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Article

Personalized Optimization Strategies for Physical Education Dance Training and Teaching in Modern Colleges and Universities Based on Multivariate Data Analysis

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Abstract: With the rapid development of economy and science and technology, it leads to the traditional sports dance training and teaching mode is hardly suitable for students' learning needs. Based on the teaching dilemma described above, a personalized optimization strategy for sports dance training and teaching in modern colleges and universities under the perspective of multivariate data analysis is proposed. In order to confirm the practical application value of the optimization strategy, the assessment scheme of the personalized optimization strategy of sports dance training and teaching in colleges and universities is designed under the joint effect of hierarchical analysis, entropy weight method and fuzzy comprehensive evaluation method, and the scheme is analyzed by examples. The evaluation value of the strategy is calculated as (0.7666, 0.1694, 0.1243, 0.0743, 0.0815), and due to obeying the principle of maximum affiliation, it is further concluded that the evaluation result of the strategy is excellent, which sufficiently proves the application efficacy of the strategy.

Keywords: hierarchical analysis; entropy weight method; fuzzy comprehensive evaluation method; sport dance

1. Introduction

Sports dance has strong educational value and exercise value, and has been incorporated into China's education system in recent years. At present, the phenomenon of not emphasizing the teaching of physical education dance is common in colleges and universities, which leads to low quality and efficiency of its teaching [1]. As a whole, the current teaching mode of physical education dance in Chinese colleges and universities still mainly follows the traditional classroom teaching mode, i.e., teachers give one-way, standardized explanations and demonstrations to students, while students passively accept the knowledge inculcation and carry out mechanical repetitive exercises [2-4]. In addition, the lack of guidance outside the classroom makes the college physical education dance program much less interesting [5]. Students' intense participation emotion will also be difficult to maintain with the depth of the course teaching, which in turn causes the teaching status quo that the teaching quality is not satisfactory [6-7].

In the face of this teaching status quo, colleges and universities must actively change the traditional concepts and educational modes of physical education dance teaching, adhere to the student as the main body, take health education theory as the guide, and carry out personalized physical education dance training and teaching activities [8-11]. Through the improvement of the teaching mode, the integration of teaching content and the optimization of the teaching evaluation system, the application and development of the personalized teaching mode is comprehensively promoted, and the quality and efficiency of teaching are continuously improved, so as to better promote the future development of physical education dance teaching [12-15].

This paper proposes a personalized optimization strategy for dance training and teaching in response to the dilemma of sports dance teaching in modern colleges and universities. In order to test the effective feasibility of the strategy, first of all, we draw on relevant literature and information to build a suitable evaluation index system, and then we use hierarchical analysis, entropy weighting method and fuzzy comprehensive evaluation method to jointly design the evaluation plan of the personalized optimization strategy of dance training and teaching. Combining the evaluation plan, questionnaire data, and index weights, the personalized optimization strategy of sports dance training and teaching in modern colleges and universities is evaluated and analyzed, aiming at proving the practical application effect of the personalized optimization strategy of sports dance training and teaching in modern colleges and universities.

2 Evaluation Programs for Sport Dance Training in Modern Universities

2.1. The Dilemma of Sport Dance Teaching in Modern Colleges and Universities

2.1.1. Status of Construction of Facilities for Specialized Sports Dance Venues

Good teaching facilities can provide a material basis for high-quality teaching, but also one of the key factors affecting the quality of teaching, as a modern sports and arts programs have unique requirements for the venue facilities, sports dance standard venue for 25 × 20 square meters, generally using plastic flooring or wooden floor splicing into, should be non-reflective, non-slip, flat, surrounded by boundaries. In the school teaching process should be equipped with sound quality sound, mirrors, multimedia teaching equipment and so on. For such a demanding venue facilities, some schools can also be and other sports teaching comprehensive use of teaching venues, such as basketball halls, volleyball halls and so on. As long as there is an open indoor rows of land and the floor is wooden or rubber can share resources, saving teaching costs. However, due to the importance of each college and university and the difference in economic level, there are still some schools can not meet the basic requirements. Through the teaching and training of sports dance in colleges and universities the status of teachers and students questionnaire survey shown in Figure 1 results show that Xi in a sample of 10 colleges and universities (A ~ J), the number of teaching venues are more 2 (A school, J school), the rest of the college venues are relatively lack of It can be seen that the 10 colleges and universities sports dance hardware facilities required is still very low, compared with the other types of sports programs, in the teaching facilities Still far less than, simply can not meet the requirements needed for teaching, which seriously restricts the development of sports dance in colleges and universities.

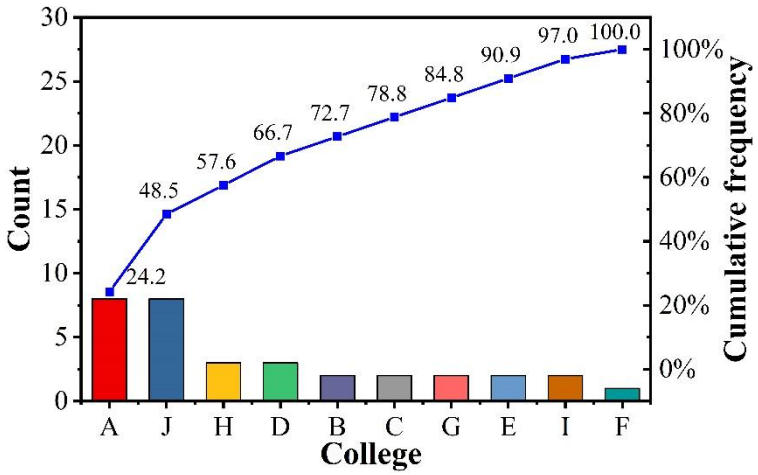

Figure 1. Investigation and statistics of facilities in dance teaching and training venues.

2.1.2. Status of the Construction of Physical Education Dance Faculties

In any educational and teaching activities, the three factors of teachers, students and places must be present. However, teachers play a guiding role in the whole teaching process, and the quality of teaching is directly affected by the quality of teachers. Teachers as the guide, designer and organizer of the teaching process should teach according to the actual situation of students. This is especially true for physical education dance teachers, whose age structure, academic structure, title structure, and years of teaching experience directly affect the quality of teaching. The characteristics of sport dance determine

the level of teachers in the teaching process, quality teachers will certainly play a positive role in students' learning movement skills, on the contrary, it will play a negative role. It can be seen that in the whole teaching activity, the teacher's power is occupying a vital position. However, the status of physical education dance faculty development is shown in Figure 2. The results show that among the 45 teachers surveyed, most of the schools have only 1-4 teachers of physical education dance, except for schools J, A and E, which have more than one teacher, and the basic composition of academic qualifications is reasonable.

