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Based on the fuzzy comprehensive evaluation and Markov chain of professional sports teaching quality comprehensive evaluation research

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ABSTRACT

In order to improve the effect of physical education teaching, this paper first of all the factors of teaching quality evaluation index system of fuzzy qualitative and quantitative analysis; Teaching evaluation can be divided into learning attitude, learning methods, learning ability, learning effects and five evaluation factors such as teaching level. The fuzzy comprehensive evaluation theory and method. Sports teaching quality evaluation model was constructed and transformed into 0 score. MATLAB for data processing, the composite scores of each class, the last on the basis of markov chain, put forward on the basis of consistent state before and after construction of transfer matrix, and with proper treatment, derived from the transfer matrix change information, to provide reasonable and effective evaluation of physical education teaching effect on the basis of theory and practice.

KEYWORDS

Fuzzy comprehensive evaluation; Teaching quality; Membership; Weight selection.

INTRODUCTION

The ordinary university sports study effect evaluation content mainly includes the theoretical knowledge to students, sports technique, physical quality and performance at ordinary times, proportion of 10-15%, 30-60%, 10-20%, 10-20%. Theoretical achievements mainly inspects students selected course related knowledge, sports technology and the physical quality mainly refer to the schools teaching outline unified evaluation criterion, performance at ordinary times, with reference to a class attendance, attitude in class by teachers. Current study effect evaluation in colleges and universities are unified, summative teacher evaluation model for evaluation.

Current study effect evaluation of colleges and universities, formulate unified standard, target, encourage students exercise actively, improve skills, the students master the theoretical knowledge into the exam results, to a certain extent, have greatly improved. But there is insufficient. The evaluation content is not comprehensive. The current evaluation at present, the lack of students in the learning process improvement, non-intelligence factors such as content of evaluation, the lack of incentive and guidance. One-sided cognitive evaluation purpose. Uniform standards, summative evaluation focusing on collecting information, diagnostic feedback purposes, ignore the evaluation also has incentive oriented, cultivate self cognitive function. Evaluation should not only learn from the past, and should be able to analysis now, looking to the future. Evaluation of single subject, subjectivity is stronger, can't scientifically quantitative analysis. To teacher evaluation as the only standard of evaluation model, easy cause error in evaluation, difficult to convince students to play an incentive role.

Wang Yan Zhou Hong (2006) pointed out that there is not enough physical education teaching evaluation method to choose science, evaluation standard is too simple, should according to the specific evaluation purpose, content, specific situation to choose the appropriate evaluation method[1]. NiJianYin (2012) for junior middle school sports teaching evaluation method are studied, research shows that based on the practice of research can be more scientific to promote students' physical education and health level[2]. This paper USES fuzzy comprehensive evaluation theory and method, physical teaching quality evaluation model was constructed.

FUZZY COMPREHENSIVE EVALUATION MODELS

In order to wholly understand students' learning status, the paper references each education thesis to define evaluation factors, divides it into learning attitude, learning method, learning ability, learning efficiency and faculty level five items, and divides into twenty factors to make questionnaire survey, questionnaire statistics is as following TABLE 1.

Evaluation grade (remark) defining

In the questionnaire table, each evaluation factor has three or four options, to three options, on a whole, we can use qualitative description method to describe evaluation grade as: Good, normal, bad. Transfer it into quantitative description, then evaluation grade can be divided into 1points, 0.7 points, 0.4 points that is $v_j = (1 \quad 0.7 \quad 0.4)$. For four options' topic, on a whole, we can use qualitative description method to describe evaluation grade as: excellent, good, medium, bad. And transfer them into quantitative description, then evaluation grade can be divided into 1points, 0.8points, 0.6points, 0.4 points that is $v_j = (1 \quad 0.8 \quad 0.6 \quad 0.4)$.

Calculate evaluation factor membership A_j: $A_j = \frac{\sum_{i=1}^{12} A_{ijk}}{\sum_{i=1}^{12}\sum_{k=1}^{n} A_{ijk}}$

For example: The first factor, sports fondness level selection, there are totally 371 people love sports. And there are totally 367 people generally like sports; while totally 75 people dislike sports. Input data and can solve:

TABLE 1 : Questionnaire statistical table

Evaluation element	Evaluation factor	Excellent (good)	Good (normal)	Medium (bad)	Bad
T_1 Learning attitude	1	371	367	75	
	2	600	153	60	13
	3	243	403	98	66
	4	346	256	183	
	5	259	453	102	
T_2 Learning method	6	423	272	106	
	7	502	137	156	24
	8	359	329	105	29
	9	600	153	60	14
T_3 Learning ability	10	503	258	43	
	11	274	444	78	
	12	420	257	139	
	13	502	259	43	
	14	264	444	88	
T_4 Learning efficiency	15	300	153	357	
	16	502	259	43	
	17	264	444	88	
	18	229	498	85	
T_5 Faculty level	19	744	53	8	
	20	174	382	180	
	21	564	122	11	
	22	286	422	61	

$$A_1 = \left[\frac{371}{371+367+75} \quad \frac{367}{371+367+75} \quad \frac{75}{371+367+75} \right]$$

That is: $A_1 = [0.5038 \quad 0.4250 \quad 0.0667]$.

