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Based on principal component analysis of gymnastics teaching quality comprehensive evaluation model of research universities

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ABSTRACT

In the traditional pattern of gymnastics teaching in colleges and universities has been lagging behind, unable to adapt to the demand of social development. In research based on the influence factors of the gymnastics teaching development in colleges and universities, this paper set up two mathematical models, the first principal component analysis (pca) was used to study the scientific college gymnastics teaching comprehensive evaluation index, and then on this basis, through a large amount of data collected by the collection object for three level index of fuzzy evaluation, the final results using normalized processing method and the purpose is to promote the popularization and development of gymnastics in the colleges and universities. Through principal component analysis got a student scores as the objective basis of the comprehensive evaluation value, combining the fuzzy comprehensive evaluation score, get above to get the weight of the two, the result is a more objective in the end, the integrated evaluation of the value is reflected in the size of the gymnastics teaching the teacher's teaching level, the greater the value shows that the higher the teaching level.

KEYWORDS

Gymnastics; Teaching quality; Principal component analysis; Comprehensive evaluation; Physiological indicator.

INTRODUCTION

Gymnastics originated in ancient Greek, its Italian is "the naked technique", because they are naked to training at the time, after being used by the European and American countries. China is called "gymnastics". Its meaning and content varies with the changes of The Times. "Gymnastics" is always stated to all gymnastics project. According to the purpose and task, gymnastics may divide into the basic gymnastics and the athletics gymnastics two kinds big. Basic gymnastics is refers to the action and technology are quite simple kind of gymnastics, its main purpose, the task is to strengthen body and develop good body posture, it faces the main object is the broad masses of the people, the most common are broadcast fitness gymnastics gymnastics and for prevention and control of occupational diseases. But athletics gymnastics may see literally, refers to the pitch for victory, obtained the excellent result, capture the medal for the main purpose of a kind of gymnastics. This kind of gymnastics difficulty of movement big, the technology is complex, has certain thrilling, is engaged in this kind of gymnastics training mainly is the athlete. Gymnastics is a traditional sports in colleges and universities teaching course, in promoting the students' physique development, improve the sports skills play a important role. However, with the development of the reform of physical education in colleges and universities, the traditional gymnastics teaching system has been unable to meet the requirement of social development, the lag of teaching concept and teaching methods of dull dull, obsolete teaching content, teaching evaluation means of single factors, such as gymnastics students learning interest, learning effect and the value of the gymnastic learning reflects the serious impact on many aspects, such as, the gymnastics teaching in colleges and universities to carry out restricted by large extent.

In order to improve the quality of gymnastics teaching, strengthening teaching management, further arouse the enthusiasm of gymnastics teachers' work, the urgent need of a quantitative method to evaluate the gymnastics teaching, and given the four classes to test the model year of the final exam. For as far as possible fully to evaluate teaching, this article selects the appropriate gymnastics teaching index, index because too much will cause the complex operation and information overlap interference, finally unable to achieve a goal. In this paper, with less and less relevant indicators to replace number and related indicators, and can reflect the information of the original indicators. Real evaluation of gymnastics is the teacher's teaching ability way ultimacy evaluation, that is only considered through the performance evaluation of the teacher, under this kind of evaluation method, how to analyze the student's final grade can objectively reflect the teacher's teaching? This article reflects the students gymnastics skills level consider the absolute index and relative index. These have determined indicators are principal component analysis, to determine evaluation of teachers teaching value. When the teacher teaching evaluation, in addition to consider the student's final grade, will also take into account the other data. Therefore, is obtained by questionnaire in this paper, some of the teacher evaluation index, main and sub factors. Due to use quantitative analysis to the evaluation of these indicators is not easy, which are fuzzy, therefore this article through the multi-level fuzzy comprehensive evaluation method, comprehensive evaluation model is set up.

GYMNASTICS TEACHING COMPREHENSIVE EVALUATION INDICATOR SYSTEM

Principal component analysis theory

Principal component analysis is a kind of statistical analysis method that converts original multiple variables into fewer comprehensive indicators, from the perspective of mathematics; it is a kind of dimension reduction process technique. Assume that it exists n pieces of geographical samples, every sample totally has p pieces of variables description, in this way it constructs a $n \times p$ order geographic data array:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ M & M & \cdots & M \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix}$$

Then how to analyze geographic things internal regularity from numerous variables data? To get the answer, obviously it should investigate in p dimensional space; the method is surely quite troublesome. To solve the difficulty, it should go through dimension reduction processing, that is to say, use fewer comprehensive indicators to replace original many indicators. In this way, it can ensure fewer comprehensive indicators can reflect original more indicators reflected information; meanwhile indicators are mutual independent from each other. However, for the kind of comprehensive indicators (that are new variables), how to get them? It is well known that most simple form is using original indicators linear combinations, by proper changing combination coefficient; it ensures new indicators are mutual independent from each other and representative to be best.

