Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(7): 1135-1140

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Research on evaluation model of fuzzy analytic hierarchy process and data envelopment analysis based on modern physical education teaching

Jingfei Chen[1], Shujuan Yuan[1] and Aimin Yang[2]

[1]Qinggong College, Hebei United University, Tangshan, Hebei, China
[2]Science College, Hebei United University, Tang Shan, China

---

ABSTRACT

With the wide application of computer multimedia and other modern technology, traditional sports teaching mode is facing more and more severe challenges, while the disadvantages of the traditional teaching completely unmasked. Therefore, modern means of education's role is being more and more important in education. And also the shortcomings and problems exists in traditional sports teaching evaluation system, which mainly use a single evaluation system. At the same time, the society also vigorously promote the modernization of teaching. Past teaching evaluation system cannot reflect modern objectives and requirements. Therefore, on the basis of the law of higher education, starting from the teaching quality and the quality of education, this paper establish two scientific comprehensive evaluation model in accordance with the requirements of modern teaching of PE teaching.

Key words: Fuzzy Theory, Analytic Hierarchy Process, Physical Education, Modernization, Data Envelopment Analysis

---

INTRODUCTION

With the development of the times and the progress of science and technology, modernization has been integrated into people's lives. In general, modernization refers to the less developed countries in order to get some advantage in developed countries, and social and cultural change through the all-encompassing global process [1-3]. To face modernization, education must rely on it self's modernization. However, the school sports is an important part of education [4-8]. The modernization of education and the sports modernization is closely related to. Therefore, college sports modernization is the needs of the development of society and education.

At present, the college physical education mainly adopts the education and teaching concept of the former Soviet Union sports teaching idea. Although, after twentieth Century 80's, we introduced many foreign advanced methods of teaching physical education, but in essence, many methods are not suitable for China's national conditions, or teaching methods with China characteristics have not formed [9-11]. The specific point of view, there are still many deficiencies in physical education teaching idea, course construction, teaching method etc.

Obviously, the traditional sports teaching mode has been unable to meet the social requirements. Also, as a measure of physical education evaluation system, it will be accompanied by many defects and problems. The traditional evaluation system is mainly used in a single evaluation system. It cannot scientifically reflect the modern teaching objectives and requirements [12].

So this paper mainly studies the physical education evaluation model meeting needs of the modernization. Of course, the modern physical education evaluation scope is very extensive, this paper establish the comprehensive evaluation model starting concretely from two aspects of physical education teaching quality and quality education assessment.

Teaching quality evaluation of sports in general refers to accurate judge based on all factors of teaching objects in teaching progress and their comprehensive results. It mainly includes the teaching evaluation of teacher and learning evaluation of student. Teaching evaluation of teacher mainly put the teaching methods as the evaluation object. Student learning assessment mainly put a student's final result as the evaluation object. The evaluation of teaching quality in the past only pay attention to the teacher's teaching methods and students' final transcript aspects of evaluation. It cannot reflect the internal dialectic relation between teaching and learning. Therefore, based on the past evaluation system, this paper introduces the teaching efficiency to improve the deficiency of the old system, and establish a new comprehensive evaluation system.

Physical education under the quality education is a research hot spot at present. This paper mainly studies the physical education evaluation system under quality education. The traditional curriculum evaluation is mainly based on student performance as the standard. And the evaluation of physical curriculum is more difficult than other curriculum evaluation. So, it's imperative to improve the old evaluation system. This paper mainly uses three indicators of social, biological and psychological to establish an evaluation system and corresponding evaluation model.

FUZZY ANALYTIC HIERARCHY EVALUATION MODEL OF TEACHING QUALITY

In this model, the qualitative description and quantitative description combine, mainly including three aspects: students' evaluation of teachers, teachers' evaluation of students and the teaching efficiency.

Firstly, this paper established a questionnaire of students' evaluation of teachers, and random selected sample of two hundred college students were questionnaire. On this basis, we get the table of student's evaluation of teachers. Evaluation table contains a total of six first class indexes, fourteen level two indexes, see table 1.