Similarly it can solve each evaluation grade membership matrix A.

$$A = \begin{bmatrix} 0.5083 & 0.4250 & 0.0667 & 0 \\ 0.3500 & 0.1917 & 0.4583 & 0 \\ 0.7227 & 0.2605 & 0.0168 & 0 \\ 0.4649 & 0.4649 & 0.0702 & 0 \\ 0.4683 & 0.3095 & 0.2222 & 0 \\ 0.5172 & 0.3017 & 0.1810 & 0 \\ 0.9914 & 0.0086 & 0 & 0 \\ 0.4138 & 0.5345 & 0.0517 & 0 \\ 0.8899 & 0.1009 & 0.0092 & 0 \\ 0.7458 & 0.1780 & 0.0508 & 0.0254 \\ 0.6083 & 0.1417 & 0.2167 & 0.0333 \\ 0.7227 & 0.2605 & 0.0168 & 0 \\ 0.4649 & 0.4649 & 0.0702 & 0 \\ 0.4919 & 0.2903 & 0.1774 & 0.0403 \\ 0.3223 & 0.2397 & 0.1570 & 0.2810 \\ 0.4000 & 0.3545 & 0.2455 & 0 \\ 0.2991 & 0.5897 & 0.1111 & 0 \\ 0.5568 & 0.3864 & 0.0568 & 0 \\ 0.3304 & 0.5478 & 0.1217 & 0 \\ 0.7458 & 0.1780 & 0.0508 & 0.0254 \end{bmatrix}$$

So that it can solve each topic comprehensive score: $B_j = A_j v_j{}'$

For example, it can solve:

$$B_1 = A_1 v_1' = (0.5083 \quad 0.4250 \quad 0.0667 \quad) \begin{bmatrix} 1 \\ 0.7 \\ 0.4 \end{bmatrix} = 0.8325$$

Finally it can solve fuzzy evaluation matrix:

$$B = \begin{bmatrix} 0.8352 \\ 0.6858 \\ 0.9124 \\ 0.8212 \\ 0.8081 \\ 0.9974 \\ 0.8107 \\ 0.964 \\ \vdots \end{bmatrix}$$

Define each evaluation indicator weight

There are many methods to define evaluation indicator weights; it mainly has Delphi method, panel of experts consulting method, questionnaire survey, and analytic hierarchy process and so on. Reference above method can define each topic impacts on evaluation factor T_l, define its weights as w_l, for example impacts on learning attitude T_1, it can endow 1, 10, 15, 16, 19 weights as w_1=(0.1 0.2 0.2 0.3 0.2)

Solve fuzzy relation matrix

Learning attitude fuzzy relation matrix T_1:

$$T_1 = w_1 \cdot B_j = (0.1 \quad 0.2 \quad 0.2 \quad 0.3 \quad 0.2) \begin{bmatrix} 0.8325 \\ 0.9388 \\ 0.7207 \\ 0.7562 \\ 0.7675 \end{bmatrix} = 0.7958$$

Similarly it can solve that learning method is:0.8673、 learning ability is:0.8409、 learning efficiency is:0.8094、 faculty level is:0.9067. Therefore, it is clear that the department students' learning attitude is relative poor, faculty level is better, teachers mostly could do the due diligence themselves. It furthermore can solve students' overall level comprehensive score:

$$Q = T_l \lambda_l = (0.7958 \quad 0.8673 \quad 0.8409 \quad 0.8094 \quad 0.9067) \begin{bmatrix} 0.21 \\ 0.19 \\ 0.20 \\ 0.22 \\ 0.18 \end{bmatrix} = 0.8414$$

In the following, we can also transform a group of fuzzy evaluation into quantity scores---centesimal system score is: $0.8414 \times 100 = 84.14$ points.

To sum up, the department students are wholly good, comprehensive score is 84.14.