If record original variable indicator as $x_1, x_2, \cdots, x_i$, their comprehensive indicator –new variable indicator is $x_1, x_2 \cdots z_m (m \le p)$. Then:

$$\begin{cases} x_1 - l_{11} x_1 + l_{12} x_2 + \cdots + l_{1p} x_p \\ x_2 - l_{21} x_1 + l_{22} x_2 + \cdots + l_{2p} x_p \\ \cdots \cdots \cdots \\ z_m - l_{m1} x_1 + l_{m2} x_2 + \cdots + l_{mp} x_p \end{cases}$$

z_1 is $x_1, x_2, \cdots, x_p$ the maximum variance in all linear combinations ; z_2 is $x_1, x_2, \cdots, x_p$ maximum variance in all linear combinations and uncorrelated to z_1 ; z_m is $x_1, x_2, \cdots, x_p$ maximum variance in all linear combinations and uncorrelated to $z_1, z_2, \cdots z_{m-1}$.

Based on above selected new indicators $z_1, z_2, \cdots, z_m$ are original indicators $x_1, x_2, \cdots, x_p$ first, second…、 m principal component. In total variance, maximum proportion is z_1, and then $z_2, z_3, \cdots, z_m$ variance gradually diminishes. In realistic questions, we often choose former ones of maximum principal components, the purpose for that is reducing indictors and also making clear main contradictions and simplifying indicators relations.

Based on above analysis, it is clear that principal components achieving is to define original indicator $x_j (j = 1,2,\cdots, p)$ in principal component $z_i (i = 1,2,\cdots, m)$ load $1_{ij} (i = 1,2,\cdots; m; j = 1,2,\cdots; p)$. They are respectively $x_1, x_2, \cdots, x_p$ correlation matrix m pieces of larger feature values corresponding features vectors.

System establishment

Input initial data all individuals' data one by one into above each principal component linear combination formula, and then calculate and get all subjects principal component scores. Students' n time's gymnastics testing results relative absolute indicators have: the teachers teaching class represented overall level average scores:

$$\bar{c} = \frac{n\text{times tests total result}}{n\text{times tests total participants}}$$

The teachers' teaching class represented variation degree uses variance:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(c_i - \bar{c})^2}$$

Now we accept mass education, teachers' one of important teaching task is to let student master basic knowledge, so teaching estimation should consider pass rate:

$$\alpha = \frac{n\text{times tests qualified number of people}}{n\text{times tests total participants}}$$

Another indicator that represents university gymnastic teachers' teaching abilities is excellent rate:

$$\beta = \frac{n\text{times tests number of excellent people}}{n\text{times tests total participants}}$$

Relative indicator:

Grade progress is beneficial to facilitate learning impetus improving; therefore progress rate $\gamma = \sum_{i=1}^{n-1}\frac{E_i}{N_i}$ is a kind of important indicator to evaluate university gymnastics teachers.

By principal component analysis of these five indicators, it can get objective gymnastics teachers teaching comprehensive evaluation value indicator E. The paper random selects one university's four classes and respectively record them as A, B, C, D. The four classes' principal components are as following:

Progress rate: $x_1 = (0.666667, 0.454545455, 0.675676, 0.774194)$.

Pass rate: $x_2 = (0.930555556, 0.909090909, 0.932432432, 0.983870968)$.

Excellent rate: $x_3 = (0.152777778, 0.227272727, 0.135510511, 0.24935484)$.

Average value: $x_4 = (74.59722222, 76.25, 73.32432432, 76.67741935)$.

Standard deviation: $x_5 = (5.103538321, 8.8705975, 6.480966119, 5.139267531)$.

Firstly, respectively solve evaluated gymnastics teachers' classes i (i=1, 2, 3, 4) the j (j=1, 2, 3, 4, 5) Indicator x_{ij}, and then further establish original data matrix X:

$$X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{bmatrix}^T = \begin{bmatrix} 0.66667 & 0.93056 & 0.15278 & 74.597 & 5.1035 \\ 0.45455 & 0.90909 & 0.22727 & 76.25 & 8.8706 \\ 0.67568 & 0.93243 & 0.13551 & 73.324 & 6.481 \\ 0.77419 & 0.98387 & 0.24194 & 76.677 & 5.1393 \end{bmatrix}$$

Secondly, with an aim to get rid of indicators dimensions interference, by standardization processing, it gets standard matrix Z, from which $Z_{ij} = (x_{ij} - \overline{x_i})/s_j$. It further establishes x_i and x_j correlation matrix v feature equation, and gets feature root $(\lambda_1, \lambda_2, \cdots \lambda_p)$, and by $q_i = \frac{\lambda_i}{\sum \lambda_i}$ calculation, it gets contribution rate q_i.