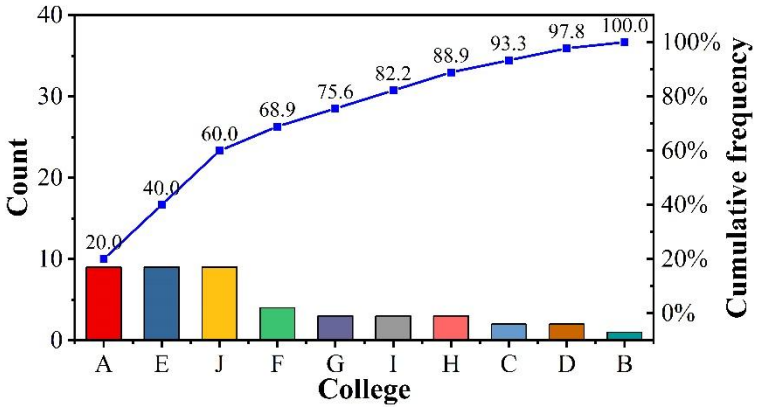

Figure 2. The construction status of the sports dance teaching staff.

2.1.3. Status of the Content of Sport Dance Teaching and Training

Sports dance teaching materials are to serve the task of realizing the purpose of teaching sports dance, and with the three elements of education and teaching materials, the teaching materials are another important link in teaching. Since sports dance entered colleges and universities, it has been loved by the students, from the first few sports colleges and universities to offer sports dance courses to many colleges and universities now offer sports dance courses. However, the Ministry of Education has not yet prepared a teaching material suitable for teaching in colleges and universities. Currently, the teaching materials on the market have not been able to meet the needs of the development of sports dance teaching in colleges and universities, and the overall content of the teaching materials is incomplete, and the teaching methods are incomplete. In order to improve the effect of school sports dance teaching and training, it is necessary to start from the teaching content system, the construction of teachers, the construction of teaching facilities, the improvement of teaching methods, the improvement of training methods and other aspects.

In order to solve the dilemma of sports dance teaching in modern colleges and universities as reflected above, the personalized optimization strategy of dance training and teaching is proposed from three aspects. Details are as follows:

2.2. Strategies for Personalized Optimization of Dance Training and Teaching

2.2.1. Developing Appropriate Teaching Content

Through the investigation of the status quo of teaching and training of sports dance in 10 colleges and universities, and summarizing and analyzing the influencing factors, we have come up with the content system and teaching methods suitable for teaching sports dance in colleges and universities: (1) Formulate the teaching objectives and contents of sports dance courses in a suitable classification. (2) Classify and prepare physical education dance teaching materials, and select and match the materials scientifically and reasonably. (3) Utilize modern teaching mode and adopt diversified teaching methods. The teaching of physical education dance courses, for different teaching content and focus, and selecting different teaching methods for classified teaching, is conducive to students' understanding of the content of physical education dance textbooks, and more quickly and effectively master the knowledge and basic skills of physical education dance. Teachers can also efficiently complete the entire teaching activities.

2.2.2. Strengthening of the Teaching Staff

Teachers are the mainstay of the school, the implementers and the instructors, and teachers play a pivotal role in the teaching and learning process. Broad knowledge and their own charisma influence the

formation of students' character, but also promote the quality of student learning. The quality of the teaching force is directly related to the lifeline of the school. Therefore, building a professional teaching team with sufficient resources, strong business ability and excellent technical level is the prerequisite guarantee for the construction and development of the course. Through the questionnaire survey and interviews, we learned that the number of professional teachers of sport dance in Chongqing is not very optimistic, from the technical level, most of them are teachers who have passed the examination and short-term training, and they also take other courses at the university, and their age structuring is not very reasonable, and most of them are elderly teachers, mainly because of the limited establishment of the school's personnel, and the high academic requirements, which make the young teachers fail to cross the threshold. As a result, no fresh blood is injected into the program, which leads to the slow development of sport dance and cannot keep pace with the times. Therefore, in view of the above situation, the following measures should be taken: Firstly, the relevant sports dance education authorities should organize more teacher training to continuously optimize the technical movement level of the teaching staff. Secondly, introduce young teachers and focus on training a group of young teachers who are growing up in the way of bringing the old with the new, so as to make them become the backbone of sport dance teaching and training. Thirdly, senior teachers are hired to give regular lectures and guidance, and more academic exchange activities are carried out to create a strong academic atmosphere.

2.2.3. Individualized Instruction Based on a Diversity Approach

Sports dance teaching is divided into theoretical teaching and practical technical teaching, statistical survey shows that the college sports dance teaching method is relatively single, the teaching content is not complete, the depth of knowledge is not enough, in view of this situation, this paper believes that we should increase the following teaching methods (procedural language teaching, a variety of intuitive teaching methods, music appreciation and analysis), improve the teaching method, the use of modern teaching techniques, personalized teaching.

In order to validate the personalized optimization strategy for dance training and teaching proposed above, this paper will combine relevant theories and information to develop a corresponding assessment plan for dance training and teaching.

2.3. Development of an Assessment Program

2.3.1. Principles for the Construction of the Evaluation Index System

The construction of evaluation index system is an evaluation guideline established to a certain extent in the development of physical education dance teaching, which is of great significance in the promotion of physical education dance teaching. This study mainly takes the four major theories of educational evaluation theory, constructivist theory, system theory and humanistic theory as the support, monitors and regulates the process of physical education dance teaching by constructing a systematic teaching evaluation index system, and guides the teaching decision-making and organization through the feedback teaching information to achieve the specific goal of testing the personalized optimization strategy of dance training and teaching.

