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FULL PAPER

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Table tennis teaching quality evaluation system research and application based on fuzzy rough clustering method

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ABSTRACT

In order to objective evaluate table tennis teachers' education teaching quality, propel to table tennis teaching quality improvement, the research uses clustering rough sets method establishing table tennis education teaching quality evaluation system. The system carries out evaluation on teaching quality from teachers' morality, teaching design, teaching way and practice result these four aspects, establishes 3 layers' hierarchical structure, evaluates judgment matrix by constructing fuzzy clustering, it gets each indicator weight and bottom layer indicator combination weight, comprehensive indicator sizes calculated by combination weight can reflect table tennis teachers' teaching quality merits. The method uses fuzzy sets theory defining each indicator weight; evaluation result is more scientific and reasonable. The system makes up for the gap of table tennis education teaching quality evaluation; it has profound significance in propelling table tennis education development and improving table tennis teaching quality.

KEYWORDS

Clustering rough sets method;
Table tennis teaching, judgment matrix;
Teaching evaluation system.

INTRODUCTION

Table tennis teaching quality evaluation is an important method and way to measure table tennis teachers' teaching comprehensive level is also an important way to make scientific management on table tennis teaching. During previous teaching quality evaluation on table tennis teachers, it generally adopts experts' evaluation, colleagues' mutual evaluation and students evaluation these three ways combining, in evaluation process, artificial factors have great influences, evaluation result may have bigger differences with actual status, therefore it is difficult to reflect authenticity and fairness, even may affect teachers' teaching enthusiasm and so harmful for teaching.

Table tennis teaching as a kind of sports teaching work, it has bigger difference with regard to other theoretical courses, table tennis teaching is basically going on sports field, meanwhile teaching objects cover school each major each level student, therefore factors defining in teaching evaluation is relative difficult; after defining factors, it is also not very realistic to make whole quantization of them, therefore, when carries out table tennis teaching quality evaluation it should implement according to qualitative and quantitative combination method. There are scholars that use analytic hierarchy process to do researches on sports teaching quality evaluation, but traditional analytic hierarchy process

FULL PAPER

normally use Saaty's weight approach to define each evaluation indicator weight, and require each paired comparative judgment matrix with satisfaction consistency, while in actual research, when orders are bigger, judgment matrix tends to be difficult to have satisfaction consistency, therefore established education teaching evaluation system may exist certain problems, and in sports education teaching quality evaluation research, all are targeted whole sports system teaching quality evaluation, table tennis teaching quality evaluation research has not yet appeared, and different sports courses have different features, use the same evaluation indicator system may also not realistic reflect teachers' teaching quality.

In order to make up for table tennis teaching quality evaluation research shortcomings, and overcome traditional evaluation method drawbacks, the research uses clustering rough sets method to make table tennis teaching quality evaluation, in the hope of providing certain references for the table tennis teaching quality evaluation.

TABLE TENNIS TEACHING QUALITY EVALUATION'S CLUSTERING ROUGH SETS METHOD INTRODUCTION

Clustering rough sets method is proposed to make up for traditional analytic hierarchy process difficulties and not scientific on testing and judging judgment matrix consistency aspect, its principle is basically the same as analytic hierarchy analysis, is also at the same time use qualitative analysis and quantitative analysis systematical analysis method, the method can systematize, quantize and modeling the complicated problems, which is also for a complicate problem, firstly decomposes it into several composition elements, and further decomposes these elements into more clear, concrete, quantifiable small factors that are indicators, according to the same layer each factor importance, it defines its weight, after using weights to connect each layer, it forms a multiple objects, multiple levels statistical model. Clustering rough sets method and traditional analytic hierarchy process have mainly two differences, one is analytic hierarchy process constructs judgment matrix by each indicator paired comparison, and needs to test judgment matrix consistency, while clustering rough sets method constructs fuzzy consistency judgment matrix through each evaluation indicator paired comparison, no need to do consistency testing; the other is two method calculate each evaluation indicator weight methods are different.

Clustering rough sets method and traditional analytic hierarchy process basic steps are similar, as following show:

(1) Establish multi layer hierarchical structure, and form into objective tree graph. Clustering rough sets model normally contains three layers that are top layer, middle layer and bottom layer, refer to Figure 1. Top layer is the objective layer that is the general objective for making analytic hierarchy process researching; middle layer is also called restraint layer, is several main factors that affect general objective; bottom layer is also called measure layer is final measure to solve problems, all are quantifiable indicators.

