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Evaluation model development of dance inquiry learning based on fuzzy analytic hierarchy process

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ABSTRACT

Under the guidance of the spirit of the new curriculum standards, this research establishes a dance inquiry learning evaluation model in order to adapt to the quality-oriented education reform for dance teaching. This model conducts evaluation of students' dance inquiry learning situation from the following three aspects: dance quality, dance performance and dance development and builds a three-layer hierarchical structure. The weights of each layer indexes and the combination weights of the bottom layer indexes can be determined by constructing a fuzzy consistent matrix, and then the value of general index calculated by combination weights reflects the pros and cons of students' dance inquiry learning. This evaluation model is used for comprehensive evaluation of four dance majors and the evaluation result is rational and reasonable, demonstrating that this evaluation system is appropriate for dance inquiry learning evaluation. This evaluation model makes up for the disadvantages of dance inquiry learning evaluation under the condition of quality-oriented education reform.

KEYWORDS

Fuzzy theory;
Analytic hierarchy process;
Dances inquiry learning;
Evaluation.

INTRODUCTION

In recent years, the implementation of quality-oriented education has been the focus of discussion and attention from all orders of society. In terms of colleges and universities, the fundamental approach to the implementation of quality-oriented education is the curriculum reform. The dance education of the new century has carried out a series of reforms in the preparation of teaching materials, teaching modules, teaching methods and teaching evaluation methods. As the last link in the curriculum system, the traditional evaluation methods cannot meet the requirements of new curriculum system any more. In other words, teachers apply new teaching modes to impart knowledge in dance teaching process in the current institutions of higher learning. The evaluation result of students' learning in the new teaching mode cannot be scientific and accurate if still adapting traditional evaluation methods, which will bring in some adverse effects or even lead to the reducing of students' enthusiasm of dance learning.

Scholars have gradually conducted researches on dance learning evaluation under the education reform background. For example, Hongwu Yi proposes in the paper "Dance teaching and evaluation system in colleges" that the establishment of dance teaching evalua-

tion system should take the following three aspects into consideration, technique evaluation, non technique evaluation and progress extent evaluation.; Peng Wang, et.al., elaborates the necessity for colleges and universities to carry out innovation in dance education; Yisheng Lu also puts forward several suggestions for the assessment and evaluation methods of dance performance. However, studies on dance learning evaluation are mainly concentrated in the macro exposition, without exploring in detail the specific evaluation indicators and criteria.

This study first determines the evaluation indexes for dance inquiry learning by referring to literatures and consulting experts of dance education. Then with fuzzy analytic hierarchy process, determine the weights of each layer evaluation indexes and the combination weight of the bottom layer indexes. Finally, build a evaluation system for dance inquiry learning. This study aims at establishing a new dance inquiry learning evaluation method adapted to the quality-oriented background and contributing to the implementation of quality-oriented education reform in China.

BRIEF INTRODUCTION OF FUZZY ANALYTIC HIERARCHY PROCESS

Fundamental principles of fuzzy analytic hierarchy process

Fuzzy analytic hierarchy process is put forward in order to make up for the difficulty and un-scientificalness of traditional analytic hierarchy process in testing the consistency of judgment matrix. Fuzzy analytic hierarchy process is a system analysis method of qualitative analysis and quantitative analysis, the principles of which are basically the same with that of AHP. This process can 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.

There are mainly two differences between fuzzy analytic hierarchy process and traditional AHP: one is that AHP constructs a judgment matrix by pairwise comparison of all indexes and need to test the consistency of the matrix, while fuzzy analytic hierarchy process builds a fuzzy consistent matrix by pairwise comparison of all indexes and need not to test the consistency of the matrix; the other is that the methods used to calculate the weights of all indexes are different between the two evaluation process.

The basic step of fuzzy analytic hierarchy process

The basic step of fuzzy analytic hierarchy process is similar to that of traditional analytic hierarchy process, shown as follows:

1) Construct a multilayer hierarchical structure and form a target tree diagram. Fuzzy analytic hierarchy model contains three layers in general, as the top layer, the middle layer and the bottom layer, shown in Figure 1. The top layer is the target layer, which means the general objective for analytic hierarchy process research; the middle layer is also called restraint layer and contains the several main factors affecting the general target; the bottom layer is also named as measure layer, meaning that the final measures to solve the problem are all quantizable indexes.