(1) Educational evaluation theory

Through the vertical analysis of the development of educational evaluation theory since the modern times in China and abroad, the vertical vein of the development of educational evaluation theory should also be sorted out in order to find a scientific basis for the construction of the evaluation index system of physical education and dance teaching. First of all, the framework construction of educational evaluation theory can be divided into external framework and internal framework. First of all, the external framework mainly refers to the disciplines or technical foundations on which the theory of educational evaluation is based. After referring to the research results of the previous researchers, the disciplines or technical foundations mainly involved in the theory of educational evaluation mainly include surveying, testing and sociology, and so on. The nature of educational evaluation determines the construction of the external framework. In this process, it is necessary to utilize the above disciplines or technical foundations involved in the external framework as a support. On the other hand, the internal framework mainly refers to the scientific system built up by different educational evaluation theories and models. Obviously, qualifying educational evaluation theories are not a patchwork of fragments, but more of a systematic generalization, which ultimately results in a universal understanding of the truth.

(2) Constructivist theory

Constructivism, as a philosophical methodology, focuses on the analysis of the structure of things, the origin of the structure, and the formation of the structure. Constructivist theory is derived from cognitivism, which is the theoretical development and breakthrough of cognitivism, and cognitivism is an important foundation of constructivist theory. Constructivist theory is an important branch of

cognitivism, constructivist theory believes that everything is a whole composed of parts, and the parts are closely related to each other, and the external and internal connections constitute a systematic connection, and in order to understand the nature of internal objects or components, it is necessary to grasp them as a whole. "Assimilation" refers to the process of absorbing external information into existing cognition, and "adaptation" refers to the process of reorganization and transformation caused by the inability to integrate external information. Obviously, students' participation in the teaching of dance sport is also a process of "assimilation" and "adaptation", which is a cycle of improvement between "balance-imbalance-new balance". Therefore, how to comprehensively evaluate this process is to clarify the basic content of constructivism, so as to provide accurate theoretical guidance for the construction of a reasonable and scientific evaluation index system for sports dance teaching.

(3) Humanistic theory

Humanistic theory mainly emphasizes that people who receive learning and education should embody human personality, dignity and value, and fully realize human self-worth, and the realization of human self-worth is the play of their own potential, and found that the psychology and nature of human beings are consistent, and advocates that the study and evaluation of human beings need to take human nature as the starting point. The researcher believes that in the construction of evaluation indexes for happy gymnastics teaching, more attention should be paid to the performance of students' personalized aspects, such as emotion, creativity and motivation as the focus of evaluation, combined with the traditional evaluation of technology, skills and physical development, in order to help enhance the scientific nature of the construction of evaluation indexes for physical dance teaching. Therefore, the construction of physical education dance teaching evaluation index system should be integrated into the “people-oriented” principle, fully reflecting the important role of people in the teaching evaluation process, and the ultimate goal of the construction of physical education dance teaching evaluation index is to serve the “people”.

(4) System theory

The connotation of system theory shows that system theory is an orderly collection of elements, which are interrelated and complementary in development and change. The construction of physical education dance teaching indicators can not be independent, but systematic, is a key point for the evaluation of the whole physical education dance teaching process in all aspects, the combination of the key points of the evaluation of each link of the teaching formed a physical education dance teaching evaluation indicator system, individual indicators affect the whole, the overall system regulates the individual indicators. Obviously, the construction of sports dance teaching evaluation indexes needs to follow the systematic principle, and system theory is one of the important theoretical supports for its construction.

2.3.2. Determination of the System of Evaluation Indicators

In order to come up with the evaluation of the effectiveness of sports dance teaching in modern colleges and universities, it is first necessary to formulate the index system of evaluation. The evaluation index composition of the teaching effect of sports dance class in colleges and universities should include the following: the first-level indexes include the teaching content and method X1 (including content standardization and advancement X11, regularity and personalized teaching X12, attention to theory and technology X13, and the reasonableness of the teaching density arrangement X14). The quality of teachers X2 (including artistic cultivation and appreciation X21, the degree of specialization of teachers X22, the level of scientific research in professional classrooms X23, the construction of teachers' morality and teacher-student relationship X24). The construction of hardware facilities X3 (including the capacity of indoor venues X31, the intactness of teaching equipment X32, the efficiency of the use of sports venues X33, and the updating speed of teaching equipment X34), which together comprise the evaluation index system of the effectiveness of the teaching of physical education and dance in modern colleges and universities, and the system of evaluation indexes is shown in Table 1.

Table 1. Evaluation index system.

Title	First-level indicator	Symbol	Secondary indicators	Symbol
Evaluation of the Effect of Sports Dance teaching	Teaching content and methods	X1	Content standardization and forward-looking nature	X11
			Regular and personalized teaching	X12
			Pay equal attention to theory and technology	X13
			The rationality of the teaching density arrangement	X14

	The quality of the teaching staff	X2	Artistic cultivation and appreciation ability	X21
			The professionalization degree of the teaching staff	X22
			The research level of professional classrooms	X23
			Teacher Ethics construction and Teacher-student relationship	X24
	The construction of hardware facilities	X3	The capacity of the indoor venue	X31
			The integrity of teaching equipment	X32
			The utilization efficiency of sports venues	X33
			The update speed of teaching equipment	X34

2.3.3. Calculation of Subjective Weights of Indicators

Hierarchical analysis is a subjective weight decision analysis method that divides the objectives into different levels, which can be divided into the following four steps: firstly, the data are divided into different levels and the corresponding hierarchical structure model is established; next, the judgment matrix is constructed, and the data are judged one by one [16-17]. Then, the data that have gone through the judgment matrix may have certain irrationality and need to be tested for consistency; finally, the data that have passed the consistency test are weighted. Hierarchical analysis method, as a subjective assignment method, has the following characteristics: (1) Simplicity: the calculation process of hierarchical analysis method is relatively simple and clear, and the calculation results are very clear. (2) Practicality: the scope of application is large and applicable to many different scenarios, facilitating the combination of qualitative and quantitative. (3) Holistic: the research object is regarded as a whole, and then broken down one by one, and each part is compared and analyzed, with meticulous logic and rigorous calculation. (4) Subjectivity: human factors are more dominant and may have an unpredictable impact on the final result.

Construct the judgment matrix in accordance with formula (1):

$$A = (a_j)_{n \times n} \tag{1}$$

where: a_j denotes the j th indicator.

The consistency is tested using formula (2), and when the consistency ratio is less than 0.1, the consistency test is considered to be passed. After testing the consistency, the weight of each layer φ_i is calculated by subjective weight formula (3):

$$p_i = \left(\prod_1^n a_{ij} \right)^{\frac{1}{n}} \tag{2}$$

$$\varphi_i = p_i \Big/ \sum_1^n p_i$$

where: a_{ij} denotes the importance of the i th indicator relative to the j th indicator; p_i is the consistency ratio; and φ_i is the subjective weight.

