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# Comprehensive evaluation of college students' physical education performances: an empirical study of Chinese students

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## ABSTRACT

In order to construct a scientific and practical model to comprehensively evaluate the college students' PE performances, the fuzzyAnalytic Hierarchy Process is used to determine the weights of the indicators and the gray relational analysis is applied to make an integrated evaluation. The results of the empirical study show that the proposed method is accurate, effective and suitable for the PE performance evaluation of college students.

## KEYWORDS

College students; Physical education performance; Comprehensive evaluation; FAHP; GRA, China.

## INTRODUCTION

In recent years, the evaluation of college students' comprehensive performance in physical education (PE) has been concerned theoretically and practically. As the last stage of the students' physical education at school as well as the critical part in the formation of their lifelong physical exercise, physical education in colleges is an important part in the cultivation of student's overall qualities. PE class, the key point in the formation of students' overall qualities, helps to cultivate students' psychological qualities, moral consciousness, fighting spirits as well as the determination and character internally, and teaches students some basic skills in sports and how to use them to instruct their future physical exercise externally. Accordingly, the comprehensive evaluation of college students' performances is of great significance. Therefore, building a fair, scientific and rational evaluation model will meet the requirement of the Chinese higher education reform and improve the teaching quality of colleges.

## LITERATURE REVIEW

The Analytic Hierarchy Process (AHP), first introduced by Saaty[1], is a method to deal with complex systems with several alternatives and provides a comparison of the corresponding results. Fuzzy AHP (FAHP) is developed for solving the hierarchical problems. Decision makers usually find that FAHP is more confident in given interval judgments than fixed value judgments. Many FAHP methods and applications in the literature have been proposed by various researchers. Van Laarhoven and Pedrcyz[2] are the first researchers to introduce the application of fuzzy logic principle to AHP, that is, the use of the triangular fuzzy numbers. FAHP is first used by Ayag and Ozdemir[3] to weigh the alternatives under multiple attributes, and then, they conduct a benefit/cost ratio analysis. Chan and Kumar [4] use a fuzzy extended analytic hierarchy process to select global suppliers. The results obtained by Wu et al. [5] show that the proposed fuzzy AHP method was superior to the traditional AHP in terms of the competitiveness evaluation of the Chinese airlines. All in all, FAHP has been used more and more often in multi-criteria evaluation because of its simplicity and similarity to human reasoning.

Grey relational analysis (GRA) is created by Professor Deng Julong in 1982, which has been continuously developed and applied. Because people's understanding of objective things and the objects evaluated are in the wide grey range, grey theory can be used to study the evaluation problem. Zhang Yun sets up an evaluation index system for venture capital project risk based on grey system theory, and proposes the comprehensive evaluation methods of combination qualitative analysis with quantitative analysis [6]; He Ming, *et. al*. makes a comparative analysis on many cost prediction methods to expound the scientific rationality of the grey system theory applied to the risk of cost prediction, and constructs the risk model of cost prediction in large-scale research projects based on grey correlation degree [7]; Han Xiao, et. al. studies the risk management issues in the large-scale research projects management, and proposes route selection and phases risk impact assessment based on grey correlation degree, which provides a viable mathematical analysis instrument for small samples and the poor information of research projects for risk evaluation [8]; Yang Junshan discusses a variety of determining ways for the index weights and the fuzzy comprehensive evaluation [9].

Therefore, this paper proposes FAHP to determine the indicator weights in evaluating the Chinese PE students' performance. Meanwhile, GRA is utilized to establish a complete and accurate evaluation model for the evaluation of the students' scores. This method will significantly reduce the ambiguity and increase the accuracy in the evaluation of the students' performance.

## METHODOLOGY

In GRA, it's necessary to preprocess all the data in Grey Relational Generating with three types as follows.

(1) The higher, the better.

$$\chi_i^*(k) = \frac{\chi_i^{(0)}(k) - min\chi_i^{(0)}(k)}{max\chi_i^{(0)}(k) - min\chi_i^{(0)}(k)} \qquad (1)$$

(2) The lower, the better.

$$\chi_i^*(k) = \frac{max\chi_i^{(0)}(k) - \chi_i^{(0)}(k)}{max\chi_i^{(0)}(k) - min\chi_i^{(0)}(k)} \qquad (2)$$

(3) For a desired value $X^{(0)}$,

$$\chi_i^*(k) = 1 - \frac{|\chi_i^{(0)}(k) - \chi^{(0)}|}{max\chi_i^{(0)}(k) - \chi^{(0)}}, \qquad (3)$$

where$\chi_i^*(k)$ is the generating value of GRA; $\min\chi_i^{(0)}(k)$ is the minimumvalue of $\chi_i^*(k)$; and $\min\chi_i^{(0)}(k)$ is the maximum value of$\chi_i^{(0)}(k)$.