MARKOV CHAIN MODEL

Markov chain is a mathematical model that establishes on the random process. Due to in sports teaching evaluation field, numerous evaluation objects forming process can be regarded as or approximately regarded as random process, together with evaluators' demands of understanding evaluation objects future value status, it let Markov chain to be widely applied in sports teaching evaluation.

Advantage of applying Markov chain method into sports teaching evaluation is considering that evaluation should eliminate basis differences. For example when evaluate different teachers' teaching effects, it tends to give evaluation based on teachers' lectured students' final performance. In fact, different teachers' lectured class students' differences in original levels affect students' final test performance. If simply evaluate teachers' teaching effects according to students' final performances without considering students' basic differences' affects, obtained conclusion cannot surely reflect practical situations, and the result is hard to be convincing. Thereupon, Markov chain analysis method considers students' original state, under the same criterion, divides students' original performance into same grade that is to define state space, and then solves one step transfer matrix, finally according to Markov chain stationary and periodicity, it solves extreme vector, and makes comparison and judgment according to extreme vector.

Markov chain basic thought

Markov chain application in sports teaching evaluation is on the basis of twice testing that is "Pre-test and post-test designing", through carefully analyzing students' twice testing changes in different performance grades, it constructs transfer matrix. On the condition that assume teaching efficiency remains steady, obtained Markov chain steady distribution state can show students' final achieved extent. Concrete thought is as following:

In teaching efficiency indicator quantization process, apply Markov chain to respectively classify a class (or grade) students' original performance according to high-low into q pieces of grades, and then calculate each grade students' numbers to total numbers ratio as state vector, use A to express:

$$A = \begin{pmatrix} \frac{n_1}{n} & \frac{n_2}{n} & \cdots & \frac{n_q}{n} \end{pmatrix}$$

Among them, n is students total number, n_i is the i (i=1, 2, $\cdots$ q) grade number of people.

After several stages' teaching, in order to investigate teaching efficiency, it needs to analyze above each grade students' changing status after stage teaching, similarly also classify students' performance tested after stage teaching according to high-low into q pieces of grades, count each grade contained students' frequency, and further solve as next step transfer matrix P:

$$P=\begin{pmatrix} \frac{n_{11}}{n_1} & \frac{n_{12}}{n_1} & \cdots & \frac{n_{1q}}{n_1} \\ \frac{n_{21}}{n_2} & \frac{n_{22}}{n_2} & \cdots & \frac{n_{2q}}{n_2} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{n_{q1}}{n_q} & \frac{n_{q2}}{n_q} & \cdots & \frac{n_{qq}}{n_q} \end{pmatrix}=\left(P_{ij}\right)_{q\times q}$$

Among them, n_i still represents preliminary stage the i grade students amount, n_{ij} represents after stage teaching, affiliated to the i grade students performances belong to the j kind students amount, and meet $\sum_{j=1}^{q} p_{ij}$ = 1, $0 \le P_{ij} \le 1$ (i, j=1, 2, $\cdots q$)

If to research multiple steps ($k>1$) transition probability $P_{(k)}$, utilize Chamman-Kolmogorov equation, it has: $P_{(k)}$ = $P_{(K-1)}$ $P_{(1)}$ = … = [$P_{(1)}$] ^{K}

When $k \sim \infty$, if Markov process involved each state probability distribution is steady and unchanged (the attribute is called periodicity, corresponding probability distribution is steady distribution), thereupon, it can solve steady probability vector, the steady and unchanged probability vector becomes evaluation criterion, and then get concrete quantitative indicator value by solving equation set.

Model application

(1) Value state consistency

In teaching practice, utilize Markov chain method to evaluate sports teaching, generally it applies successive two values states (as twice test results) connections to describe transition probability matrix, and accordingly make evaluation on evaluation object achieved current state practices. But whether successive twice used value scale is consistent or not, successive twice evaluation scenes of evaluation objects are consistent or not, both of them will affect defined state matrixes. Now take one class successive twice tests as examples, assume the first time the class test average result is 80 points, standard deviation is 10 points, and there are ten people in [100, 90] points, fifteen people in [90, 80] points, ten people in [80, 70]points, six people in [70, 60]points, four people in [60, 0] points. In the second time test, the class average result is 85points, standard deviation is 8points. And, the first time test result distribution in the second time test result is as TABLE 2:

TABLE 2: Twice test original result relation

		The second time test result				
		100~90	**90~80**	**80~70**	**70~60**	**60~0**
The first time test result	100~90	8	2			
	90 ~80	3	12			
	80 ~70		5	2	3	
	70 ~60			3	3	0
	60 ~0				2	2