2.3.4. Calculation of objective weights for indicators

Entropy is a measure of uncertainty. The importance of the data is determined by calculating the entropy value of the data, i.e., the higher the entropy value, the greater the degree of dispersion of the indicator, and the higher the importance of the data. The entropy weight method has the following characteristics: (1) Objectivity: it interprets the attributes possessed by the data itself and will not be affected by the subjectivity of human factors. (2) Accuracy: It can relatively accurately assign the weights of data with time series one by one according to the attributes possessed by the data itself. (3) Lack of flexibility: it is not applicable to the horizontal comparison of each indicator Jane, and different time series will produce different weights [18]. Therefore, the use of hierarchical analysis combined with the entropy weight method can neutralize the subjectivity of human factors, but also balance the

differences between different years of different data.

Since there are differences in magnitude and statistical criteria between different data, it is necessary to use standardization methods to standardize the data, using the deviation standardization formula to transform the decision matrix X into a standardized decision matrix $R = (r_j)_{n\times n}$. Formula (4) is used for the larger and better positivity indicators, and formula (5) is used for the smaller and better inverse indicators, i.e.,:

$$r_{ij} = (x_{ij} - x_i^{\min}) / (x_i^{\max} - x_i^{\min}) \tag{4}$$

$$r_{ij} = (x_i^{\max} - x_{ij}) / (x_i^{\max} - x_i^{\min}) \tag{5}$$

where: r_{ij} is the result of standardization of each indicator, x_{ij} is the actual value, $x_i^{\max}$, $x_i^{\min}$ represent the maximum and minimum values, respectively. The objective weights are calculated using the following equations (6), (7) and (8):

$$f_{ij} = r_{ij} \Big/ \sum_{i=1}^{m} r_{ij} \tag{6}$$

$$H_i = -K \sum_{j=1}^{n} f_{ij} \ln(f_{ij}) \tag{7}$$

$$\mu_i = 1 - H_i \Big/ \left(m - \sum_{1}^{m} H_i \right) \tag{8}$$

where: x_{ij} is the indicator in the i th row and j th column, r_{ij} is the indicator in the i th row and j th column of the decision matrix, f_{ij} is the contribution of the indicator in the i th row and j th column, H_i is the total amount of contribution of the indicator in the i th row and j th column, and μ_i is the objective weights.

2.3.5. Combination Weight Calculation

According to the principle of minimum value information entropy and Lagrange median theorem, equations (9), (10) and (11) are applied to calculate the comprehensive weights. The specific weight calculation formula is shown below:

$$\min F = \sum_{i=1}^{n} \omega_i (\ln \omega_i - \ln \varphi_i) + \sum_{i=1}^{n} \omega_i (\ln \omega_i - \ln \mu_i) \tag{9}$$

$$s.t \sum_{i=1}^{n} \omega_i = 1 \tag{10}$$

$$\omega_i = (\varphi_i \mu_i)^{0.5} \Big/ \sum_{i=1}^{n} (\varphi_i \mu_i)^{0.5} \tag{11}$$

where: φ_i is the subjective weight, μ_i is the objective weight, and ω_i is the combination weight.

2.3.6. Fuzzy Integrated Evaluation

The evaluation process of the fuzzy comprehensive evaluation method is as follows:

(1) Establishment of factor set

The evaluation system can be analyzed through the general objective layer, target layer, criterion layer, and indicator layer. The factor set is an ensemble composed of indicators that can have an impact on the evaluation project.

(2) Determination of weight set

The weight of the target layer for the total target layer, the weight of the criterion layer for the target layer, the weight of the indicator layer for the criterion layer, and the above three points together constitute the weight set.

(3) Determination of evaluation criteria set

All the conclusions obtained for the evaluation program together constitute the set of evaluation criteria, and according to the evaluation results, the set of evaluation criteria is generally divided into several levels, as shown in equation (11).

$$V = (V_1, V_2, \ldots, V_m) \tag{12}$$

In Eq. (11), V_m represents the evaluation result, such as "Excellent", "Good", "medium", "poor", "bad", etc., and m is the number of ratings of the evaluation.

(4) Calculation of evaluation membership

First, the membership function is established, and then the matrix is established based on the actual value of each indicator. For:

$$R = (R_1, R_2, \ldots, R_m)^T = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \tag{13}$$

In Eq. (13): R_i is the exponential fuzzy relationship matrix for the ith criterion.

(5) Selection of fuzzy operators

In general, every setting of fuzzy operator can get the corresponding evaluation model, so there are countless kinds of fuzzy synthesis operations in theory. However, in practical application, the three fuzzy operators used more often are main factor-determining type, main factor highlighting type and weighted average type respectively. The evaluation result of the main factor-determining fuzzy operator is only determined by the factors that play the most important role in the evaluation, and the rest of the factors basically have no effect on the evaluation result; the main factor highlighting type is closer to the main factor-determining type, and its operation is more delicate, which not only highlights the main factors, but also takes into account the other factors; the weighted average type of the comprehensive evaluation model, according to the difference in the weight, can consider the impacts of all the evaluation factors on the evaluation project, and is more suitable for the evaluation of projects that require a high degree of autonomy. The weighted average type comprehensive evaluation model, according to the different weights, can comprehensively consider the impact of all evaluation factors on the evaluation of the project, and is more suitable for the situation that requires the most comprehensive.

(6) Evaluation criteria

Through the calculation and processing of the above steps, the evaluation result indicator set V can be obtained, and the evaluation result is finally obtained by using the principle of maximum affiliation.

3. Analysis of Sports Dance Assessment in Colleges and Universities

3.1. Analysis of the Results of the Weighting of Evaluation Indicators

3.1.1. Analysis of Subjective Weighting Results

(1) Construction of judgment matrix

In order to better judge the importance of each factor, the 1-9 scale method is proposed, using the score between 1-9 to indicate the degree of relative importance between factors. The data of judgment matrix in this paper are mainly obtained through expert scoring method. In order to make the data informative and authoritative. In terms of the selection of experts, 20 experts engaged in the teaching of physical education dance in colleges and universities were invited to participate in the scoring, and the relatively objective scoring data given by the experts according to the actual status quo was constructed to evaluate the index judgment matrix as shown in Table 2 to Table 5.

Table 2. Judgment matrix(X).

W	X1	X2	X3
X1	1	0.5	0.2
X2	2	1	0.5
X3	5	2	1

Table 3. Judgment matrix(X1).

