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Dancesport mathematical model of fuzzy comprehensive evaluation

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ABSTRACT

In order to conduct scientific and rational evaluation of teaching effect of dancesport public elective, this study establishes the evaluation index system model including the scientifically property, educational property, technical property and artistic property, 4 classifications and 16 small classes in general, on the basis of literature review and consulting experts. Determine the weight of each index in analytic hierarchy process and build the evaluation model of dancesport teaching effect in fuzzy comprehensive evaluation method. By the case study of the dancesport teaching effect in a college, it indicates that the evaluation result of this evaluation model can be scientific and reasonable and this model takes account of all influencing factors on dancesport teaching effect. It is suggested for popularization and application in the teaching effect evaluation of dancesport or other sports courses.

KEYWORDS

Analytic hierarchy process;
Fuzzy comprehensive evaluation;
Dancesport.

INTRODUCTION

Dancesport also called "international standard dance", is a fusion of sports and art. This emerging project contains characteristics of many disciplines such as sociology, kinematics, psychology and aesthetic, and plays important role in the healthy and comprehensive development for students. As a result, many colleges and universities are now offering the dancesport public elective. The start of dancesport in China is a little late and is in the development stage, when teachers teaching dancesport teaching mostly from non dancesport majors. At the same time, there are still no unified planning materials and syllabus of dancesport teaching in colleges and universities and the teaching content is confusing. Therefore, improvement of the dancesport teaching system and scientific evaluation of dancesport teaching effect is an urgent problem.

By means of literature study, questionnaire survey and expert consultation, this study constructs the evaluation index framework of dancesport teaching effect. Determine the weight of each evaluation index in analytic hierarchy process and conduct comprehensive evaluation of dancesport teaching effect in fuzzy comprehensive evaluation method. This study aims at providing certain support for the perfection of dancesport public elective class in colleges and contributing to the enhancement of dancesport teaching effect.

FULL PAPER

CONSTRUCTION OF EVALUATION INDEX SYSTEM OF DANCESPORT TEACHING EFFECT

In order to establish a scientific and reasonable evaluation system, this study first refers to a large number of articles on physical fitness training and evaluation of basketball players and preliminarily selects out the evaluation indexes of special physical fitness for basketball athletes. Based on this, design a questionnaire and conduct a questionnaire survey of coaches and athletes from 5 CBA teams. Determine the basic framework for evaluation according to the statistical results of the questionnaire. Redesign the questionnaire in conjunction with the basic framework and form an expert advisory table. Through the final round of expert consultation of 8 head coaches and 5 physical trainers from CBA teams and 5 basketball experts, simplify the evaluation indexes. Ultimately, conduct special physical fitness evaluation from three categories as basketball players' body shape, sport quality and physiology function, or from a total of 10 small classes, and the index system is shown in TABLE 1.

FUZZY COMPREHENSIVE EVALUATION MODEL OF THE DANCESPORT TEACHING EFFECT

Comprehensive evaluation is a method of conducting evaluation of evaluation objects in general, based on overall consideration of various factors' effect on the object or system. If the selected evaluation indexes possess certain fuzziness, then the comprehensive evaluation method used is identified as fuzzy comprehensive evaluation. The theoretical basis of fuzzy comprehensive evaluation is fuzzy mathematical theory, in which the fuzzy object to be evaluated and fuzzy concepts reflecting the properties of the fuzzy object, i.e. fuzzy evaluation indexes, are regarded as a fuzzy set. Build accurate membership function by proceeding relative computing and transformation of the formed fuzzy set, for the purpose of evaluating of the fuzzy object in quantitative methods in the end. The mathematical model used in fuzzy comprehensive evaluation is simple and easy to understand and master, and the evaluation result of multi-factor and multi-layer complex problem in

TABLE 1: Evaluation index system of dancesport teaching effect

First layer index	Secondary index	Three-layer index
Teaching effect U	Educational property U_1	Explicit teaching target U_{11}
		Reflect syllabus requirements and suiTABLE for the curriculum system U_{12}
		Fit teaching principle and reflect education reform idea U_{13}
		Impart knowledge, foster ability and emphasize on the thought and quality education U_{14}
	Scientifical property U_2	Standardization and forwardness of the content U_{21}
		Discipline and individuation teaching U_{22}
		Reasonable arrangement of teaching density and intensity U_{23}
		Whether helps to form the life-long sport idea for students U_{24}
	Technical property U_3	The teaching arrangement of key and difficult points is reasonable or not U_{31}
		The content emphasizes the individual development combining the student's practical situation U_{32}
		Accurate explanation and demonstration, favorable music effect can simulate students' learning interest U_{33}
		Feedback treatment of students' information is reasonable or not U_{34}
	Artistic property U_4	Rational design of dance movement U_{41}
		Diversification and interest of teaching content U_{42}
		Art mastery and appreciation U_{43}
		The lecturer is natural and decent, the words and deeds are infectious U_{44}

this model is favorable. The setup procedure of fuzzy comprehensive evaluation model of dancesport teaching effect is shown in the following text.