Therefore established transition probability matrix is:

$$\begin{pmatrix} 0.8 & 0.2 & 0 & 0 & 0 \\ 0.2 & 0.8 & 0 & 0 & 0 \\ 0 & 0.5 & 0.2 & 0.3 & 0 \\ 0 & 0 & 0.5 & 0.5 & 0 \\ 0 & 0 & 0 & 0.5 & 0.5 \end{pmatrix}$$

On the other hand, if both transform twice test results into Z- standard score, then it can change TABLE 2 into TABLE 3:

TABLE 3 : Twice test Z- Standard score result relation

		The second time test result				
		1.88 ~ 0.63	**0.63 ~ -0.63**	**-0.63- ~ -1.88**	**-1.88 ~ -3.22**	**-3.22 ~ -10.630**
The first time test result	2 ~ 1	8	2			
	1 ~ 0	3	12			
	0 ~ -1		5	2	3	
	-1 ~ -2			3	3	0
	-2 ~ -8				2	2

By above TABLE 3, it is clear that successive twice test scores are not equal, first time test result five states and second time test results five states have no comparability. Therefore, established transition probability matrix significances are unconvinced.

(2) Value state probability distribution

Markov chain described process is when K tends to be infinitely great, appears or arrives at each state probability distribution is steady and unchanged, and then it can utilize Markov chain model to evaluate. When utilize obtained probability vector to solve equation set, it has already artificially defined vector feature root as 1, and further establish evaluation criterion. As for each state arrive at stable and unchanged or not, utilize should verify by solving, and in practical teaching application, evaluator don't consider the condition but assume it arrives at steady state, in fact, the condition has certain effects on constructing steady probability distribution.

Model improvement

(2) Construct transition matrix

Combine students' successive twice test results into a sample (x_{11}, x_{12}, $\cdots, x_{1m}$, x_{21}, x_{22}, $\cdots, x_{2m}$), solve its average number ($\overline{X}$) and standard deviation (S). Due to research shows that students' academic achievement basically is in normal distribution or gets closer to normal distribution, therefore according to normal distribution law, utilize $\overline{X}$ and S can classify certain intervals' q pieces of grades. Then use q pieces of grades to calculate students previous time test each grade students number occupied total number proportion's state vector, use A to express: $A = \begin{pmatrix} \frac{n_1}{n} & \frac{n_2}{n} & \cdots & \frac{n_q}{n} \end{pmatrix}$

Among them, n is students total number, n_i is the i (i =1, 2, $\cdots$ q) grade number of people.

In order to investigate teaching effects, it needs to analyze above each grade students each grade changing status in the second time test. Similarly also according to q pieces of grades interval criterion, count second time test result each grade contained students' frequency, and further solve as following one step transition matrix P:

$$P=\begin{pmatrix} \frac{n_{11}}{n_1} & \frac{n_{12}}{n_1} & \cdots & \frac{n_{1q}}{n_1} \\ \frac{n_{21}}{n_2} & \frac{n_{22}}{n_2} & \cdots & \frac{n_{2q}}{n_2} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{n_{q1}}{n_q} & \frac{n_{q2}}{n_q} & \cdots & \frac{n_{qq}}{n_q} \end{pmatrix} = (P_{ij})_{q\times q}$$

Among them, n_i still represents the preliminary stage the i grade students number, n_{ij} represents after stage teaching, affiliated to i grade students performance that belong to j kind students number, and meet $\sum_{j=1}^{q} p_{ij} = 1$, $0 \le P_{ij} \le 1$, ($i.j$ =1, 2, $\cdots q$). In this way it solves value states inconsistency problems, and fully gives Markov chain one step transition matrix features into play, that is to say, it can eliminate basic differences, and also can concentrate on reflecting its changing efficiency advantage.

(2) Establish model and analysis

In order to avoid Markov chain occurring multiple steps transition, and is required to solve steady probability distribution on the condition of extreme state such rigor condition. After considering one step transition matrix, utilize students " progress degree" that students make progress or retrogress such problems, which is to concern a class or a grade students' performance is as progress is larger than retrogress, or retrogress is larger than progress, to grasp the overall progress status. Now assume that cultivate i grade students into $j(i > j)$ grade students is progress, cultivate i grade students into $j(i < j)$ grade students is retrogress, grasp the point then it can eliminate basic difference, and meanwhile can also reflect teaching efficiency merits. In order to correctly refine changing information from transition matrix, specially establish following model:

$S^{ij} = (i-j)^3\ p^{ij} = \frac{(i-j)^3 n_{ij}}{n_i}$, ($i.j$ =1, 2, $\cdots q$). Among them, S^{ij} is called p_{ij} transferring progress degree, $(i-j)^3$ is called p^{ij} weight. $i-j$ value size and positive or negative represents progress or retrogress extent, index "3" is used to adjust positive or negative and weight sizes.

