]; \mu_{ij}, \nu_{ij} \right)_{m \times n}$ is the trapezoidal intuitionistic fuzzy decision matrix, where μ_{ij} indicates the degree that the alternative A_i satisfies the attribute G_j given by the decision maker, ν_{ij} indicates the degree that the alternative A_i doesn't satisfy the attribute G_j given by the decision maker, $\mu_{ij} \subset \left[0,1 \right]$, $\nu_{ij} \subset \left[0,1 \right]$, $\mu_{ij} + \nu_{ij} \le 1$, $i = 1,2,\cdots,m$, $j = 1,2,\cdots,n$.

In the following, we apply GRA method to solve MADM problems with trapezoidal intuitionistic fuzzy information.

Step 1. Determine the positive ideal and negative ideal solution based on trapezoidal intuitionistic fuzzy information.

$$\tilde{r}^+ = \left(\tilde{r}_1^+, \tilde{r}_2^+, \cdots, \tilde{r}_n^+ \right) \tag{5}$$

$$\tilde{r}^- = \left(\tilde{r}_1^-, \tilde{r}_2^-, \cdots, \tilde{r}_n^- \right) \tag{6}$$

Where

$$\tilde{r}_j^+ = \left(\left[a_j^+, b_j^+, c_j^+, d_j^+ \right]; \mu_j^+, \nu_j^+ \right) = \left(\left[1,1,1,1 \right]; 1, 0 \right) \quad \tilde{r}_j^- = \left(\left[a_j^-, b_j^-, c_j^-, d_j^- \right]; \mu_j^-, \nu_j^- \right) = \left(\left[1,1,1,1 \right]; 1, 0 \right)$$

Step 2. Calculate the grey relational coefficient of each alternative from PIS and NIS using the following equation, respectively:

$$\xi_{ij}^{+}=\frac{\min\limits_{1\le i\le m}\min\limits_{1\le j\le n}d\left(\tilde{r}_{ij},\tilde{r}_{j}^{+}\right)+\rho\max\limits_{1\le i\le m}\max\limits_{1\le j\le n}d\left(\tilde{r}_{ij},\tilde{r}_{j}^{+}\right)}{d\left(\tilde{r}_{ij},\tilde{r}_{j}^{+}\right)+\rho\max\limits_{1\le i\le m}\max\limits_{1\le j\le n}d\left(\tilde{r}_{ij},\tilde{r}_{j}^{+}\right)},\ i=1,2,\cdots,m,\ j\in 1,2,\cdots,n \quad \textbf{(7)}$$

$$\xi_{ij}^{-}=\frac{\min\limits_{1\le i\le m}\min\limits_{1\le j\le n}d\left(\tilde{r}_{ij},\tilde{r}_{j}^{-}\right)+\rho\max\limits_{1\le i\le m}\max\limits_{1\le j\le n}d\left(\tilde{r}_{ij},\tilde{r}_{j}^{-}\right)}{d\left(\tilde{r}_{ij},\tilde{r}_{j}^{-}\right)+\rho\max\limits_{1\le i\le m}\max\limits_{1\le j\le n}d\left(\tilde{r}_{ij},\tilde{r}_{j}^{-}\right)},\ i=1,2,\cdots,m,\ j\in 1,2,\cdots,n \quad \textbf{(8)}$$

where the identification coefficient $\rho=0.5$.

Step 3. Calculating the degree of grey relational coefficient of each alternative from PIS and NIS using the following equation, respectively:

$$\xi_{i}^{+}=\sum_{j=1}^{n}w_{j}\xi_{ij}^{+},\xi_{i}^{-}=\sum_{j=1}^{n}w_{j}\xi_{ij}^{-},i=1,2,\cdots,m. \quad \textbf{(9)}$$

The basic principle of the GRA method is that the chosen alternative should have the “largest degree of grey relation” from the positive ideal solution and the “smallest degree of grey relation” from the negative ideal solution. Obviously, for the weight vector given, the smaller ξ_i^- and the larger ξ_i^+, the better alternative A_i is.