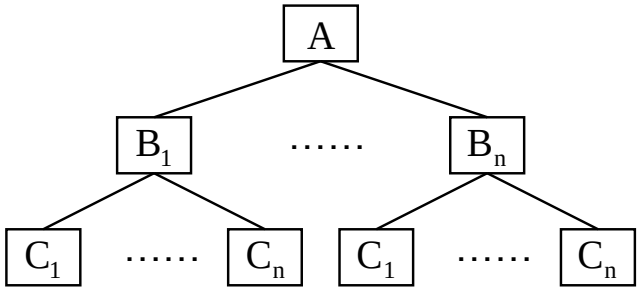

Figure 1 : Clustering rough sets model structure

(2) Construct fuzzy consistency judgment matrix

Use R to express fuzzy consistency judgment matrix, firstly select previous layer one indicator, define next layer correlated indicators, and make comparison of next layer each indicator relative importance. Assume previous layer indicator C can use next layer indicator $a_1, a_2, \cdots, a_n$ to explain, then it can construct fuzzy consistency judgment matrix, refer to TABLE 1.

Among them, $r_{ij}\,(i=1,2,\cdots,n;\ j=1,2,\cdots,n)$ represents when it makes comparison of previous layer indi-

TABLE 1 : Fuzzy consistency judgment matrix

C	a_1	a_2	...	a_n
a_1	r_{11}	r_{12}	...	r_{1n}
a_2	r_{21}	r_{22}	...	r_{2n}
...	...	...	...	...
a_n	r_{n1}	r_{n2}	...	r_{nn}

cator C's i evaluation indicator a_i and the j evaluation indicator a_j, indicator a_i and indicator a_j importance degree. In order to quantize "importance degree" such concept, it can use following evaluation standard, refer to TABLE 2.

According to Table 2 scoring method, indicator C evaluation indicator $a_1, a_2, \cdots, a_n$ making paired comparison, and then it can get fuzzy judgment matrix: $R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nn} \end{bmatrix}$

The judgment matrix has following three properties:

(1) $r_{ii} = 0.5, i = 1,2,\cdots,n;$

(2) $r_{ij} = 1 - r_{ji}, i, j = 1,2,\cdots,n;$

(3) $r_{ij} = r_{ik} - r_{jk}, i, j, k = 1,2,\cdots,n.$

3) Calculate each indicator weight

Given indicator $a_1, a_2, \cdots, a_n$ weight sets to be $W = (\omega_1, \omega_2, \cdots, \omega_n)$, then:

$$r_{ij} = 0.5 + a(\omega_i - \omega_j), \quad i,j = 1,2,\cdots,n$$

In formula, $0 < a \le 0.5, a$ is evaluator measurement on evaluation objects' difference level.

When R is consistent, above formula is not strictly true, at this time, it can use least square principle to solve weight vector $W = (\omega_1, \omega_2, \cdots, \omega_n)$, refer to following formula (1):

$$\begin{cases} \min z = \sum_{i=1}^{n}\sum_{j=1}^{n}[0.5 + a(\omega_i - \omega_j) - r_{ij}]^2 \\ s.t.\sum_{i=1}^{n}\omega_i = 1, \omega_i \ge 0, (1 \le i \le n) \end{cases} \quad (1)$$

According to Lagrange theorem, above formula and following formula are equivalent:

$$\min L(\omega,\lambda) = \sum_{i=1}^{n}\sum_{j=1}^{n}[0.5+a(\omega_i-\omega_j)-r_{ij}]^2 + 2\lambda(\sum_{i=1}^{n}\omega_i - 1)$$

In formula, λ is Lagrange multiplier.