Table 1 Evaluation Index

First class index	Second class index
Teaching plan	Moderate teaching hour
	Clear teaching plan
Teaching content	Reasonable structure
	Ability training
	Moderate exercise
Teaching ability	Students infected
	Skilled action
After-class tutoring	Reasonable methods
	Earnest guidance
Teaching Achievement	Teaching level improved
	Self-learning ability improved
Teaching method	Abundant teaching methods
	Ordered teaching progress
	Extended teaching

This paper establishes five kinds of evaluation grades: excellent, good, qualified, unqualified and poor. Using the analytic hierarchy process, we determine the weights of index and the score of evaluation grades, see table 2.

Table 2 Evaluation Table

Second class index	Evaluation grade					Synthetic weight
	excellent	good	qualified	unqualified	poor	
Moderate teaching hour	0.2	0.7	0.1	0	0	0.07
Clear teaching plan	0.1	0.6	0.2	0.1	0	0.06
Reasonable structure	0.1	0.8	0.1	0	0	0.1
Ability training	0.2	0.3	0.4	0.1	0	0.09
Moderate exercise	0.1	0.5	0.3	0	0.1	0.08
Students infected	0.2	0.2	0.1	0.1	0	0.09
Skilled action	0.2	0.7	0.1	0	0	0.12
Reasonable methods	0.1	0.5	0.2	0.1	0.1	0.05
Earnest guidance	0.4	0.3	0.1	0.2	0	0.08
Teaching level improved	0.3	0.4	0.2	0.1	0	0.09
Self-learning ability improved	0	0.3	0.5	0.1	0.1	0.02
Abundant teaching methods	0.1	0.3	0.4	0.2	0	0.03
Ordered teaching progress	0.2	0.5	0.3	0	0	0.11
Extended teaching	0.2	0.3	0.4	0.1	0	0.09

Using fuzzy comprehensive evaluation method, let W_i as the synthetic weights and V_j as grade, we firstly derive

the distribution of membership $B_j = \sum W_i R_{ij}$, where $\sum W_i = 1$ and R_{ij} are membership grade. Then we get the students' evaluation value of teacher $G_T = \sum B_j V_j^T$, where V_j^T is the transpose of the matrix of rating scores. Put the data in table 2 into the fuzzy comprehensive evaluation method, we get $B_j = (0.146, 0.509, 0.31, 0.02, 0.01)$ and $G_T = 0.764$.

Secondly, calculate the value of teachers' evaluation of students. This paper first determines the structure of students' final grade, and then establish thirteen evaluation grades of scores, see table 3.

Table 3 Final Grade Distribution

Scores	>95	>89	>83	>77	>71	>65	>59	>53	>47	>41	>35	>29	<29
Grades	2.00	1.65	1.34	1.00	0.66	0.32	0.01	-0.32	-0.66	-1	-1.3	-1.65	-2
Ratio	0.03	0.06	0.11	0.20	0.22	0.26	0.10	0.02	0.02	0	0.03	0.01	0

Using equation $G_s = \sum R_j V_j^T$, this paper obtains the value of teachers' evaluation of students $G_s = 0.682$, where V_j^T the transposed matrix of thirteen kinds of rating scores and R_j is the ratio of thirteen kinds of evaluation grade.

Finally, establish the model of the teaching efficiency. Teaching efficiency measure the level of teaching and learning these two aspects of the quality of activities, and reflect the function of teaching and learning these two aspects of activities quality. Let $H_{(T)}$ as the teacher's lecture efficiency, if $-2 < G_T < 2$, $0 \le G_s < 2$, then we have

$$H_{(T)} = \ln\left(1 + \frac{G_s\sqrt{(2-G_T)(2-G_s)}}{(2-G_T)^2}\right)$$

If $G_s < 0$, we have

$$H_{(T)} = \ln\left(1 + \frac{G_s\sqrt{(2-G_T)(2-G_s)}}{(2-G_s)^2}\right)$$

From the above two equations, we obtain when $G_T = 2$, students' class evaluation of teacher out; when $G_T = -2$, the students' evaluation of teacher is zero. At the same time, using these two equations, we obtain the $H_{(T)}$, see table 4.

