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Research Article

An Evaluation Model for the Teaching Reform of the Physical Education Industry

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In order to promote the development of sports industry teaching and accurately evaluate the teaching reform of sports industry, this paper constructs an evaluation model based on the teaching reform of sports industry. In addition, the k-means method is used to classify the teaching effect and simplify the data collection process, so as to improve the accuracy of teaching reform evaluation. The sample data come from the data released by the sports department and the government from 2017 to 2020, as well as the actual survey. The 26 evaluation indexes were determined by expert survey, questionnaire interview, and relevant domestic literature. In addition, the Euclidean distance in *K-means* method is used to calculate the weight of each index, and the results of the evaluation model are analyzed. The results show that the evaluation accuracy of the sports industry teaching reform model proposed in this paper is 98.4% and the error is 1.3%. The evaluation result is better than the previous ant colony model and is suitable for the evaluation of sports teaching reform.

1. Introduction

Sports industrialization teaching is an important measure to promote the development of national fitness. It is of great significance to improve physical quality and give full play to the social function of sports. The teaching contents and objectives of sports industry cannot meet the actual needs of teaching reform and affect the healthy development of sports industry, so the teaching of sports industry needs continuous reform. At present, the evaluation method of sports industrialization teaching reform is too subjective and lacks quantitative and qualitative analysis model. Therefore, building a teaching evaluation model of sports industry with high accuracy and small error is a problem that needs to be solved by the sports department at present. The results are shown as Figure 1.

The key to the teaching reform of sports industry is to give full play to its social function and socio-economic promotion. However, the teaching reform of sports industry lacks effective evaluation methods, especially comprehensive evaluation methods, which makes the teaching reform of sports industry unable to proceed smoothly. Based on the abovementioned background and reasons, this paper proposes an evaluation model based on improved ant colony algorithm and makes an experimental analysis on the teaching reform of sports industry to verify the effectiveness of this method.

2. The Influence Factors of Physical Education Industry Teaching

2.1. The Role of Physical Education Industry Teaching. The teaching reform of sports industry is a dynamic and complex social activity, involving many factors. Teaching reform includes not only national fitness and local economy but also national and government planning. Therefore, the teaching reform of sports industry needs accurate analysis and demonstration in order to achieve the expected goal. In addition, the teaching reform of sports industry also presents the characteristics of periodicity and randomness. Comprehensive analysis is needed to effectively identify the uncontrollable factors in the reform [1].

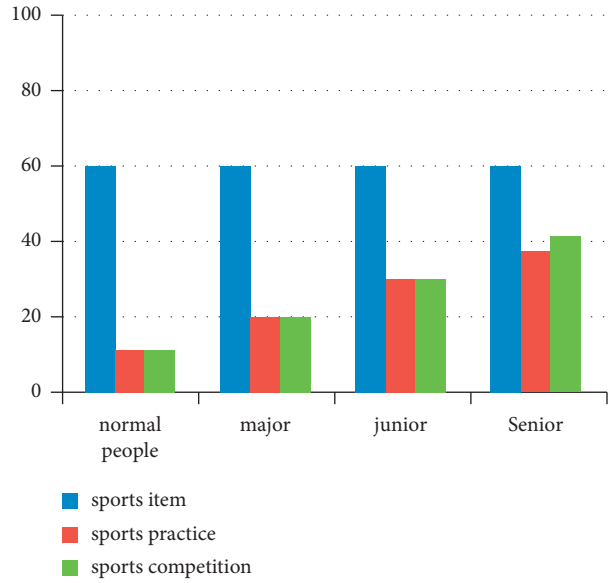

Figure 1: The results of sports in different grades.

2.2. The Effect of Teaching Reform of Physical Education Industry. A large number of studies show that regression analysis and other methods focus on controllable objective factors such as the study by Broo et al. [2], ignoring the correlation between controllable and uncontrollable factors. Therefore, there is a large deviation between the theoretical results and the actual results of the teaching reform of sports industry [3]. In addition, the teaching reform of sports industry is affected by many factors, and a single calculation method cannot meet the calculation requirements [4].