Let $\min L(\omega,\lambda)$ relative $\omega_i (i = 1,2,\cdots,n)$ to calculate partial derivative, and let it equal to 0, and then it can get following equations (2):

$$a\sum_{j=1}^{n}[0.5 + a(\omega_i - \omega_j) - r_{ij}] - a\sum_{k=1}^{n}[0.5 + a(\omega_k - \omega_i - r_{ki}] + \lambda = 0 \quad (2)$$

$(i = 1,2,\cdots,n)$

The equations are equal to following equations (3):

$$\sum_{j=1}^{n}[2a^2(\omega_i - \omega_j) + a(r_{ji} - r_{ij}) + \lambda = 0 \quad (3)$$

$(i = 1,2,\cdots,n)$

The number of unknown in the equations is n+1, which are $\omega_1, \omega_2, \cdots \omega_n, \lambda$, the number of equations is n+1:

$$\begin{cases} 2a^2(n-1)\omega_1 - 2a^2\omega_2 - 2a^2\omega_3 - \cdots - 2a^2\omega_n + \lambda = a\sum_{j=1}^{n}(r_{1j} - r_{j1}) \\ -2a^2\omega_1 + 2a^2(n-1)\omega_2 - 2a^2\omega_3 - \cdots - 2a^2\omega_n + \lambda = a\sum_{j=1}^{n}(r_{2j} - r_{j2}) \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ -2a^2\omega_1 - 2a^2\omega_2 - 2a^2\omega_3 - \cdots + 2a^2(n-1)\omega_n + \lambda = a\sum_{j=1}^{n}(r_{nj} - r_{jn}) \\ \omega_1 + \omega_2 + \cdots + \omega_n = 1 \end{cases} \quad (4)$$

Solve the equations, and then it can get each evaluation indicator weight.

4) Use weighting method calculating bottom layer indicator combination weight C_i, C_i =B layer indicator weight*C layer indicator weight.

5) Calculate comprehensive knowledge *GI*, in selected evaluation indicators, in case if it has both low optimal indicator and high optimal indicator, it should proceed with same tendency handling, method is: High optimal indicator: Pi= Actual value/ Expectation value, Low optimal indicator: Pi= Expectation value/ actual value, after same tendency handling, calculate comprehensive indicator $GI = \sum_{j=1}^{m} C_i P_i$.

TABLE TENNIS TEACHING QUALITY EVALUATION SYSTEM CONSTRUCTION

Evaluation indicators selection

Table tennis teaching quality evaluation system is relative complicated, it has also many influence factors, therefore proceed with table tennis teaching quality evaluation system construction is a very huge project, whether evalu-

FULL PAPER

TABLE 2 : Clustering rough sets method each layer evaluation standard

Importance scale r_{ij}	Relative importance degree	Explanation
0.5	Equal important	By comparing two indicators, they are of equal importance.
0.6	Slightly important	By comparing two indicators, one indicator is slightly important than the other one.
0.7	Obvious important	By comparing two indicators, one indicator is obvious important than the other one.
0.8	Actually important	By comparing two indicators, one indicator is actually important than the other one.
0.9	Absolute important	By comparing two indicators, one indicator is absolute important than the other one.
0.1, 0.2, 0.3, 0.4	Comparing reversely	If indicator a_i and indicator a_j importance ratio is r_{ij}, then indicator a_j and indicator a_i importance ratio is $r_{ji} = 1 - r_{ij}$

TABLE 3 : Table tennis education teaching quality evaluation indicator system

First class indicator A	Second class indicator B	Third class indicator C
Education teaching quality A	Teachers' morality B1	Teaching plan preparation C1
		Term courses plan C2
		Start and end courses on time C3
		After –class training C4
	Teaching design B2	Content is plenty and reasonableC5
		Content linkageC6
		Supplement content utilization C7
	Teaching way B3	Scientificity C7
		Innovation C9
		Diversity C10
	Practice result B4	Students' capacity improvement C11
		Students' test result C12
		Teaching attraction C13

ation indicators selection is correct is the importance that affects evaluation system is suitable or not. In order to more comprehensive, more systematical and more scientific select table tennis education teaching evaluation quality system each indicator and improve system evaluation precise, it should let selected each indicator to be scientific and with realistic feasibility, during indicator selection process, it takes objective oriented, scientificity, integrality, objectivity and practicability as basic principles, combining with table tennis teaching quality evaluation basic theory, according to table tennis teaching actual status and table tennis teaching evaluation inherence, from teachers' morality, teaching design, teaching way and practice as well as others multiple aspects, preliminarily select table tennis teaching quality evaluation system influence factors as indicators. After preliminarily selecting indicators, it consults long-term go in for table tennis teaching professors, long-term participate teaching management works' experts as well as long-term working in table tennis theoretical researching experts, combines their opinions, finally it selects teachers' morality, teaching design, teaching way and practice result as sports teaching evaluation system indicators, each indicator carries out decomposing by using different indicators, finally it establishes a three layers hierarchical structure that can refer to TABLE 3.