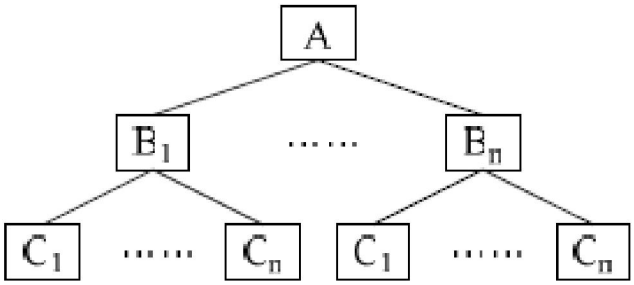

Figure 1 : Model structure of fuzzy analytic hierarchy process

2) Build a fuzzy consistent matrix. R stands for the fuzzy consistent judgment matrix. Firstly, select certain factor in the upper layer and determine the indexes that are related to the factor, from the lower layer. Then compare the relative importance of indexes in the lower layer. Suppose that a upper layer indexes can be explained by indexes $a_1, a_2, \cdots, a_n$ from the next layer, and then a fuzzy consistent judgment matrix can be built, as shown in TABLE 1.

In Table 1, $r_{ij}(i=1,2,\cdots,n;\ j=1,2,\cdots,n)$ means the relative

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TABLE 1 : Fuzzy consistent 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}

importance of index a_i, the number i index from upper factor C, and index a_j, the number j index from the same upper factor C. In order to quantify the concept of "importance", the following evaluation standard can be used, shown in TABLE 2.

In accordance with the evaluation method in Table 2, after pairwise comparison of the evaluation indexes of factor C, $a_1, a_2, \cdots, a_n$ a fuzzy judgment matrix can be obtained:

TABLE 2 : Evaluation standard for fuzzy analytic hierarchy process

Importance scale r_{ij}	Degree of relative importance	Explanation
0.5	Equally important	The two elements compared are equally important
0.6	Slightly important	Within the two elements compared, the importance of one element is slightly higher than the other
0.7	Absolutely important	Within the two elements compared, the importance of one element is apparently higher than the other
0.8	Really important	Within the two elements compared, the importance of one element is significantly higher than the other
0.9	Absolutely important	Within the two elements compared, the importance of one element is extremely higher than the other
0.1,0.2,0.3,0.4	Converse comparison	If the importance degree ratio of index a_i to index a_j is r_{ij}, then the importance degree ratio of index a_j to index a_i is $r_{ji}=1-r_{ij}$

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nn} \end{bmatrix}$$

The matrix has the 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 the weight of each index

Suppose the weight set of indexes $a_1, a_2, \cdots, a_n$ is $W=(\omega_1,\omega_2,\cdots,\omega_n)$, then $r_{ij}=0.5+a(\omega_i-\omega_j),\ i,j=1,2\cdots,n$

In the above formula $0<a\le 0.5$, a is the evaluator's measure of the degree of difference between the proposed evaluation objects.

When R is inconsistent, the above formula is not strictly true. Then weight vector can be determined by the least squares principle, shown in 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's theorem, the above formula and the formula below 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 the formula λ is the Lagrange multiplier.

Calculate partial derivatives of $\min L(\omega,\lambda)$ about $\omega_i(i=1,2,\cdots,n)$ and supposing that value of $\min L(\omega,\lambda)$ is zero, the following equation set can be obtained:

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

The above equation set is equivalent to the following equation set:

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

The number of unknowns in this equation set is n+1, i.e. $\omega_1,\omega_2,\cdots\omega_n,\lambda$, and the number of equations is n+1,

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

Solve the equation set (4) and weight of each evaluation index can be determined.

4) Calculate the combination weight C_i of the bottom layer indexes in weighting method.
C_i=index weight of layer B*index weight of layer C.
5) Calculate the general index GI. Both low priority and high priority indexes exists and the same trend processing is needed in the selection of evaluation indexes. The specific method is: for high priority index: Pi=actual value/expected value; for low priority index: Pi=expected value/actual value. Determine the general index after same trend processing:

$$GI = \sum_{j=1}^{m} C_i P_i \quad (5)$$

THE CONSTRUCTION OF DANCE INQUIRY LEARNING EVALUATION SYSTEM

The selection of evaluation indexes

Evaluation of dance learning runs through the entire process of dance teaching, for this reason, the construction of dance inquiry learning evaluation system is a huge project and the proper selection of evaluation indexes is a key factor determining the fitness and suitability of the evaluation system. In order to select all evaluation indexes of dance inquiry learning more comprehensively, systematically and scientifically and increase accuracy of the system evaluation, each selected index should possess certain scientificalness and realistic feasibility. In the process of the selection of indexes, with goal orientation, scientificalness, integrity, objectivity and practicality as fundamental principles and combining the basic theory of dance inquiry learning evaluation with the actual situation of dance learning and the essence of evaluation, this study preliminarily selects indexes affecting dance inquiry learning evaluation system from three aspects: dance quality, dance performance and dance development. After the initial selection of indicators, professors long engaged in dance teaching, experts long engaged in research work on educational theory and teaching management experts are all consulted for suggestions. Ultimately, dance quality, dance performance and dance development are selected as secondary indexes of dance inquiry learning evaluation system, and each secondary index is decomposed into several three-layer indexes. Then a three-layer hierarchical structure is built as Table 3.