W	X11	X12	X13	X14
X11	1	2	0.33	0.25
X12	0.5	1	2	5
X13	3	0.5	1	0.5
X14	4	0.2	2	1

Table 4. Judgment matrix(X2).

W	X21	X22	X213	X24
X21	1	0.25	4	3
X22	4	1	4	8
X23	0.25	0.25	1	0.5
X24	0.33	0.125	2	1

Table 5. Judgment matrix(X3).

W	X31	X32	X33	X34
X31	1	0.33	0.25	0.1429
X32	3	1	0.2	0.5
X33	4	5	1	0.33
X34	7	2	3	1

(2) Hierarchical single sorting to compute feature vectors

Hierarchical single sort refers to the pairwise comparison of all the elements of the current level for an element of the previous level, and then sort them in order of importance. In layman's terms, hierarchical single sort is to solve the weight of each index according to the judgment matrix we constructed. According to the judgment matrix constructed above, on this basis, the weights of the indicators can be calculated using the square root method or the sum product method, and the square root method is used in this paper to solve the problem. The square root method calculates the weights in the following way (take the judgment matrix in Table 2 as an example): (1) Calculate the fourth power of the product of each row to get a 4-dimensional vector, as follows:

$$p_{X1} = \left(\prod_{i=1}^{3} a_{ij}\right)^{1/3} = (1*0.5*0.2) = 0.4642$$

$$p_{X2} = \left(\prod_{i=1}^{3} a_{ij}\right)^{1/3} = (2*1*0.5) = 1$$

$$p_{X3} = \left(\prod_{i=1}^{3} a_{ij}\right)^{1/3} = (5*2*1) = 2.1544$$

Normalizing the vectors gives the weight vectors, also known as weights, which are calculated as follows:

$$\varphi_{X1} = p_{X1} / \sum_{i=1}^{3} p_i = 0.1283$$

$$\varphi_{X2} = p_{X2} / \sum_{i=1}^{3} p_i = 0.2764$$

$$\varphi_{X3} = p_{X3} / \sum_{i=1}^{3} p_i = 0.5953$$

Based on the obtained weight vector, the maximum characteristic root can be calculated as follows:

$$\lambda_{\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(XW)_i}{W_i} = \sum_{i=1}^{3}\begin{bmatrix}1 & 2 & 0.2\\ 2 & 5 & 0.5\\ 5 & 2 & 1\end{bmatrix}\begin{bmatrix}0.1283\\ 0.2764\\ 0.5953\end{bmatrix} / \frac{1}{3} * \begin{bmatrix}0.1283\\ 0.2764\\ 0.5953\end{bmatrix} = 3.0055$$

After obtaining the maximum characteristic root, the CI value can be obtained according to Eq:

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{3.0055-3}{2} = 0.0028$$

Combine the RI values to solve for the CR:

$$CR = \frac{CI}{CR} = \frac{0.0028}{0.52} = 0.0053$$

After the above calculation process, the results obtained are shown in Table 6.

Table 6. Judge the results of the matrix analytic hierarchy process(X).

X	Feature vector	Weight value	Maximum eigenvalue	CR
X1	0.4642	0.1283	3.0055	0.0053
X2	1	0.2764		
X3	2.1544	0.5953		

Similarly, the weight data of the secondary indicators under X1~X3 are calculated respectively, and the results obtained are shown in Tables 7~9.

Table 7. Judge the results of the matrix analytic hierarchy process(X1).

X1	Feature vector	Weight value	Maximum eigenvalue	CR
X11	0.6373	0.1522	4.0711	0.0266
X12	1.4953	0.3571		
X13	0.9306	0.2222		
X14	1.1247	0.2685		

Table 8. Judge the results of the matrix analytic hierarchy process(X2).

X2	Feature vector	Weight value	Maximum eigenvalue	CR
X21	1.3161	0.2335	4.0662	0.0248
X22	3.3636	0.5968		
X23	0.4204	0.0746		
X24	0.5359	0.0951		

Table 9. Judge the results of the matrix analytic hierarchy process(X3).

X3	Feature vector	Weight value	Maximum eigenvalue	CR
X31	0.3295	0.0631	4.0732	0.0274
X32	0.7401	0.1418		
X33	1.6028	0.3072		
X34	2.5457	0.4879		

(3) Hierarchical total ranking

According to the subjective relative weights of the evaluation indicators obtained above, the subjective absolute weights of the indicators can be calculated, and the subjective absolute weights of the evaluation indicators are shown in Table 10.

Table 10. Subjective absolute weight of the evaluation index.

Title	First-level indicator	Weight	Secondary indicators	Relative weight	Absolute weight
Evaluation of the Effect of Sports Dance teaching	X1	0.1283	X11	0.1522	0.0195
			X12	0.3571	0.0458
			X13	0.2222	0.0285
			X14	0.2685	0.0344
	X2	0.2764	X21	0.2335	0.0645
			X22	0.5968	0.1650
			X23	0.0746	0.0206

			X24	0.0951	0.0263
	X3	0.5953	X31	0.0631	0.0376
			X32	0.1418	0.0844
			X33	0.3072	0.1829
			X34	0.4879	0.2904

3.1.2. Analysis of Objective Weighting Results

(1) Data sources

This paper obtains data directly or by calculation by inquiring the teaching materials of sports dance in modern colleges and universities from 2015 to 2024 and so on. Experts in the relevant fields were consulted during the data collection period to ensure the authenticity and reliability of the data as much as possible, laying the foundation for the validity of the subsequent evaluation calculations, and the data are summarized as shown in Table 11. The data shows that the data distribution range is 5~10.

Table 11. Data summary.

Index	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
X11	7	8	6	5	7	5	6	8	5	6
X12	5	9	7	9	9	6	6	9	6	5
X13	7	9	9	6	8	8	6	8	7	9
X14	8	6	7	7	6	7	9	7	7	8
X21	5	9	8	5	7	6	7	6	7	5
X22	7	8	9	6	5	9	10	7	8	5
X23	6	6	6	7	8	7	8	7	8	9
X24	6	8	7	7	10	8	8	10	9	5
X31	6	8	6	7	9	5	8	9	9	9
X32	8	7	10	8	9	8	5	6	6	7
X33	7	6	7	8	6	6	6	9	6	8
X34	9	10	5	7	8	8	10	5	5	10

(2) Normalization

Due to the problem of non-uniformity of the scale of the indicators, it is necessary to normalize them, and the results of the normalization process are shown in Table 12. After the normalization process, the data of each index are located in the range of [0, 1].