Step 4. Calculating the relative relational degree of each alternative from PIS using the following equation,

$$c_{i}=\xi_{i}^{+}\Big/\left(\xi_{i}^{-}+\xi_{i}^{+}\right),i=1,2,\cdots,m. \quad \textbf{(10)}$$

Step 5. Rank all the alternatives $A_i\left(i=1,2,\cdots,m\right)$ and select the best one (s) in accordance with $c_i\left(i=1,2,\cdots,m\right)$. If any alternative has the highest c_i value, then, it is the most important alternative.

Step 6. End.

NUMERICAL EXAMPLE

Entering the21st century, with the rolling forward of information and the wave of globalization, various cultures continuously enter our country, making a fierce hit to traditional Chinese culture and, people’s values, thinking and behavior are changing greatly, especially the college students who are walking in the forefront of the times at university campus, have a strong cultural sense of innovation and the ability to accept new things quickly. Meanwhile, the quality of the demand for talents is transferring from the "standardization" to diversified direction. Quality standards of the new developments of training personnel for colleges and universities have put forward new demands, and how to adapt to the times and the needs of self-development for college students, and how to construct the corresponding training objectives and quality standards has become the problem to be solved immediately in colleges and universities. Based on the College Physical Teaching Guidelines Evaluation promulgated by Ministry of Education in2002, the quality of teaching, combining with the current social status and behavioral characteristics of the college students, and the previous research results, the all-round discussion on the connotation of the quality of teaching from the views of experts and scholars, teachers and recommendations and, standards, and reconstruction of the ordinary college PE course, the quality of teaching scientific evaluation system, designed from the perspective of objectivity, comprehensiveness, realism, simplicity, ease, etc. in line with evaluation criteria of the College Physical Education and social development to enrich and improve the Teaching Quality Evaluation System, effective guidance for sports teaching practice, to enhance and improve the quality of PE teaching, and ultimately a college physical education training objective will have certain practical significance. This section presents a numerical example to evaluate the physical education teaching quality in universities and colleges with trapezoidal intuitionistic fuzzy information to illustrate the method proposed in this paper. There is a panel with five possible schools $A_i\left(i=1,2,\cdots,5\right)$ to evaluate. The education institution must take a decision according to the following four attributes: □G_1 is the sports basic theoretical knowledge evaluation; □G_2 is the physical fitness and sports skill evaluation; □G_3 is the learning attitude evaluation; □G_4 is the affective expression. The five possible schools $A_i\left(i=1,2,\cdots,5\right)$ are to be evaluated using the trapezoidal intuitionistic fuzzy set by the decision makers under the above four attributes, and construct the decision matrix as follows $\tilde{R}=\left(\tilde{r}_{ij}\right)_{5\times 4}$:

$$\tilde{R}=\begin{bmatrix}
\left([0.4,0.5,0.7,0.8];0.2,0.5\right) & \left([0.3,0.4,0.5,0.6];0.1,0.6\right) & \left([0.6,0.7,0.9,1.0];0.2,0.7\right) & \left([0.5,0.6,0.7,0.8];0.1,0.8\right)\\
\left([0.3,0.4,0.6,0.7];0.6,0.1\right) & \left([0.4,0.5,0.6,0.8];0.3,0.4\right) & \left([0.5,0.6,0.8,0.9];0.6,0.3\right) & \left([0.6,0.7,0.8,1.0];0.3,0.6\right)\\
\left([0.4,0.5,0.6,0.7];0.4,0.2\right) & \left([0.2,0.4,0.6,0.8];0.5,0.2\right) & \left([0.6,0.7,0.8,0.9];0.4,0.4\right) & \left([0.4,0.6,0.8,1.0];0.5,0.4\right)\\
\left([0.1,0.2,0.4,0.6];0.2,0.3\right) & \left([0.5,0.6,0.7,0.8];0.1,0.5\right) & \left([0.2,0.4,0.6,0.8];0.2,0.5\right) & \left([0.7,0.8,0.9,1.0];0.1,0.7\right)\\
\left([0.1,0.2,0.3,0.4];0.6,0.2\right) & \left([0.4,0.5,0.6,0.7];0.4,0.2\right) & \left([0.3,0.4,0.5,0.6];0.6,0.2\right) & \left([0.6,0.7,0.8,0.9];0.4,0.4\right)
\end{bmatrix}$$

Then, we utilize the approach developed to get the most desirable schools. If the information about the attribute weights is completely known and the known weight information is: $w=\left(0.30,0.20,0.40,0.10\right)$. Then, we utilize the approach developed to get the most desirable alternative (s).