TABLE 3 : Evaluation index system of dance inquiry learning

First layer index A	Secondary layer B	Three-layer index C
Dance inquiry learning result A	Dance quality B1	Dance musicality C1
		Dance technique C2
		Dance language C3
		Dance rhyme C4
	Dance performance B2	Dance performance C5
		Dance composition C6
		Expressive pattern C7
		Expressive ability C8
		Expressive quality C9
	Dance development B3	Emotion and value C10
		Process and methods C11
		Knowledge and skills C12

Build fuzzy consistent matrix

According to the above method of building a fuzzy consistent matrix, build fuzzy consistent matrixes for all layers, shown in Table 4, Table 5, Table 6 and Table 7.

Calculate the weight of each index

Construct equation set for each fuzzy consistent matrix respectively, as equation set (4) format. Using the Matlab software for programming, determine the

TABLE 4 : Fuzzy consistent matrix of the first layer factors

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

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TABLE 5 : Fuzzy consistent matrix of the second layer indexes (dance quality)

B1	C1	C2	C3	C4	C5	C6
C1	0.5	0.5	0.6	0.6	0.4	0.6
C2	0.5	0.5	0.6	0.6	0.4	0.6
C3	0.4	0.4	0.5	0.5	0.3	0.5
C4	0.4	0.4	0.5	0.5	0.3	0.5
C5	0.6	0.6	0.7	0.7	0.5	0.7
C6	0.4	0.4	0.5	0.5	0.3	0.5

TABLE 6 : Fuzzy consistent matrix of the second layer indexes (dance performance)

B2	C7	C8	C9
C7	0.5	0.5	0.5
C8	0.5	0.5	0.5
C9	0.5	0.5	0.5

TABLE 7 : Fuzzy consistent matrix of the second layer indexes (dance development)

B3	C10	C11	C12
C10	0.5	0.4	0.3
C11	0.6	0.5	0.4
C12	0.7	0.6	0.5

weights of indexes in each matrix.

Weight vector of each secondary index in dance inquiry learning result: $W_1 = [0.45, 0.31, 0.24]^T$

Weight vector of each evaluation index for secondary index dance quality: $W_2 = [0.18, 0.18, 0.14, 0.14, 0.21, 0.14]^T$

Weight vector of each evaluation index for secondary index dance performance: $W_3 = [0.33, 0.33, 0.33]^T$

Weight vector of each evaluation index for secondary index dance development: $W_4 = [0.27, 0.33, 0.4]^T$

TABLE 8 : Evaluation system of dance inquiry learning

First layer index A	Secondary index B	Weight	Three-layer index C	Weight	Combination weight
Dance inquiry learning result A	Dance quality B1	0.45	Dance musicality C1	0.18	0.081
			Dance technique C2	0.18	0.081
			Dance language C3	0.14	0.063
			Dance rhyme C4	0.14	0.063
	Dance performance B2	0.31	Dance performance C5	0.21	0.095
			Dance composition C6	0.14	0.063
			Expressive pattern C7	0.33	0.102
			Expressive ability C8	0.33	0.102
			Expressive quality C9	0.33	0.102
	Dance development B3	0.24	Emotion and value C10	0.27	0.065
			Process and methods C11	0.33	0.079
			Knowledge and skills C12	0.4	0.096

TABLE 9 : Evaluation result of students from the 5 teachers

Student	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
1	85	86	82	85	88	84	83	86	85	90	84	85
2	90	89	88	91	89	82	86	86	85	82	80	84
3	83	85	87	86	88	85	84	88	87	85	83	82
4	87	86	85	88	85	83	85	87	86	84	85	83

Accordingly, the dance inquiry learning evaluation system is shown in Table 8.

CASE STUDY

Four students from a college majoring dance as evaluation objects, five teachers give each a grade from the above 12 aspects. The data obtained after averaging is shown in Table 9.

Determine the general index for each student according to formula (5). The ranking list of the four students' dance inquiry learning performance on the basis of is shown in Table 10.

The value of general index reflects the student's comprehensive performance of dance inquiry learning and the evaluation result by this index is scientific and rea-

sonable.

TABLE 10 : Four students' dance inquiry learning general result and ranking

Student	*GI*	Ranking
1	84.578	4
2	85.325	1
3	84.594	3
4	84.678	2

CONCLUSIONS

From the three aspects of dance quality, dance performance and dance development, this study builds an evaluation system for dance inquiry learning based on fuzzy analytic hierarchy process. With the scientific quantization of all evaluation indexes, this method constructs fuzzy consistent matrix to analyze the importance degree of each index and calculates the combination weight of the bottom layer indexes, which has favorable research results. This evaluation system is applied in the comprehensive evaluation of four dance major students and the evaluation result is reasonable and scientific, indicating that this evaluation system is suitable for the evaluation of dance inquiry learning. This evaluation system makes up for the shortcomings of traditional dance inquiry learning evaluation under the quality-oriented education reform background and has profound significance in promoting the reform and development of dance education.

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