Component analysis	Feature root λ_i	Contribution rate q_i
(x_1)1	2.36259	0.47252
(x_2)2	1.35642	0.27128
(x_3)3	1.281	0.2562
(x_4)4	0	0
(x_5)5	0	0

And then, by orthogonal transformation Jacobi iteration method, calculate and get corresponding feature vector matrix as following:

$$\begin{bmatrix} 0.29714 & 0.47187 & -0.43607 & -0.64782 & 0.28146 \\ -0.41695 & 0.63211 & 0.065738 & -0.056332 & -0.64738 \\ 0.73834 & -0.16843 & -0.083372 & -0.0092981 & -0.64765 \\ 0.25441 & 0.47054 & -0.31631 & 0.75816 & 0.1975 \\ 0.35776 & 0.35776 & 0.8\ 3577 & -0.047567 & 0.20791 \end{bmatrix}$$

Finally, by Matlab software, it calculates score matrix as:

$$\begin{bmatrix} -1.6257 & -0.065298 & -0.019943 & -1.711 \\ 0.11259 & 0.78723 & -0.33308 & 0.56674 \\ 0.17744 & 0.0092437 & 0.85307 & 1.0398 \\ 0.40092 & -0.73449 & -0.42562 & -0.75919 \end{bmatrix}$$

By score matrix, it can calculate E(A)= -3.4219, E(B)= 1.1335, E(C)= 2.0796, E(D)= -1.5184. Based on above data, it can get: Class A is the worst, secondary is class D, the third is class B, the best is class C.

GYMNASTICS TEACHING QUALITY MULTIPLE HIERARCHY FUZZY COMPREHENSIVE EVALUATION MODELS

Multiple hierarchy fuzzy comprehensive evaluation theory

Set k layer component element domain of discourse U($k \geq 2$), $U = (U_1^{(1)} \ U_2^{(1)} \ \cdots \ U_m^{(1)})$ is first layer (top layer) m pieces of elements, $V = (v_1 \ v_2 \ \cdots \ v_n)$ is its remark set, then multiple hierarchy fuzzy comprehensive evaluation model is (in general, it selects $k = 4$): $B = A \circ R$, from which each layer weight vector is using A to express, the x+1 layer each weight vector is using x to express, the bottom layer (the k layer) fuzzy relation matrix is using R to express.

Multiple hierarchy fuzzy comprehensive evaluation method is calculating layer-to-layer from bottom layer (the k layer), until finally getting final remark set B. The k layer evaluation conclusion is the $k-1$ layer element membership. Calculation steps are:

(1) Go ahead with the fourth layer calculation, respectively get that:

$$
\begin{aligned}
B_{111} &= A_{111} \circ R_{111} \\
B_{112} &= A_{112} \circ R_{112} \\
&\vdots \\
B_{11s} &= A_{11s} \circ R_{11s} \\
&\vdots \\
&\vdots \\
B_{mq1} &= A_{mq1} \circ R_{mq1} \\
B_{mq2} &= A_{mq2} \circ R_{mq2} \\
&\vdots \\
B_{mqo} &= A_{mqo} \circ R_{mqo}
\end{aligned}
$$

After completing the third layer calculation, let $R_1 = \begin{pmatrix} B_{11} \\ B_{12} \\ \vdots \\ B_{1p} \end{pmatrix}, \quad \cdots, \quad R_m = \begin{pmatrix} B_{m1} \\ B_{m2} \\ \vdots \\ B_{mq} \end{pmatrix}$

$$
\begin{aligned}
B_1 &= A_1 \circ R_1 \\
&\vdots \\
B_m &= A_m \circ R_m
\end{aligned}
$$

(2)Implement the second layer calculation and get , after second layer calculation, set $R = \begin{pmatrix} B_1 \\ \vdots \\ B_m \end{pmatrix}$.

(3) Enter into the top layer calculation, it gets final remark set $B = A \circ R$, and then make quantification.