Table 4 Teaching Efficiency

$H_{(T)}$	-1	0	0.2	0.4	0.6	0.8	1	1.2	1.4	1.5	1.6	1.8	1.9
-1	-0.4	0	0.05	0.1	0.13	0.16	0.18	0.19	0.19	0.18	0.17	0.14	0.1
0	-0.31	0	0.09	0.16	0.22	0.27	0.3	0.31	0.32	0.32	0.3	0.25	0.2
0.2	-0.28	0	0.11	0.19	0.26	0.31	0.35	0.37	0.45	0.36	0.35	0.29	0.22
0.4	-0.27	0	0.12	0.22	0.3	0.36	0.4	0.41	0.43	0.42	0.41	0.33	0.3
0.6	-0.25	0	0.16	0.27	0.36	0.42	0.47	0.5	0.51	0.49	0.48	0.4	0.31
0.8	-0.23	0	0.18	0.33	0.43	0.51	0.57	0.6	0.61	0.59	0.57	0.48	0.38
1	-0.2	0	0.24	0.41	0.54	0.63	0.69	0.73	0.72	0.73	0.7	0.59	0.47
1.2	-0.18	0	0.32	0.53	0.69	0.8	0.87	0.92	0.92	0.91	0.88	0.75	0.61
1.4	-0.16	0	0.45	0.74	0.93	1.06	1.15	1.2	1.2	1.19	1.16	0.99	0.81
1.5	-0.14	0	0.56	0.89	1.1	1.25	1.34	1.38	1.41	1.38	1.35	1.19	0.98
1.6	-0.12	0	0.72	1.9	1.34	1.5	1.59	1.67	1.65	1.64	1.61	1.43	1.22
1.8	-0.08	0	1.39	1.9	2.2	2.4	2.45	2.56	2.57	2.55	2.51	2.3	2.05
1.9	-0.05	0	2.25	2.8	3.2	3.6	3.48	3.5	3.56	3.54	3.5	3.25	2.96

From table 4, we get that among learning quality G_s, teachers' teaching quality G_T and teaching efficiency $H_{(T)}$, it is not a simple linear relationship, but interrelated and influence each other. Then, we set five evaluation criteria of $H_{(T)}$: $H_{(T)} < 0$ denotes poor teaching state; $H_{(T)} = 0$ denotes general teaching state; $0 < H_{(T)} \le 0.6$ denotes moderate teaching state; $0.6 < H_{(T)} \le 1$ denotes good teaching state; $H_{(T)} > 1$ denotes excellent teaching state.

Using the results of $G_T = 0.764$ and $G_s = 0.682$, combined with $H_{(T)} = \ln\left(1 + \frac{G_s\sqrt{(2-G_T)(2-G_s)}}{(2-G_T)^2}\right)$, we get $H_{(T)} = 0.45$. So, according to the model, we obtain the result that the state evaluation between teaching and learning is moderate.

EVALUATION MODEL FUZZY DATA ENVELOPMENT ANALYSIS OF PE QUALITY EDUCATION

Data envelopment analysis is to use mathematical programming (including linear programming, multi-objective programming) model, evaluation has a plurality of input, especially the relative effectiveness of the multiple output decision unit. It has the advantage of accuracy of objective data, but in real life it is difficult to find the accurate data of factors, which is fuzzy. In this paper, the accuracy of data envelopment analysis and fuzziness of comprehensive evaluation are complementary, and get fuzzy comprehensive evaluation model of data envelopment analysis, which is divided into three steps: the first step, fuzzy operation of non-quantitative index; the second step, using data envelopment analysis, calculate accurate index weight, and make the operation results fuzzy; the third step, evaluate fuzzy result comprehensively, and get the final evaluation results.

If there are m evaluation unit, $(c+d)$ evaluation index, c quantitative index, d non-quantitative index in the model.

Fuzzy operation of non-quantitative weights

If $C = (c_1, c_2, \cdots, c_q)$ is set of factors, $V = (v_0, v_1, \cdots, v_{p-1})$ is a collection of comments, then comprehensive evaluation matrix is

$$R_j = \begin{bmatrix} r_{j10} & r_{j11} & \cdots & r_{j1(p-1)} \\ r_{j20} & r_{j21} & \cdots & r_{j2(p-1)} \\ \cdots & \cdots & \cdots & \cdots \\ r_{jq0} & r_{jq1} & \cdots & r_{jq(p-1)} \end{bmatrix}$$