Table 12. Normalize the processing result.

Index	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
X11	0.6667	1.0000	0.3333	0.0000	0.6667	0.0000	0.3333	1.0000	0.0000	0.3333
X12	0.0000	1.0000	0.5000	1.0000	1.0000	0.2500	0.2500	1.0000	0.2500	0.0000
X13	0.3333	1.0000	1.0000	0.0000	0.6667	0.6667	0.0000	0.6667	0.3333	1.0000
X14	0.6667	0.0000	0.3333	0.3333	0.0000	0.3333	1.0000	0.3333	0.3333	0.6667
X21	0.0000	1.0000	0.7500	0.0000	0.5000	0.2500	0.5000	0.2500	0.5000	0.0000
X22	0.4000	0.6000	0.8000	0.2000	0.0000	0.8000	1.0000	0.4000	0.6000	0.0000
X23	0.0000	0.0000	0.0000	0.3333	0.6667	0.3333	0.6667	0.3333	0.6667	1.0000
X24	0.2000	0.6000	0.4000	0.4000	1.0000	0.6000	0.6000	1.0000	0.8000	0.0000
X31	0.2500	0.7500	0.2500	0.5000	1.0000	0.0000	0.7500	1.0000	1.0000	1.0000
X32	0.6000	0.4000	1.0000	0.6000	0.8000	0.6000	0.0000	0.2000	0.2000	0.4000
X33	0.3333	0.0000	0.3333	0.6667	0.0000	0.0000	0.0000	1.0000	0.0000	0.6667
X34	0.8000	1.0000	0.0000	0.4000	0.6000	0.6000	1.0000	0.0000	0.0000	1.0000

(3) Calculation of indicator contribution degree

According to the above formula, the contribution degree of each evaluation indicator is calculated, and the results of the evaluation indicator contribution degree are shown in Table 13.

Table 13. Evaluation index contribution degree results.

Index	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
X11	0.1539	0.2308	0.0769	0.0000	0.1539	0.0000	0.0769	0.2308	0.0000	0.0769
X12	0.0000	0.1905	0.0952	0.1905	0.1905	0.0476	0.0476	0.1905	0.0476	0.0000
X13	0.0588	0.1765	0.1765	0.0000	0.1177	0.1177	0.0000	0.1177	0.0588	0.1765
X14	0.1667	0.0000	0.0833	0.0833	0.0000	0.0833	0.2500	0.0833	0.0833	0.1667
X21	0.0000	0.2667	0.2000	0.0000	0.1333	0.0667	0.1333	0.0667	0.1333	0.0000
X22	0.0833	0.1250	0.1667	0.0417	0.0000	0.1667	0.2083	0.0833	0.1250	0.0000
X23	0.0000	0.0000	0.0000	0.0833	0.1667	0.0833	0.1667	0.0833	0.1667	0.2500
X24	0.0357	0.1071	0.0714	0.0714	0.1786	0.1071	0.1071	0.1786	0.1429	0.0000
X31	0.0385	0.1154	0.0385	0.0769	0.1538	0.0000	0.1154	0.1538	0.1538	0.1538
X32	0.1250	0.0833	0.2083	0.1250	0.1667	0.1250	0.0000	0.0417	0.0417	0.0833
X33	0.1111	0.0000	0.1111	0.2222	0.0000	0.0000	0.0000	0.3333	0.0000	0.2222
X34	0.1481	0.1852	0.0000	0.0741	0.1111	0.1111	0.1852	0.0000	0.0000	0.1852

(4) Labeled entropy value, coefficient of variation and objective weights

On the basis of the known index contribution, the entropy value of the evaluation indicators, the coefficient of variation and the objective weight can be calculated using the formula, and the calculation results are shown in Table 14. The results show that the objective weight values of the first-level evaluation indicators are 0.3261, 0.3150 and 0.3589.

Table 14. Calculation result.

First-level indicator	Weight	Secondary indicators	Entropy value	Coefficient of difference	Objective weight
X1	0.3261	X11	0.8011	0.1989	0.1025
		X12	0.8348	0.1652	0.0851
		X13	0.8716	0.1284	0.0661
		X14	0.8596	0.1404	0.0724
X2	0.3150	X21	0.7997	0.2003	0.1032
		X22	0.8645	0.1355	0.0698
		X23	0.8094	0.1906	0.0982
		X24	0.9152	0.0848	0.0437
X3	0.3589	X31	0.9112	0.0888	0.0457
		X32	0.9052	0.0948	0.0489
		X33	0.6614	0.3386	0.1745
		X34	0.8255	0.1745	0.0899

3.1.3. Analysis of Portfolio Weighting Results

Through the above calculation, the objective weights and subjective weights of the evaluation indexes are finally derived, and the values of the combination weights of the evaluation indexes can be further calculated with the theoretical support of the corresponding calculation formula, and the results of the combination weights are analyzed as shown in Table 15. Based on the data performance in the table, it can be seen that X1 (0.2272) < X2 (0.2957) < X3 (0.4471).

Table 15. Analysis of combined weight results.

First-level indicator	Subjective weight	Objective weight	Combined weight	Secondary indicators	Subjective weight	Objective weight	Combined weight
X1	0.1283	0.3261	0.2272	X11	0.0195	0.1025	0.0610
				X12	0.0458	0.0851	0.0655
				X13	0.0285	0.0661	0.0473
				X14	0.0344	0.0724	0.0534
X2	0.2764	0.3150	0.2957	X21	0.0645	0.1032	0.0839
				X22	0.1650	0.0698	0.1174
				X23	0.0206	0.0982	0.0594
				X24	0.0263	0.0437	0.0350
X3	0.5953	0.3589	0.4471	X31	0.0376	0.0457	0.0417
				X32	0.0844	0.0489	0.0667

				X33	0.1829	0.1745	0.1787
				X34	0.2904	0.0899	0.1902

3.2. Analysis of the Results of the Comprehensive Evaluation

According to the comprehensive evaluation index system of dance sport teaching, the evaluation set of dance sport teaching V={"excellent V1", "good V2", "medium V3", "poor V4" and "poor V5"} was set. In the form of a questionnaire survey, experts were invited to evaluate the 12 indicators in the evaluation index system of physical dance teaching, and the 5-level Likert scale was used, and 5, 4, 3, 2, and 1 were used to represent very satisfied, relatively satisfied, generally satisfied, dissatisfied, and very dissatisfied. A total of 150 questionnaires were distributed and 138 valid questionnaires were recovered, with an effective rate of 92.00%. The reliability and validity of the questionnaire were analyzed by SPSS software, and the Cronbach coefficient of 12 evaluation indicators was 0.877, and the Cronbach coefficient of the standardized item was 0.902, indicating that the reliability of the questionnaire was good. The KMO value was 0.842, the approximate chi-square of Bartlett sphericity test was 138.17, and the corresponding P value was 0.004, indicating that the validity of the questionnaire was good. The results of the questionnaire are shown in Table 16~Table 18.