Establish the index set $_U$ and evaluation set $_V$ of fuzzy comprehensive evaluation model

As can be seen from TABLE 1, index set of special physical fitness evaluation for basketball athletes is $U=(U_1,U_2,U_3)$ = (body shape, sport quality, physiological function). And evaluation set of special physical fitness evaluation for basketball athletes is $V=(V_1,V_2,V_3,V_4,V_5)$= (excellent, good, medium, lower, poor). The quantization of the five evaluation level is shown in TABLE 2.

TABLE 2 : The quantization of the five evaluation level

Symbol	Level	Quantization
V_1	Very satisfied	90
V_2	Satisfied	80
V_3	In general	70
V_4	Not very satisfied	60
V_5	Not satisfied	50

Construct the factor set and evaluation set of fuzzy comprehensive evaluation model

As can be seen from TABLE 1, the factor set of comprehensive evaluation of dancesport teaching effect is: $U=(U_1,U_2,U_3)$ = (educational property, scientifical property, technical property and artistic property). And the evaluation set of comprehensive evaluation of dancesport teaching effect is: $V=(V_1,V_2,V_3,V_4,V_5)$ = (very satisfied, satisfied, in general, not very satisfied, not satisfied). The quantification method of the 5 evaluation grade is shown in TABLE 2.

Determine the weight of each evaluation index in analytic hierarchy process *W*

Analytic hierarchy process (AHP) is a system analytical method with qualitative analysis and quantitative analysis which could realize the systematization, quantification and modeling of a complex problem. In other words, the complex problem is first divided into several elements, all of which further are decomposed into more explicit, specific and quantizable little factors, i.e. indexes. Determine the weights of all indexes in each layer according to the importance degree. A multi-objective and multilayer statistical model is formed when connecting each layer by weights.

According to the established multilayer hierarchical structure in TABLE 1, calculate the weights of all indexes by building a pairwise judgment matrix. There are a variety of methods for weight scale computing in AHP and Saaty's method of weighting is the most commonly used, in which each index is compared with one another and given a grade first, and the standard for evaluation is shown in TABLE 3.

TABLE 3 : Evaluation standard for Saaty's weighting method

Importance scale a_{ij}	Degree of relative importance
1	Equally important
3	Slightly important
5	Basically important
7	Really important
9	Absolutely important
2,4,6,8	Median of two contiguous importance degree
Reciprocal	If the importance degree ratio of index i to index j is a_{ij} , then the importance degree ratio of index j to index i is $a_{ji}=\frac{1}{a_{ij}}$.

Build judgment matrix *A*

Build a pair wise comparison judgment matrix by comparing between any two indexes from a lower layer of a certain evaluation factor with expert scoring method. Suppose that the number of evaluation indexes is *n*, i.e. $X=(x_1,x_2,\ldots,x_n)$, and determine each index's impact on factor *Y* and the judgment matrix built is $A=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$:

In the formula a_{ij} means the importance degree ratio on factor *Y* of number *i* evaluation index x_i and number *j* evaluation index *x*. And matrixs $_X A=(a_{ij})_{n\times n}$ atisfies that $i=j, a_{ij}=1, i,j=1,2,\cdots,n$:.

With this kind of scale method, conduct importance comparison of each two indexes from each evaluation layer of evaluation index for dancesport teaching effect and build a pairwise comparison judgment matrix, shown in TABLE 4.