Based on the above analysis, this paper proposes an improved ant colony algorithm to analyze various factors of teaching reform in sports industry, extract the key indicators, and give weights to the indicators to form the final teaching reform model [5].The specific model calculation formula is expressed as follows:

$$\begin{cases} c_{ij} = x_i - \dfrac{\overline{x_j}}{\sqrt{s_{ij}}}, \\ \overline{x_j} = \sum_{i=1}^{n} x_{ij}, \\ s_{ij} = \sum_{i=1}^{n} \left(x_{ij} - \overline{x_j}\right)^2, \end{cases} \tag{1}$$

where i is the number of parameters, j is the frequency of parameter values, n is the number of samples, c_{ij} is the amount after processing x_{ij}, $\overline{x}_j$ is the average value of x_{ij}, and s_{ij} is the variance of x_{ij}.

3. *K-Means* Classification

In order to ensure the accuracy of teaching reform evaluation and simplify the data collection process, it is necessary to classify the teaching effect by *K-means*. This paper uses the *K-means* classification of index division. In the process of data collection, there is no significant sudden change between the last test time t_i and the next test time t_{i+1} of each evaluation dimension, so there is a correlation between the evaluation dimensions of t_i and t_{i+1}. Therefore, t_{i+1} sports effect evaluation data come from TI's evaluation results, so as to realize the continuous evaluation of teaching effect. *K-means* classification is based on the sum of squared error clustering results, and its similarity judgment method is Euclidean distance. Among them, the standard *K-means* classification has the problems of large center$_P$ deviation and inconsistent *K-means* of all kinds of samples, which affect the accuracy of *K-means* classification. In this paper, the concept of contour coefficient S_k is introduced to limit the range of various types in *K-means*, so as to improve the accuracy of classification and the similarity of sample classification. The calculation formula of sample center is as follows:

$$\begin{cases} P(i) = \dfrac{p(i) - q(i)}{\max\{q(i), p(i)\}}, \\ \overline{P} = \dfrac{1}{n} \sum_{i=1}^{n} P(i). \end{cases} \tag{2}$$

where i is the sample ID, $q(i)$ is the distance from sample i to other points in the cluster, $p(i)$ is the minimum distance from i to other points in the noncluster, and $\overline{P(i)}$ is the average distance from the sample to the cluster. After obtaining the center of each sample, the total evaluation result of P_E the whole dataset should be calculated. The calculation formula is as follows:

$$P_E = \overrightarrow{\sqrt{\sum_{k=1}^{m} \omega_k \left(P_k - min\left(P_k\right)\right)^2 / k}}, k = 1, 2 \cdots, m, \tag{3}$$

where ω_k is the weight in the whole sample, the sum of which is 1, P_k is the center of different clustering samples, $\min(P_k)$ is the center of clustering k, and $P_E$is the Euclidean distance between the average center and the minimum distance center of clustering k, representing the final evaluation result of sports effect. The teaching effect evaluation is arranged in ascending order of P_E, and the minimum value is selected as the initial cluster analysis value.

4. Construction of Sports Teaching Effect Evaluation System

4.1. Mathematical Description of the Improved Algorithm. The gradient descent logic in the standard ant colony algorithm will increase the number of local extremum and affect the accuracy of the results and the convergence speed of the calculation [6]. The *K-means* classification is integrated into the ant colony algorithm to construct the sports effect evaluation system. The contour coefficient S_k can limit the gradient descent direction (positive and negative) in the process of ant colony algorithm, reduce the occurrence rate of local extremum, and improve the accuracy of calculation. $\omega_k$can simplify the evaluation process of teaching reform in sports industry [7].

Suppose that the evaluation index vector of understanding sports in the sports teaching effect evaluation system is $x_r = (x_1, \ldots, x_m)^T$, the evaluation standard vector of subtle influence is $Y_r = (Y_1, \ldots, Y_n)^T$, the evaluation result vector of actual training is $O_r = (o_1, \ldots, o_l)^T$, and the expectation vector of teaching effect evaluation target is $D_r = (d_1, \ldots, d_l)^T$. Among them, the weight between understanding the sports evaluation index vector and the subtle influence is w_{ik}, contour coefficient is S_{ik}, the weight between the subtle influence and the actual training evaluation standard vector is w_{kj}, and contour coefficient is S_{kj}, and then the mathematical model of sports effect evaluation system is shown in the following formula:

$$\begin{cases} y_j = f\left[\overbrace{\sum_{i=1}^{m}\left(w_{ik}x_i + S_{ik}\right)}\right], \\ o_k = f\left[\sum_{j=1}^{p}\left(w_{kj}y_i + S_{kj}\right)\right]. \end{cases} \tag{4}$$