Model establishment

Now common evaluation way is ultimate evaluation, that is to say, it uses results to evaluate gymnastics teachers. Then in the method, how to analyze students final results so that can objective reflect teachers' teaching. The paper considers students' gymnastics technology level represented absolute indicator and relative indicator. Make principal component analysis of defined indicators, and then it gets comprehensive evaluation values. If only consider using gymnastics course final results to evaluate, it causes indicators to be single, so the paper adds other indicators. Therefore, the paper puts forward gymnastics teachers' evaluation's other indicators (that are divided into main factors and sub factors). Due to make quantitative analysis of these indicators evaluation is not easy; that is to say, fuzzy data are too many, therefore the paper adopts multiple hierarchy fuzzy comprehensive evaluation method to establish model, as following TABLE 1.

TABLE 1 : Gymnastics education teaching quality evaluation indicator system

The first layer	The second layer (main factor)	The third layer (sub factor)
Teaching quality	Teaching attitude F1(0.2)	Classroom readiness degree F11(0.3)
		Classroom teaching records F12(0.3)
		Work correction and after-school tutoring F13(0.4)

	Fulfill syllabus requirements F21(0.2)
Teaching content F2(0.3)	Extracurricular materials and textbook combination F22(0.4)
	Classroom discussion implementing F23(0.4)
	Students gymnastics interest stimulating F31(0.4)
Teaching strategies and methods F3(0.2)	Gymnastics lecturing appropriateness F32(0.3)
	Guide for differences, focus on teaching according to one's aptitude F33(0.3)
	Test results at ordinary time F41(0.4)
Teaching efficiency F4(0.3)	Gymnastics exchange and applying capacity F42(0.4)
	Classroom attendance rate and work hand in rate F43(0.2)

At first, establish investigation table about evaluation on university gymnastic teachers' teaching quality and level, then make investigation interviewing, obtained data is as TABLE 2.

TABLE 2: Number of students and teachers attend lectures statistics according to grade evaluation on each indicator

Main factor	Sub factor	Students evaluation (200 people)					Teachers attending lectures evaluation (4 people)				
		Excellent	Good	Normal	Poor	Bad	Excellent	Good	Normal	Poor	Bad
Teaching attitude F1(0.2)	F11(0.3)	46	24	26	4	0	1	1	0	0	0
	F12(0.3)	42	20	32	4	2	1	0	1	0	0
	F13(0.4)	20	18	50	10	2	0	0	1	1	0
Teaching content F2(0.3)	F21(0.2)	34	26	18	22	0	0	1	1	0	0
	F22(0.4)	18	29	36	17	0	0	0	1	1	0
	F23(0.4)	17	18	36	28	1	0	0	1	1	0
Teaching strategies and methods F3(0.2)	F31(0.4)	48	24	18	10	0	0	2	0	0	0
	F32(0.3)	40	28	30	2	0	1	0	1	0	0
	F33(0.3)	28	34	29	8	1	0	2	0	0	0
Teaching efficiency F4(0.3)	F41(0.4)	50	26	20	3	1	2	0	0	0	0
	F42(0.4)	16	24	31	25	4	0	0	2	0	0
	F43(0.2)	46	26	22	6	0	1	0	1	0	0

Secondly, analyze collected objects to the third layer indicator's fuzzy evaluation, as TABLE 3.

TABLE 3: 200 students to indicator F11 (lessons preparation full extent) fuzzy evaluation

Grade	Excellent	Good	Normal	Poor	Bad
Number of people	46	24	26	4	0
Percentage	0.46	0.24	0.26	0.04	0.00

The evaluation result can use fuzzy set to record as R111= (0.46, 0.24, 0.26, 0.04, 0.00). Similarly, it can solve 200 students to indicator F12、F13 fuzzy evaluation fuzzy set:

R112=(0.42, 0.20, 0.32, 0.04, 0.02)

R113=(0.20, 0.18, 0.50, 0.10, 0.02)

Thereupon, it gets students to indicator F1 single factor evaluation matrix:

$$R11=\begin{bmatrix} 0.46 & 0.24 & 0.26 & 0.04 & 0.00 \\ 0.42 & 0.20 & 0.32 & 0.04 & 0.02 \\ 0.20 & 0.18 & 0.50 & 0.10 & 0.02 \end{bmatrix}$$

Then, analyze collected objects to the second layer indicator's fuzzy evaluation. Teaching attitude F1 four indicators weights allocation is
F11(0.3)、F12(0.3)、F13(0.4), is can use fuzzy set to express as A11=(0.3, 0.3, 0.4). Thereupon, it gets 200 students to F1 comprehensive evaluation as:

$$B11'=(0.3, 0.3, 0.4).\begin{bmatrix} 0.46 & 0.24 & 0.26 & 0.04 & 0.00 \\ 0.42 & 0.20 & 0.32 & 0.04 & 0.02 \\ 0.20 & 0.18 & 0.50 & 0.10 & 0.02 \end{bmatrix}=(0.3440\ 0.2040\ 0.3740\ 0.0640\ 0.0140)$$