Calculate weights: Calculate the weight with square root method. Determine the Quadrature of the judgment matrix by row elements and then work out the power.

$$w_i=\left(\prod_{j=1}^{n} c_{ij}\right)^{1/n}, \quad (i,j=1,2,\ldots,n) \qquad (1)$$

FULL PAPER

TABLE 4: Judgment matrix among all indexes

Index	Judgment matrix			
U_1	1	2	2	3
U_2	0.5	1	1	2
U_3	0.5	1	1	2
U_4	0.333	0.5	0.5	1
U_{11}	1	0.5	1	2
U_{12}	2	1	2	3
U_{13}	1	0.5	1	2
U_{14}	0.5	0.333	0.5	1
U_{21}	1	0.5	0.25	3
U_{22}	2	1	0.5	4
U_{23}	4	3	1	6
U_{24}	0.333	0.25	0.167	1
U_{31}	1	4	2	3
U_{32}	0.25	1	0.333	0.5
U_{33}	0.5	3	1	2
U_{34}	0.333	2	0.5	1
U_{41}	1	2	4	3
U_{42}	0.5	1	3	2
U_{43}	0.25	0.333	1	0.5
U_{44}	0.333	0.5	2	1

After standardization, the weight coefficient is:

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i} \quad (2)$$

Weight vector: $W = (w_1, w_2, \ldots, w_n)$.

Calculate the weight of indexes from each layer based on formula (1) and formula (2,

Weights of indexes from the first evaluation system: $W = (w_1, w_2, w_3, w_4) = (0.414, 0.233, 0.233, 0.121)$

Weights of indexes for factor "educational property" from the secondary evaluation system:

$W_1 = (w_{11}, w_{12}, w_{13}, w_{14}) = (0.233, 0.414, 0.233, 0.121)$

Weights of indexes for factor "scientifical property" from the secondary evaluation system:

$W_2 = (w_{21}, w_{22}, w_{23}, w_{24}) = (0.17, 0.268, 0.5, 0.063)$

Weights of indexes for factor "technological property" from the secondary evaluation system:

$W_3 = (w_{31}, w_{32}, w_{33}, w_{34}) = (0.446, 0.093, 0.29, 0.171)$

Weights of indexes for factor "artistic property" from the secondary evaluation system:

$W_4 = (w_{41}, w_{42}, w_{43}, w_{44}) = (0.446, 0.29, 0.093, 0.171)$

Consistency test:

$$CI = \frac{\lambda_{\max} - m}{m - 1} \quad (3)$$

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{m} \lambda_i / m \quad (4)$$

$$\lambda_i = \sum_{j=1}^{m} a_{ij} w_j / w_i \quad (5)$$

Determine the random consistency ratio:

$$CR = \frac{CI}{RI} \quad (6)$$

RI means the random average consistency index of the same order and the value of RI under different orders is shown in TABLE 5.

TABLE 5 : The value of RI under different orders

Order	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

If CR<0.1, it can be regarded that the judgment possesses favorable consistency.

Based on formula (3) to formula (6), at last calculate the value of random consistency ratio, CR, of the first layer matrix and all secondary matrix, and the result is shown in TABLE 6.

TABLE 6 : Consistency test result

Matrix	CR	Consistency result
First layer matrix U	0.025	Satisfying
Secondary matrix U_1	0.016	Satisfying
Secondary matrix U_2	0.015	Satisfying
Secondary matrix U_3	0.023	Satisfying
Secondary matrix U_4	0.031	Satisfying

Judging from TABLE 6, if the value of CR for each matrix is lower than 0.1, it demonstrates that all judgment matrixes possess favorable consistency.

Build a fuzzy relation matrix

Repeatedly test basketball athlete' performance according to the evaluation index system for dancesport teaching effect and grade each index in accordance with scoring standard of the National Sports Commission. By collation and statistical analysis of the test results, it can be determined that the degree of membership of number *i* evaluation index to number *j* level is r_{ij}. If the single factor fuzzy evaluation of number *i* factor is a fuzzy subset of *V*, $R_{ik} = (r_{i1}, r_{i2}, \ldots, r_{i5})$, then the single factor evaluation matrix R_i is:

$$R_i = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{15} \\ r_{21} & r_{22} & \cdots & r_{25} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{n5} \end{bmatrix} \quad (7)$$

Single factor fuzzy evaluation is $B_i = W_i \cdot R_i$. As:

$$R = \begin{bmatrix} B_1 \\ B_2 \\ \cdots \\ B_m \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{15} \\ b_{21} & b_{22} & \cdots & b_{25} \\ \cdots & \cdots & \cdots & \cdots \\ b_{m1} & b_{m2} & \cdots & b_{m5} \end{bmatrix} \quad (8)$$

Then apply fuzzy comprehensive evaluation method in the evaluation of matrix *R*, and the membership vector of the target layer to evaluation set *V* is *B=W.R*.

General membership is the total grades of the tested object after fuzzy evaluation, which can be used for the evaluation of each object. Based on the principle of maximum membership, determine the evaluation level of the object, V_j, and the final result of comprehensive evaluation of the basketball player' special physical fitness can be obtained.