The output error between different layers e = output vector o-expected vector p, and the calculation is shown in the following equation:

$$e = \frac{1}{2}(D-O)^2 = \overbrace{\frac{1}{2}\sum_{k=1}^{l}\left(d_k - f\left[\sum_{j=1}^{p}\left(w_{jk}y_i + b_{jk}\right)\right]\right)^2}$$

$$= \frac{1}{2}\sum_{k=1}^{l}\left(d_k - f\left[\sum_{j=1}^{p}\left(w_{jk}f\left[\sum_{i=1}^{m}\left(w_{ij}x_i + b_{ij}\right)\right] + b_{jk}\right)\right]\right)^2. \tag{5}$$

Different input vectors get different output values, which makes a group of weights and thresholds of comprehensive construction effect, social function, and social economy realize internal representation. After repeated learning and national fitness, determine the network parameters with the minimum error and stop the analysis of national fitness. After the analysis of the effect of national fitness, the corresponding comprehensive evaluation is made for different objects.

Ant colony algorithm is divided into three layers: input layer, regulation layer, and output layer. When the input parameters are the same, different weights and thresholds will lead to different output results. In order to improve the accuracy of output results, reasonable weight setting should be carried out. In addition, in the process of teaching reform evaluation of sports industry, human subjective factors and objective factors of data collection will also lead to inaccurate output results. Therefore, the error adjustment function should be increased to reduce the influence of the above interference factors on the results.

4.2. The Consistency Processing of Evaluation Data of Teaching Reform in Sports Industry

4.2.1. Consistency of Social Function. Because the teaching evaluation data of sports industry comes from all aspects, including not only structured but also semistructured data, the inconsistency of data results will increase the computational complexity and prolong the calculation time of evaluation results. Therefore, it is necessary to standardize the data of teaching reform of sports industry. The specific calculation formula is shown as

$$\iint d_i = \int \alpha \frac{\overline{\overline{\Delta d + \beta}}}{d_{\max} - d_{\min} + \beta}, \tag{6}$$

where d_i is the teaching effect evaluation data, $\iint d_i$ is the result of d_i normalization, and $d_{\max}$ and $d_{\min}$ are the maximum and minimum values of each evaluation index. Because the data projection is in the range of (0,1), the values of each index approach and cannot reach 0 and 1. Therefore, when $\iint d_i = d_{\max}$, $\alpha \approx 1$; when $\iint d_i = d_{\min}$, $\beta \approx 0$.

4.3. Error Analysis of Evaluation Results. The error of evaluation results is divided into mean square error E_m and relative error percentage E_C, both of which are used to evaluate the error from the qualitative and quantitative point of view [8], realizing the comprehensive evaluation of teaching effect evaluation. E_m = estimated value−actual value, the overall result error of sports effect; E_C is the error percentage between samples in the index which reflects the error of the index, and the specific calculation is shown in the following formula:

$$\begin{cases} \lim\limits_{x\longrightarrow\infty} E_m = \dfrac{\left[\sum_{i=1}^{n-1}\left(\overbrace{d_i - \xi}\right)^2\right]}{n-1}, \\ \lim\limits_{x\longrightarrow\infty} E_C = \dfrac{\xi - d_i}{d_i} \times 100\%. \end{cases} \tag{7}$$

5. The Empirical Analysis on the Evaluation of Teaching Reform in Physical Education Industry

In order to verify the effect of improved ant colony algorithm on the evaluation of sports industry teaching reform, this paper collects 46 data of sports industry teaching reform and makes 200 iterative analyses on the results [9]. Each evaluation index is the average value, and the period from June 2017 to January 2021 is selected. At the same time, set the accuracy of the calculation result to 0.001. The specific data results are shown in Table 1.

5.1. Sample K-Means Classification. Taking the national fitness method x_1, social function x_2, local economy x_3, and local policy x_4 as the initial indicators, combined with the data in Table 2, the effect of physical education industry teaching is studied, as shown in Table 2.

According to the above analysis, the similarity of the range of each input variable and the total input variable is high, and there is no significant difference. The *K-means* classification result is better. Determine the outline system of the whole sports effect evaluation system; determine the

Table 1: Actual measurement results ($n = 46$).