Normalize evaluation result B1', by 0.3440+0.2040+0.3740+0.0640+ 0.0140=1, it gets:

$$B11=\left(\frac{0.3440}{1},\frac{0.2040}{1},\frac{0.3740}{1},\frac{0.0640}{1},\frac{0.0140}{1}\right)=(0.3440\ 0.2040\ 0.3740\ 0.0640\ 0.0140)$$

The normalization result shows that in 200 students, 34.40% student's evaluation on the teacher teaching attitude is "excellent", 20.40% evaluation is "good", 37.40% evaluation is "normal", 6.40% evaluation is "poor", and 1.40% evaluation is "bad". Similarly, it can get the100 students to teaching content F2, teaching strategies and methods F3, teaching efficiency F4 comprehensive evaluation as:

B12=(0.2008 0.24 0.324 0.24 0.004)

B13=(0.3960 0.2820 0.2490 0.0700 0.0030)

B14=(0.3560 0.2520 0.2480 0.1240 0.0200)

Thereupon, it can get:

$$R_1=\begin{bmatrix} 0.3340 & 0.2040 & 0.3740 & 0.0640 & 0.0140 \\ 0.208 & 0.24 & 0.324 & 0.224 & 0.004 \\ 0.3960 & 0.2820 & 0.2490 & 0.0700 & 0.0030 \\ 0.3560 & 0.2520 & 0.2480 & 0.1240 & 0.0200 \end{bmatrix}$$

So:

$$B1=A1\circ R1=(0.2\ 0.3\ 0.2\ 0.3)\circ\begin{bmatrix} 0.3340 & 0.2040 & 0.3740 & 0.0640 & 0.0140 \\ 0.208 & 0.24 & 0.324 & 0.224 & 0.004 \\ 0.3960 & 0.2820 & 0.2490 & 0.0700 & 0.0030 \\ 0.3560 & 0.2520 & 0.2480 & 0.1240 & 0.0200 \end{bmatrix}=(0.3172\ 0.2448\ 0.2962\ 0.1312\ 0.0106)$$

B1 is students to the teacher fuzzy comprehensive evaluation, it shows 31.72% student's evaluation on the teacher is "excellent", 24.48% evaluation is "good", 29.28% evaluation is "normal", 13.12% evaluation is "poor", and 1.06% evaluation is "bad". Similarly, it can get teachers attend lectures to the teacher fuzzy comprehensive evaluation result as:

B2=(0.2400 0.2000 0.4000 0.1600 0.0000)

$$R1' = \begin{bmatrix} 0.3150 & 0.2423 & 0.2928 & 0.1289 & 0.0210 \\ 0.2400 & 0.2000 & 0.4000 & 0.1600 & 0.0000 \end{bmatrix}$$

So $R = (0.4 \quad 0.6) \circ R_1^{'}$ =(0.2700 0.2169 0.3571 0.1476 0.0084)

Now give scores to each remark:" Excellent"——90~100 ; "Good"——80~89 ; "normal"——70~79 ; "poor"——60~69 ; "bad"——50~59. Therefore, the gymnastic teacher fuzzy comprehensive evaluation score is (all score sections respectively take middle value):

$$G = 0.2708 * 95 + 0.2179 * 85 + 0.3584 * 75 + 0.1484 * 65 + 0.0042 * 55 = 81.027$$

It belongs to "good" grade.

If make evaluations on multiple gymnastics teachers, model one gets a comprehensive evaluation value with students scores as objective evidence by principal component analysis, then combines with above obtained fuzzy comprehensive evaluation scores, it gets the two weights, result is a more objective final comprehensive evaluation value, from which the value size reflects in gymnastics teachers' teaching level, the value gets bigger, then it shows teaching level gets higher.

CONCLUSIONS

Comprehensive evaluation index system for gymnastics teaching, this paper get the representative of the overall level of the class average degree, divorced with variance, pass the final examination, gymnastics teachers teaching proficiency and progress rate the five indicators. Through principal component analysis to get objective comprehensive evaluation index of gymnastics teachers teaching; Then the test model, and finally get the comprehensive evaluation value. Multilevel fuzzy comprehensive evaluation model for gymnastics teaching quality, this article first listen to the teacher by students and teachers rank evaluation of each index statistics of the number of data, and then through the multi-level fuzzy evaluation indicators and the gymnastics teaching teacher evaluation level. The purpose is to promote the popularity of the sport in colleges and universities, gymnastics in colleges and universities teacher's teaching ability and level.

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