Step 1. Calculate the grey relational coefficient of each school from PIS and NIS

$$\tilde{r}_j^{+}=\left(\left[a_j^{+},b_j^{+},c_j^{+},d_j^{+}\right];\mu_j^{+},\nu_j^{+}\right)=\left([1,1,1,1];1,0\right)\quad \tilde{r}_j^{-}=\left(\left[a_j^{-},b_j^{-},c_j^{-},d_j^{-}\right];\mu_j^{-},\nu_j^{-}\right)=\left([1,1,1,1];1,0\right)$$

$$\xi^{+}=\left(\xi_{ij}^{+}\right)_{5\times 4}=\begin{bmatrix}
0.732 & 0.721 & 0.843 & 0.732\\
0.956 & 0.858 & 1.000 & 0.954\\
0.836 & 0.809 & 0.715 & 0.765\\
0.767 & 0.798 & 0.876 & 0.792\\
0.765 & 0.889 & 0.752 & 0.743
\end{bmatrix}$$

$$\xi^{-}=\left(\xi_{ij}^{-}\right)_{5\times 4}=\begin{bmatrix}
0.745 & 1.000 & 0.667 & 0.987\\
0.547 & 0.758 & 0.590 & 0.522\\
0.643 & 0.665 & 0.976 & 0.887\\
0.923 & 0.865 & 0.611 & 0.763\\
0.875 & 0.663 & 0.721 & 0.754
\end{bmatrix}$$

Then, we can get the degree of grey relational coefficient of each school from PIS and NIS

$$\xi_1^+ = 0.765, \xi_2^+ = 0.906, \xi_3^+ = 0.765, \xi_4^+ = 0.732, \xi_5^+ = 0.771$$

$$\xi_1^- = 0.821, \xi_2^- = 0.554, \xi_3^- = 0.677, \xi_4^- = 0.739, \xi_5^- = 0.726$$

Step 3. Calculate the relative relational degree of each school from PIS

$$c_1 = 0.476, c_2 = 0.612, c_3 = 0.487, c_4 = 0.526, c_5 = 0.532$$

Step 4. Rank all the schools $A_i\left(i = 1, 2, 3, 4, 5\right)$ in accordance with the $\xi_i \quad \left(i = 1, 2, \cdots, 5\right)$: $A_2 \succ A_5 \succ A_4 \succ A_3 \succ A_1$, and thus the most desirable school is A_2.

CONCLUSION

Education's quality of teaching is the lifeline of the university, and it is the eternal theme to promote the education's quality in building and development of university. Especially, the teaching quality guarantee in university which concerned unprecedented in the transformation period of higher education from elite education to mass education. P.E education is goal leading activity, and in the education activity the P.E. teacher is the leader whose education's quality, which is high or low, affect the interesting of the students who are engaged in the physic activity, and effect of the mastery of P.E. knowledge and skill, and even the establishment of thought in the lifelong. Following the deepening development in P.E. education reformatory, the evaluation and monitoring of education quality of teaching has been become an available way in verify the achievements of teaching reform above. Above all, it plays an important role in discussing and studying the subject of teaching monitoring and evaluation of P.E. teachers' in universities. In this paper, we have investigated the trapezoidal intuitionistic fuzzy MADM problem for evaluating the physical education teaching quality in universities and colleges. Then, based on the traditional GRA method, calculation steps for solving trapezoidal intuitionistic fuzzy multiple attribute decision-making problems are given. Finally, an illustrative example about physical education teaching quality in universities and colleges evaluation is given to verify the developed approach and to demonstrate its practicality and effectiveness.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article.

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