The Grey Relational Grade$\Gamma$ is used to indicate the relationship among the series. Let$(X, \Gamma)$ be a Grey Relational Space.Xstands for the collection of Grey Relational Factors, and let $\chi_i$be the compared series and$\chi_0$the reference series.

$$\chi_0(k) = (\chi_0(1), \chi_0(2), \cdots, \chi_0(k)) \qquad (4)$$

$$\chi_i(k) = (\chi_i(1), \chi_i(2), \cdots\cdots, \chi_i(k)) \in X, i = 1, \cdots., m. \ \ k = 1, \cdots, n \in N \quad (5)$$

The Grey Relational Grade is calculated as follows.

$$\Gamma_{0i} = \frac{\Delta_{\min}+\Delta_{\max}}{\Delta^{'}+\Delta_{\max}}, i = 1,\cdots,m , k = 1,\cdots,n , \; j \in i \quad (6)$$

where $\chi_0(k)$ is the reference sequence, $\chi_i(k)$ the comparative sequences; $\Delta_{0i}(k) = |X_0(k) - X_i(k)|$;$\Delta_{\min} = \forall_j^{\min} \in i \, \forall_k^{\min} \, |X_0(k) - X_j(k)|$;$\Delta_{\max} = \forall_j^{\max} \in i \, \forall_k^{\max} |X_0(k) - X_j(k)|$;$\Delta = \sqrt{\sum_{k=1}^{n}\left(\frac{\Delta_{0i}^2(k)}{n}\right)}$.

## EMPIRICAL STUDY

Six course scores of eight students from Hunan Institute of Science and Technology are selected randomly for this study noted as $x_1$ to $x_8$.To comprehensively evaluate the students' scores, the comparison series constituting of each student's scores is noted

$$B_i(j) = [B_i(1), B_i(2),..., B_i(t)] \; i = 1,2,...,m \; j = 1,2,...,t , \quad (7)$$

where $m$ stands for the number of students; and $t$ stands for number of program types. Use the highest scores as the referring series, noted as

$$B_0(j) = \{B_o(1), B_0(2),..., B_0(t)] \; m+1 \; B_0(j), B_1(j),..., B_m(j), ] , B_0 = 88,97,93,87,93,97 \quad . \quad (8)$$

In order to reduce the interference of random factors, use the following formula to obtain the characteristic matrix of all the scores.

$$x_i = B_i(j) / B_0(j), (i = 1,2,...,m; j = 1,2,...,t) \quad (9)$$

Then the difference matrix $|B_0(j) - B_i^{'}(j)|$ can be obtained. According to the gray system theory, define correlation coefficient of the comparison series $B_0(j)$ in the indicator $B_i^{'}(j)$ as follows.

$$b_{ij} = \frac{\min_i \min_j |B_0(j) - B_i^{'}(j)| + \rho \max_i \max_j |B_0(j) - B_i^{'}(j)|}{|B_0(j) - B_i^{'}(j)| + \rho \max_i \max_j |B_0(j) - B_i^{'}(j)|}, \quad (10)$$

where the discrimination coefficient $\rho = 0.5$ .

The weight of each type of the courses, namely, track and field, theory and match can be obtained by the following formula and the weights are shown in Table 1.

$$\omega_i = \frac{1}{n}\sum_{j=1}^{n}\frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}}, \quad i = 1,2, \ldots n, n = 3 \quad (11)$$

**TABLE 1: Credits and weights of each course**

| Course | Dash | Long-distance race | Tennis | Martial arts | Athletic physiology | Athletic psychology |
|---|---|---|---|---|---|---|
| **Score** | 6 | 7 | 5 | 4 | 3 | 3 |
| **Type** | Track and field | | Match | | Theory | |
| **Weight** | 0.1241 | 0.5172 | 0.5168 | 0.5170 | 0.3593 | 0.3589 |

Find out the course credits $q_j$ and the weight of each course can be obtained as follows.

$$T_i = \frac{\sum_{k=1}^{n} a_{ik} q_i w_k}{\sum_{i=1}^{m}\sum_{k=1}^{n} a_{ik} q_i w_k}, \quad i = 1,2, \ldots, m. \quad m = 6, n = 3, a_{ik} = \begin{cases} 1 & \text{if item i is type k,} \\ 0 & \text{otherwise.} \end{cases} \quad (12)$$

Then, the decentralization weight of each course can be obtained. In order to facilitate the comparison, each student's gray weighted correlation degree can be obtained as follows.

$$r_i = \sum_{j=1}^{t} T_J b_{ij} , i = 1,2, \ldots ,8 \quad , \quad (13)$$

where $T_j$ is weight of course $j$, $j = 1,2, \ldots ,6$.

Finally,each student's standardized average score $\gamma_i^{'} \times 100$ can be obtained as follows.

$x_1$ =71.63, $x_2$ =73.13, $x_3$ =62.82, $x_4$ =58.20, $x_5$ =48.41, $x_6$ =74.25, $x_7$ =61.95 and $x_8$ =68.46. With the proposed comprehensive evaluation model based on FAHP and GRA, the student's performanceranking is

$x_6 > x_2 > x_1 > x_8 > x_3 > x_7 > x_4 > x_5$;while with the simple average method, the ranking is $x_2 > x_6 > x_1 > x_3 > x_7 > x_8 > x_4 > x_5$. Compared with the students' real performance, the ranking order with the proposed method in this study is highly improved.

## CONCLUSIONS

The result of the proposed method which reflects synthetically thereal learning level and position in the class can eliminate the difference in the course importance by its weight. Moreover, the applied GRA can eliminate the difference in the difficulty degree of the courses. The results of the empirical study show that this method is scientific, fair and feasible.

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