Construct fuzzy consistency judgment matrix

According to above fuzzy consistency judgment

TABLE 4 : First class indicator fuzzy consistency judgment matrix

A	B1	B2	B3	B4
B1	0.5	0.8	0.7	0.6
B2	0.2	0.5	0.4	0.3
B3	0.3	0.6	0.5	0.4
B4	0.4	0.7	0.6	0.5

TABLE 5 : Second class indicator fuzzy consistency judgment matrix (Teachers' morality)

B1	C1	C2	C3	C4
C1	0.5	0.5	0.3	0.4
C2	0.5	0.5	0.3	0.4
C3	0.7	0.7	0.5	0.6
C4	0.6	0.6	0.4	0.5

TABLE 6 : Second class indicator fuzzy consistency judgment matrix (Teaching design)

B2	C5	C6	C7
C5	0.5	0.6	0.7
C6	0.4	0.5	0.6
C7	0.3	0.4	0.5

TABLE 7 : Second class indicator fuzzy consistency judgment matrix (Teaching way)

B3	C8	C9	C10
C8	0.5	0.6	0.6
C9	0.4	0.5	0.5
C10	0.4	0.5	0.5

TABLE 8 : Second class indicator fuzzy consistency judgment matrix (Practice result)

B4	C11	C12	C13
C11	0.5	0.7	0.8
C12	0.3	0.5	0.6
C13	0.2	0.4	0.5

matrix construction method, it constructs each class fuzzy consistency judgment matrix as following TABLE 4 to TABLE 8.

Calculate each indicator weight

For each fuzzy consistent judgment matrix, respectively construct equations (4) format equations, use Matlab software programming, and calculate each judgment matrix indicators' weights.

Table tennis education teaching quality each second class indicators' weight vector is $W_1 = [0.323,0.177,0.226,0.274]^T$.

Second indicator teachers' morality each evaluation indicator weight vector is $W_2 = [0.213,0.213,0.311,0.262]^T$.

Second indicator teaching design each evaluation indicator weight vector is $W_3 = [0.4,0.333,0.267]^T$.

Second indicator teaching way each evaluation indicator weight vector is $W_4 = [0.35,0.3,0.35]^T$.

Second indicator practice result each evaluation indicator weight vector is $W_5 = [0.444,0.311,0.244]^T$.

TABLE 9 : Table tennis teaching quality evaluation system

First class indicator A	Second class indicator B	Weight	Third class indicator C	Weight	Combination weight
Education teaching quality A	Teachers' morality B1	0.323	Teaching plan preparation C1	0.213	0.069
			Term courses plan C2	0.213	0.069
			Start and end courses on time C3	0.311	0.1
			After –class training C4	0.262	0.085
	Teaching design B2	0.177	Content is plenty and reasonable C5	0.4	0.071
			Content linkage C6	0.333	0.059
			Supplement content utilization C7	0.267	0.047
	Teaching way B3	0.226	Scientificity C7	0.35	0.079
			Innovation C9	0.3	0.068
			Diversity C10	0.35	0.079
	Practice result B4	0.274	Students' capacity improvement C11	0.444	0.122
			Students' test result C12	0.311	0.085
			Teaching attraction C13	0.244	0.067

FULL PAPER

Accordingly, it can get table tennis education teaching quality evaluation system, refer to TABLE 9.

From the evaluation system bottom indicators combination weights, it can calculate to be tested table tennis teachers' comprehensive indicator GI, it can make ranking and evaluation on table tennis teachers' teaching quality through GI values.

CONCLUSIONS

The research uses clustering rough sets method establishing table tennis teaching quality evaluation system; the method carries scientific quantization on all each evaluation indicator, and analyzes each indicator importance degree by construction fuzzy consistency judgment matrix, and gains better research results. The evaluation system makes up for the gap on table tennis education teaching quality evaluation; it has profound significance in propelling table tennis education development and improving table tennis teaching quality.

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