$A_j = (a_{j1}, a_{j2}, \cdots, a_{jq})$ is weight matrix. So, j th decision unit fuzzy operation non quantitative weights are

$$B_j = A_j R_j = (a_{j1}, a_{j2}, \cdots, a_{jq}) \begin{bmatrix} r_{j10} & r_{j11} & \cdots & r_{j1(p-1)} \\ r_{j20} & r_{j21} & \cdots & r_{j2(p-1)} \\ \cdots & \cdots & \cdots & \cdots \\ r_{jq0} & r_{jq1} & \cdots & r_{jq(p-1)} \end{bmatrix} = (b_{j1}, b_{j2}, \cdots, b_{jp})$$

Data envelopment calculation of quantify weight

If $X_j = (x_{1j}, x_{2j}, \cdots, x_{nj})^T$ and $Y_j = (y_{1j}, y_{2j}, \cdots, y_{sj})^T$ are the input and output vector of i th evaluation unit $DMU_i (1 \le i \le m)$, where $j = 1,2,\cdots,m$, each vector coordinates are all positive. If we use $v = (v_1, v_2, \cdots, v_n)^T, u = (u_1, u_2, \cdots, u_s)^T$

denote the weight vector of input and output, using linear programming model by Charnes-Cooper transform:

$$\begin{cases} \max \mu^T Y_{j0} \\ s.t. \quad \omega^T X_j - \mu^T Y_j \ge 0, j = 1,2,\cdots,m \\ \omega^T X_{j0} = 1 \\ \omega \ge 0, \mu \ge 0 \end{cases}$$

Put the data into this model, the optimal solution B_j' is accurate quantitative calculation of the index weight.

Although the data from envelopment analysis method is more objective and more persuasive, but do not have the perceptual cognition such as “excellent, good, qualified, unqualified" and membership grade form in fuzzy comprehensive evaluation. Therefore, the application of the fuzzy degree of membership grade function:

Data envelopment analysis results can be considered separately for the membership grade of comment sets $V=(v_0,v_1,\cdots,v_{p-1})$, assuming $r=(r_0,r_1,\cdots,r_{p-1})$ is membership, then

$$r_j=\begin{cases}\dfrac{x-(j-1)\dfrac{1}{p-1}}{\dfrac{1}{p-1}} & ,(j-1)\dfrac{1}{p-1}\le x<j\dfrac{1}{p-1}\\ \dfrac{(j+1)\dfrac{1}{p-1}-x}{\dfrac{1}{p-1}} & ,j\dfrac{1}{p-1}\le x<(j+1)\dfrac{1}{p-1}\\ 0\end{cases}$$

Put B_j' into function above and get membership grade $B_j=(b_{j1},b_{j2},\cdots,b_{jp})$.

Comprehensive evaluation

$$R_j=\begin{bmatrix}B_{j1}\\B_{j2}\\\cdots\\B_{jk}\end{bmatrix},j=1,2,\cdots,m$$

Comprehensive evaluation the results above. The comprehensive evaluation matrix is , where k is the project number of all index (non-quantitative and quantitative) .Assume $A_j=(a_{j1},a_{j2},\cdots,a_{jk}),j=1,2,\cdots,m$ are weights, then $B=A$ and

$$R\Rightarrow B_j=(a_{j1},a_{j2},\cdots,a_{jk})\begin{bmatrix}B_{j1}\\B_{j2}\\\cdots\\B_{jk}\end{bmatrix}=(b_{j1},b_{j2},\cdots,b_{jp}),j=1,2,\cdots,m$$

Using the maximum membership degree principle, the final results of comprehensive evaluation is v_i of $(v_0,v_1,\cdots,v_{p-1})$ corresponding the maximum value b_{ji} of $B_j=(b_{j1},b_{j2},\cdots,b_{jp})$.

Application

Let $U=\{U_A,U_B,U_C\}$ as evaluation set, where $U_A=\{U_{A1},U_{A2},U_{A3},U_{A4}\}$ = {knowledge, physical quality, capacity, technology} denote biological factors, $U_B=\{U_{B1},U_{B2},U_{B3},U_{B4}\}$ = {intelligence, endurance, self-control ability, perception ability} denote psychological factors, $U_C=\{U_{C1},U_{C2},U_{C3},U_{C4}\}$ = {sports concept, sports, adapting ability, physical quality} denote social factors. So there are three first class index and sixteen second class index.