CASE STUDY

A certain college in a certain province opened the dancesport public elective class. Randomly select 85 students, who participates in the dancesport class, by random sampling for further investigation. And the survey content includes the 16 questions from the evaluation index system for dancesport teaching effect. There are 5 options for each question, i.e. "very satisfied, satisfied, in general, not very satisfied, not satisfied".

$$R_1 = \begin{bmatrix} 0.73,0.24,0.04,0.00,0.00 \\ 0.68,0.29,0.03,0.00,0.00 \\ 0.65,0.32,0.02,0.01,0.00 \\ 0.67,0.33,0.00,0.00,0.00 \end{bmatrix}, \quad R_2 = \begin{bmatrix} 0.71,0.28,0.01,0.00,0.00 \\ 0.59,0.27,0.09,0.05,0.00 \\ 0.61,0.29,0.07,0.03,0.00 \\ 0.68,0.25,0.06,0.01,0.00 \end{bmatrix}, \quad R_3 = \begin{bmatrix} 0.68,0.27,0.03,0.02,0.00 \\ 0.64,0.30,0.05,0.01,0.00 \\ 0.72,0.28,0.00,0.00,0.00 \\ 0.65,0.24,0.08,0.03,0.00 \end{bmatrix}, \quad R_4 = \begin{bmatrix} 0.69,0.27,0.04,0.00,0.00 \\ 0.71,0.28,0.01,0.00,0.00 \\ 0.63,0.29,0.07,0.01,0.00 \\ 0.66,0.27,0.06,0.01,0.00 \end{bmatrix}$$

From the above analysis, the weight of each evaluation index is:

$$W = (w_1, w_2, w_3, w_4) = (0.414, 0.233, 0.233, 0.121)$$

$$W_1 = (w_{11}, w_{12}, w_{13}, w_{14}) = (0.233, 0.414, 0.233, 0.121), \quad W_2 = (w_{21}, w_{22}, w_{23}, w_{24}) = (0.17, 0.268, 0.5, 0.063)$$

$$W_3 = (w_{31}, w_{32}, w_{33}, w_{34}) = (0.446, 0.093, 0.29, 0.171), \quad W_4 = (w_{41}, w_{42}, w_{43}, w_{44}) = (0.446, 0.29, 0.093, 0.171)$$

The fuzzy comprehensive evaluation result is:

$$B_1 = W_1 \times R_1 = (0.233, 0.414, 0.233, 0.121) \times \begin{bmatrix} 0.73,0.24,0.04,0.00,0.00 \\ 0.68,0.29,0.03,0.00,0.00 \\ 0.65,0.32,0.02,0.01,0.00 \\ 0.67,0.33,0.00,0.00,0.00 \end{bmatrix} = (0.68, 0.29, 0.03, 0.00, 0.00)$$

In a similar way:

$$0.63,0.28,0.06,0.03,0.00), \quad B_3 = W_3 \times R_3 = (0.67, 0.27, 0.04, 0.02, 0.00), \quad B_4 = W_4 \times R_4 = (0.69, 0.27, 0.04, 0.00, 0.00)$$

Then the overall fuzzy evaluation result is:

$$B = W \times R = (0.414, 0.233, 0.233, 0.121) \times \begin{bmatrix} 0.68,0.29,0.03,0.00,0.00 \\ 0.63,0.28,0.06,0.03,0.00 \\ 0.67,0.27,0.04,0.02,0.00 \\ 0.69,0.27,0.04,0.00,0.00 \end{bmatrix} = (0.67, 0.28, 0.04, 0.01, 0.00)$$

From the above analysis, it can be seen that 67% of the students surveyed is very satisfied with the dancesport teaching effect, 28% is satisfied, 4% is in general and 1% is not very satisfied.

According to the quantification standards of each layer, comprehensive evaluation score is:

$$C = B \times V^T = (0.67, 0.28, 0.04, 0.01, 0.00) \times (90, 80, 70, 60, 50)^T = 86.1$$

CONCLUSIONS

On the basis of referring to large number of articles and conducting a questionnaire, combining the consulting suggestion from related experts, this study establishes an evaluation system for dancesport teaching effect. Determine the weight of each evaluation index with analytic hierarchy process and build the evaluation model of dancesport teaching effect with fuzzy comprehensive evaluation method. Through the case study of the dancesport teaching effect of certain college, it shows that the evaluation result of this evaluation model is scientific and reasonable. And the evaluation model takes account of all factors affecting dancesport teaching effect. This evaluation model is suggested for popularization and application in the teaching effect evaluation for dancesport or other sports course.

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