Table 16. Questionnaire results(X1).

Index	V1	V2	V3	V4	V5
X11	65	17	10	12	34
X12	70	16	11	14	27
X13	54	15	12	19	38
X14	69	15	16	16	22

Table 17. Questionnaire results(X2).

Index	V1	V2	V3	V4	V5
X21	60	16	20	14	28
X22	52	12	18	10	46
X23	62	19	19	17	21
X24	56	14	10	20	38

Table 18. Questionnaire results(X3).

Index	V1	V2	V3	V4	V5
X31	58	11	17	20	32
X32	54	19	19	10	36
X33	67	19	14	13	25
X34	51	17	18	17	35

Based on the questionnaire evaluation data, the ratio of the number of people belonging to the evaluation set to the total number of valid questionnaires for each evaluation indicator is calculated, and a fuzzy evaluation matrix for the 3 criterion layers is established R. The details are as follows:

$$R_{X1}=\begin{bmatrix} 0.4710 & 0.1232 & 0.0725 & 0.0870 & 0.2464 \\ 0.5072 & 0.1159 & 0.0797 & 0.1014 & 0.1957 \\ 0.3913 & 0.1087 & 0.0870 & 0.1377 & 0.2754 \\ 0.5000 & 0.1087 & 0.1159 & 0.1159 & 0.1594 \end{bmatrix}$$

$$R_{X2}=\begin{bmatrix} 0.4348 & 0.1159 & 0.1499 & 0.1014 & 0.2029 \\ 0.3768 & 0.0870 & 0.1304 & 0.0725 & 0.3333 \\ 0.4493 & 0.1377 & 0.1377 & 0.1232 & 0.1522 \\ 0.4058 & 0.1041 & 0.0725 & 0.1449 & 0.2754 \end{bmatrix}$$

$$R_{X3}=\begin{bmatrix}0.4203 & 0.0797 & 0.1232 & 0.1449 & 0.2319\\ 0.3913 & 0.1377 & 0.1377 & 0.0725 & 0.2609\\ 0.4855 & 0.1377 & 0.1014 & 0.0942 & 0.1812\\ 0.3696 & 0.1232 & 0.1304 & 0.1232 & 0.2536\end{bmatrix}$$

The fuzzy comprehensive evaluation value of each index in the guideline layer is calculated according to the formula, as shown in Table 19~Table 21. Taking X1 as an example, the calculation process is shown below:

$$G_{X1}=W_{X1}\times R_{X1}=\begin{bmatrix}0.4710 & 0.1232 & 0.0725 & 0.0870 & 0.2464\\ 0.5072 & 0.1159 & 0.0797 & 0.1014 & 0.1957\\ 0.3913 & 0.1087 & 0.0870 & 0.1377 & 0.2754\\ 0.5000 & 0.1087 & 0.1159 & 0.1159 & 0.1594\end{bmatrix}\times\begin{bmatrix}0.0610\\ 0.0655\\ 0.0473\\ 0.0534\end{bmatrix}$$

$$=\begin{bmatrix}0.0287 & 0.0332 & 0.0185 & 0.0267\\ 0.0075 & 0.0076 & 0.0051 & 0.0058\\ 0.0044 & 0.0052 & 0.0041 & 0.0062\\ 0.0053 & 0.0066 & 0.0065 & 0.0062\\ 0.0150 & 0.0128 & 0.0130 & 0.0085\end{bmatrix}=\begin{bmatrix}0.1072\\ 0.0261\\ 0.0199\\ 0.0247\\ 0.0494\end{bmatrix}$$

The remaining X2 and X3 are the same, and the detailed calculation process will not be given again.

Table 19. Fuzzy comprehensive evaluation value(X1).

Index	X11	X12	X13	X14	Evaluation value
V1	0.0287	0.0332	0.0185	0.0267	0.1072
V2	0.0075	0.0076	0.0051	0.0058	0.0261
V3	0.0044	0.0052	0.0041	0.0062	0.0199
V4	0.0053	0.0066	0.0065	0.0062	0.0247
V5	0.0150	0.0128	0.0130	0.0085	0.0494

Table 20. Fuzzy comprehensive evaluation value(X2).

Index	X21	X22	X23	X24	Evaluation value
V1	0.0365	0.0442	0.0267	0.0142	0.1216
V2	0.0097	0.0102	0.0082	0.0036	0.0317
V3	0.0122	0.0153	0.0082	0.0025	0.0382
V4	0.0085	0.0085	0.0073	0.0051	0.0294
V5	0.0170	0.0391	0.0090	0.0096	0.0748

Table 21. Fuzzy comprehensive evaluation value(X3).

Index	X31	X32	X33	X34	Evaluation value
V1	0.0175	0.0261	0.0868	0.0703	0.2007
V2	0.0033	0.0092	0.0246	0.0234	0.0605
V3	0.0051	0.0092	0.0181	0.0248	0.0573
V4	0.0060	0.0048	0.0168	0.0234	0.0511
V5	0.0097	0.0174	0.0324	0.0482	0.1077

Combined with the above to find the comprehensive evaluation value of the second-level indicators, the fuzzy comprehensive evaluation matrix of the target level is constructed, as shown in Table 22. The calculation process is shown below:

$$G_X = W_X \times R_X = \begin{bmatrix} 0.1072 & 0.0261 & 0.0199 & 0.0247 & 0.0494 \\ 0.1216 & 0.0317 & 0.0382 & 0.0294 & 0.0748 \\ 0.2007 & 0.0605 & 0.0573 & 0.0511 & 0.1077 \end{bmatrix} \times \begin{bmatrix} 0.2272 \\ 0.2957 \\ 0.4471 \end{bmatrix}$$

$$= \begin{bmatrix} 0.1533 \\ 0.0424 \\ 0.0414 \\ 0.0372 \\ 0.0815 \end{bmatrix}$$

Table 22. Fuzzy comprehensive evaluation value(X).