Let $m=\{m_A,m_B,m_C\}$ as weight set, where $m_A=\{m_{A1},m_{A2},m_{A3},m_{A4}\}=\{0.3,0.2,0.2,0.1\}$, $m_B=\{m_{B1},m_{B2},m_{B3},m_{B4}\}=\{0.4,0.3,0.2,0.3\}$, $m_C=\{m_{C1},m_{C2},m_{C3},m_{C4}\}=\{0.3,0.2,0.3,0.2\}$. $V=$ {excellent, good, medium, poor}is evaluation grade.

If we evaluate a student's psychological factors, the evaluation of four second class indexes of intelligence, endurance, self-control ability, perception ability are{0.2, 0.3, 0.3, 0.15, 0.05}、{0.15, 0.4, 0.3, 0.15, 0}、{0.3, 0.35, 0.3, 0.05, 0}和{0.25, 0.3, 0.2, 0.15, 0.1}, then we get evaluation matrix

$$R=\begin{pmatrix} 0.2 & 0.3 & 0.15 & 0.3 & 0.05 \\ 0.15 & 0.4 & 0.15 & 0.3 & 0 \\ 0.3 & 0.35 & 0.05 & 0.3 & 0 \\ 0.25 & 0.3 & 0.15 & 0.2 & 0.1 \end{pmatrix}$$

On the basis of weighting set, we get the fuzzy matrix

$$R=(0.3,0.3,0.2,0.2)\begin{pmatrix} 0.2 & 0.3 & 0.15 & 0.3 & 0.05 \\ 0.15 & 0.4 & 0.15 & 0.3 & 0 \\ 0.3 & 0.35 & 0.05 & 0.3 & 0 \\ 0.25 & 0.3 & 0.15 & 0.2 & 0.1 \end{pmatrix}$$

$$=(0.2,0.3,0.3,0.15,0.1)$$

After normalization, we get $R=(0.19,0.29,0.28,0.15,0.09)$. This shows that 19% of people think that the comprehensive evaluation of his psychological factors is excellent, 29% consider good, 28% consider medium, 15% consider qualified, 9% consider poor.

Then, give score to each evaluation grade: excellent 95, good 85, medium 75, qualified 60, poor 50 points. In this way, we get the comprehensive evaluation score

$$W=(0.19,0.29,0.28,0.15,0.09)\begin{pmatrix} 95 \\ 85 \\ 75 \\ 60 \\ 50 \end{pmatrix}=77.2$$

Finally, again according to the calculation of the distribution of weight, we get his psychological factor score is 7.72. Similarly we can also obtain score of other factors. So we get the student's aggregate score.

CONCLUSION

With the modernization of the physical education, traditional physical education teaching evaluation system does not accord with the modern teaching requirements and objectives any more. This paper established a new evaluation system. However, the modern physical education evaluation scope is very extensive, this paper concretely start from two aspects of teaching quality assessment and PE assessment under quality education, establish fuzzy AHP evaluation model of the teaching quality and the fuzzy data envelopment analysis evaluation models of quality education in physical education course, and make a scientific, objective and accurate evaluation of the application.

REFERENCES

[1]Liu Xiao-lan. *China Sport Science and Technology*. **1984**, 29(13), 46-49.
[2]Luo Yang-chun. *Journal of Shanghai Physical Education Institute*. **1994**, 23(12), 46-47.
[3]Wan Hua-zhe. *journal Of Nanchang Junior Colle*ge. **2010**, 3, 154-156.
[4]Li Ke. *Journal of Shenyang Sport University.* **2012**, 31(2), 111-113.
[5]Zhang Shu-xue. *Journal of Nanjing Institute of Physical Education*. **1995**, 31(2), 25-27.
[6]Pan Li. *Journal of nanjing institute of physical education(natural science).* **2004**, 19(1), 54-55.
[7]Li Yu-he; Ling Wen-tao. *Journal of Guangzhou Physical Education Institute*. **1997**, 17(3), 27-31.
[8] Xu Guo-qin. *Journal Of Hebei Institute Of Physical Education*. **2008**, 22(2), 70-72.
[9] Chen Qing-hong. *China Sport Science and Technology*. **1990**, 21(10), 63-65
[10] Tian Jun-ning. *Journal of Nanjing Institute of Physical Education.* **2000**, 14(4), 149-150.
[11] Zhang B.; Zhang S.; Lu G.. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(9), 256-262.
[12] Bing Zhang. *Journal of Chemical and Pharmaceutical Research*, **2014**, 5(2), 649-659.