$S = (S_{ij})_{q\times q} = \left|\frac{(i-j)^3 n_{ij}}{n_i}\right|_{q\times q}$ is called transition matrix p_{ij} progress matrix.

$E_{(s)} = \sum_{i=1}^{q}\sum_{j=1}^{q} s_{ij} = \sum_{i=1}^{q}\sum_{j=1}^{q}(i-j)^3 p_{ij} = \sum_{i=1}^{q}\sum_{j=1}^{q}(i-j)^3 \frac{n_{ij}}{n_i}$ is called transition matrix p_{ij} efficiency degree.

Model comparison

Now assume that its test used value scale is consistent. In the end of first school year, two classes sports comprehensive test each grade state vector (excellent, good, medium, qualified, unqualified):

$C_A = (\frac{8}{46}, \frac{23}{46}, \frac{7}{46}, \frac{7}{46}, \frac{1}{46})$, ($C_B = (\frac{7}{46}, \frac{22}{46}, \frac{8}{46}, \frac{8}{46}, \frac{1}{46})$

After one year teaching, two class's students' sports state probability transition matrix:

$$P_A = \begin{pmatrix} \frac{3}{8} & \frac{1}{4} & \frac{1}{8} & 0 & \frac{1}{4} \\ \frac{5}{23} & \frac{10}{23} & \frac{4}{23} & \frac{4}{23} & 0 \\ \frac{1}{7} & \frac{2}{7} & \frac{4}{7} & 0 & 0 \\ 0 & \frac{1}{7} & \frac{3}{7} & \frac{3}{7} & 0 \\ 0 & 0 & 0 & 1 & 0 \end{pmatrix} \quad P_B = \begin{pmatrix} \frac{2}{7} & \frac{3}{7} & \frac{1}{7} & \frac{1}{7} & 0 \\ \frac{8}{22} & \frac{9}{22} & \frac{3}{22} & \frac{2}{22} & 0 \\ \frac{1}{8} & \frac{3}{8} & \frac{1}{2} & 0 & 0 \\ 0 & 0 & \frac{5}{8} & \frac{1}{4} & \frac{1}{8} \\ 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

Set grade state vector (excellent, good, medium, qualified, unqualified) respectively to be replaced by (1, 2, 3, 4, 5,), it can get P_A progress matrix is:

$$S_A \begin{pmatrix} 0 & -\frac{1}{4} & -1 & 0 & -12 \\ \frac{5}{23} & 0 & -\frac{4}{23} & -\frac{32}{23} & 0 \\ \frac{8}{7} & \frac{2}{7} & 0 & 0 & 0 \\ 0 & \frac{8}{7} & \frac{3}{7} & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{pmatrix} \quad S_B = \begin{pmatrix} 0 & -\frac{3}{7} & \frac{8}{7} & -\frac{27}{7} & 0 \\ \frac{8}{22} & 0 & -\frac{3}{22} & -\frac{32}{22} & 0 \\ 1 & \frac{3}{8} & 0 & 0 & 0 \\ 0 & 0 & \frac{5}{8} & 0 & -\frac{1}{8} \\ 0 & 0 & 0 & 1 & 0 \end{pmatrix}$$

It can get: $E(S_A) \approx -9.64$, $E(S_B) \approx -3.79$; Therefore, it shows class B teaching efficiency is obvious better than class A. Only from improved Markov chain method, it can also see that two classes teaching efficiency is not so high, because in the view of model perceptual intuition, if teaching efficiency is high, then cultivate i grade students into $j(i > j)$ grade students would be more, $i - j$ value is positive, possibility that $E_{(s)} = \sum_{i=1}^{q}\sum_{j=1}^{q}(i-j)^3 \frac{n_{ij}}{n_i}$ to be positive would be large.

CONCLUSION

The paper through students' reflection and evaluation, applies fuzzy mathematical theory to establish fuzzy comprehensive evaluation mathematical model. Established fuzzy comprehensive evaluation model not only well solves sports teaching quality evaluation problem, but also the model can be promoted and applied into other evaluation models. Meanwhile used Markov chain considers transition matrix construction meanings, and fully utilizes Markov chain one step transition matrix basic features, correctly refines changing information from transition matrix without excessive assumption conditions, established model is simple, reasonable and practical, which has important significances in effective evaluating sports teaching effects.

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