Index	X1	X2	X3	Evaluation value
V1	0.0276	0.0360	0.0897	0.1533
V2	0.0059	0.0094	0.0270	0.0424
V3	0.0045	0.0113	0.0256	0.0414
V4	0.0056	0.0087	0.0228	0.0372
V5	0.0112	0.0221	0.0482	0.0815

The final evaluation value of sport dance teaching is based on the evaluation set V = {"Excellent V1", "Good V2", "Moderate V3", "Poor V4", "Poor V5"}, to get the final evaluation value of physical education dance teaching. The calculation process is as follows:

$$E_X = G_X \times V = \begin{bmatrix} 0.1533 \\ 0.0424 \\ 0.0414 \\ 0.0372 \\ 0.0815 \end{bmatrix} \times \begin{bmatrix} 5 \\ 4 \\ 3 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.7666 \\ 0.1694 \\ 0.1243 \\ 0.0743 \\ 0.0815 \end{bmatrix}$$

Calculated sports dance teaching evaluation value (excellent: 0.7666, good: 0.1694, medium: 0.1243, poor: 0.0743, poor: 0.0815), and its corresponding degree of affiliation (excellent: 0.1533, good: 0.0424, medium: 0.0414, poor: 0.0372, poor: 0.0815), according to the maximum degree of affiliation principle, it can be concluded that the effect of the personalized optimization strategy of dance training and teaching is excellent, which well confirms the practical application effect of its strategy, indicating that the teaching strategy formulated in this paper around the teaching content, the construction of teachers and teachers, and the personalized teaching has made the level of training and teaching of physical education and dance in modern colleges and universities to rise to a new height.

4. Conclusion

Through the questionnaire on the teaching of sports dance in colleges and universities, it reflects the current dilemma of sports dance teaching in colleges and universities, and in view of the above dilemma, this paper proposes a personalized optimization strategy for dance training and teaching. In order to verify the effectiveness of its strategy, using the hierarchical analysis method, entropy weight method, fuzzy comprehensive evaluation method, a corresponding assessment program was developed. Under the theory of this scheme, the optimization strategy of this paper is evaluated and analyzed by examples. The evaluation value of the personalized optimization strategy of dance training and teaching is (0.7666, 0.1694, 0.1243, 0.0743, 0.0815), and under the constraints of the principle of maximum affiliation, it is concluded that the evaluation result of this strategy is excellent, which verifies the application value of its strategy.

References

1. Gao, X., & Cao, S. (2021). Teaching reform and innovation of sports dance in colleges and universities. Front Sport Res, 3(5).
2. Ge, L. (2022). Research on the teaching practice of college sports dance from the perspective of behavioral psychology. Psychiatria Danubina, 34(suppl 4), 91-91.
3. Chen, L., & Hu, F. (2017, April). Study on the Aesthetic Education Value of College Sports Dance and Its Realization Approach. In 7th International Conference on Education, Management, Information and Mechanical Engineering (EMIM 2017) (pp. 1611-1614). Atlantis Press.
4. Pennington, C. G. (2017). Moral development and sportsmanship in physical education and sport. Journal of Physical Education, Recreation & Dance, 88(9), 36-42.
5. Jowett, G. E., Hill, A. P., Curran, T., Hall, H. K., & Clements, L. (2021). Perfectionism, burnout, and engagement in dance: The moderating role of autonomy support. Sport, Exercise, and Performance Psychology, 10(1), 133.
6. Gao, X., & Ma, S. (2023). Research on the Teaching Reform of Dance Curriculum from the Perspective of Core Literacy Cultivation. education, 6(30), 112-118.
7. Ljubojevic, A. L., Jovanović, S., Bijelic, S., & Šebić, L. (2020). Coordination abilities in dance sport: systematic development in the training process. Sportski logos.
8. Liu, Y., Yang, G., & Feng, X. (2024). Research on the Education and Teaching of Physical Education Dance Courses in Colleges and Universities Based on Deep Learning. International Journal of High Speed Electronics and Systems, 2540172.
9. Mao, R. (2021). The design on dance teaching mode of personalized and diversified in the context of internet. In E3S Web of Conferences (Vol. 251, p. 03059). EDP Sciences.
10. Uspuriene, B. A., & Sniras, S. A. (2018). Effect of sports training programme on juvenile sports dancers motivation. Pedagogics, psychology, medical-biological problems of physical training and sports, (3), 163-169.
11. Álvarez, J. A. E., García, J. P. F., Da Conceição, F. A., & Jiménez-Reyes, P. (2019). Individualized training based on force–velocity profiling during jumping in ballet dancers. International journal of sports physiology and performance, 15(6), 788-794.
12. Colquitt, G., Pritchard, T., Johnson, C., & McCollum, S. (2017). Differentiating instruction in physical education: Personalization of learning. Journal of Physical Education, Recreation & Dance, 88(7), 44-50.
13. Liu, X., Soh, K. G., Dev Omar Dev, R., Li, W., & Yi, Q. (2023). Design and implementation of adolescent health Latin dance teaching system under artificial intelligence technology. Plos one, 18(11), e0293313.
14. Ran, W. (2020). Practical Analysis of the Integration Mode of Teaching and Training of Aerobics in Colleges and Universities. Open Access Library Journal, 7(10), 1-6.
15. Li, J., Kou, H., Wang, J., & Ren, W. (2024). Enhancing online learning for dance majors: A customized teaching approach using massive open online courses. Education and Information Technologies, 29(4), 5139-5167.
16. Kim Eun Hye,Kim Ji Young & Kwon Jae Yoon. (2018). Development of Evaluation Indicators of Teaching Competency for the School Dance Education through the AHP. Korean Association For Learner-Centered Curriculum And Instruction,18(12),715-729.
17. Ji Young Kim,Su Jin Lim & Hyoung Nam Kim. (2016). Exploration of the Dance Career Intervention by AHP Method : Focusing on Vocational Guidance, Career Education and Career Counseling. The Korean Journal of Physical Education,55(6),661-676.
18. Feng Yu,Yi Wu,Xian Ming Shao & Jian Chun Guo. (2014). Fuzzy Comprehension Evaluation of Sunny Sports Activity Using Entropy Weight. Applied Mechanics and Materials,3066(539-539),908-910.