Test number	Fitness effect	Improvement of local economy	Result	Variance
1	10	24	6	0.81
2	6	42	5	0.81
3	5	35	5	1.89
4	4	43	5	0.81
5	5	45	6	1.08
6	10	44	5	1.89
7	5	25	5	1.35
8	3	42	5	1.08
9	10	30	6	1.08
10	15	39	6	1.35
11	2	26	6	1.89
12	7	22	6	0.81
13	10	36	5	1.89
14	6	41	6	1.89
15	9	41	6	1.89
16	12	45	6	1.35
17	14	32	5	0.81
18	9	24	6	1.62
19	4	30	5	1.08
20	16	24	6	0.81
21	9	25	5	1.62
22	5	26	6	1.35
23	16	36	6	1.35
24	2	23	5	0.81
25	14	38	6	1.89
26	13	27	5	0.81
27	13	29	5	1.62
28	10	39	6	1.35
29	2	37	5	1.89
30	13	28	6	1.35
31	3	29	6	1.89
32	8	35	5	1.35
33	8	33	6	1.35
34	5	37	6	1.62
35	9	24	5	1.08
36	5	23	5	1.89
37	16	26	6	1.35
38	13	45	6	1.89
39	2	45	6	1.35
40	9	45	6	1.89
41	4	45	5	0.81
42	16	29	5	1.89
43	8	26	5	1.08
44	8	30	5	1.35
45	10	37	6	1.62
46	7	27	5	0.81

Table 2: The sample classification results.

Category	Number of samples	Initial cluster center				p_i
		x_1	x_2	x_3	x_4	
x_1	231	114.0	140.9	102.2	135.7	114.0
x_2	102	79.6	85.4	92.2	84.5	79.6
x_3	321	181.7	173.1	134.4	17.5	171.7
x_4	162	148.4	124.5	111.3	102.2	138.4
Total	816	552.7	575.3	549.5	544.1	552.7

classification number k to get the optimal value. Firstly, 816 samples are normalized, k is increased from 2 to 7, and S_t is the contour coefficients. The result is shown as Table 3.

When the number of clusters is $k = 4$, the coefficient S_k is the largest, which indicates that the clustering effect is the highest under the 4-equal partition. Therefore, this paper chooses $k = 4$ as the initial number of clusters, and P_i carries on the 4-equal partition clustering. Then, P_E are the teaching effect evaluation results of sports which are calculated and arranged in ascending order. The results show that the minimum value of P_E is 0.786, the maximum value is 4.232, and the value range is 0.786–4.232. Among them, *K-means* is an iterative clustering analysis algorithm. The step is to divide the data into k groups, then randomly select k objects as the initial clustering center and then calculate the clustering of each object and each seed. On the one hand, *K-means* method randomly selects sports industry projects to reduce the subjectivity of human evaluation and realize the quantitative analysis of the results; on the other hand, this method classifies the sports industry projects and realizes the qualitative analysis of the results. Therefore, *K-means* method has the comprehensive advantages of qualitative and quantitative analysis and is suitable for the needs of teaching reform and evaluation of sports industry.

5.2. The Error Calculation of Evaluation Results of Teaching Reform in Physical Education Industry. According to the calculation results in Figure 2, the error rate of the improved algorithm is significantly lower than that of the original algorithm, and the results of the improved algorithm are basically consistent with the actual results. Therefore, the accuracy of the improved algorithm is better, which is consistent with the actual results. The errors of sports effect are calculated by different iterations [10], and the evaluation results of sports effect under different target errors are calculated. The results expressed are shown in Figure 2.

As can be seen from Figure 2, with the increase of evaluation data of teaching reform in sports industry, the calculation accuracy of the improved ant colony algorithm is consistent with the actual situation and better than the standard ant colony algorithm. The results show that the improved ant colony algorithm is more stable under the same amount of data, mainly because *K-mean* classification can improve the convergence of the evaluation model.

5.3. The Calculation Accuracy Analysis of Teaching Evaluation of Physical Education Industry. In order to further verify the effectiveness of the improved algorithm, the calculation accuracy should be verified to ensure that it meets the evaluation requirements, i.e., >95%. Based on the effect of national fitness, social function, and local economy, this paper makes a comprehensive analysis on the function system of sports. The results show that the index of this method is between 0 and 60, the social function is above 97%, and the calculation time is controlled between 0 and 30 seconds. Therefore, the comprehensive results of sports effect, social function, and calculation time are in line with the requirements, and the constructed quality action system can affect the actual movement. The results are shown as Figure 3.

Table 3: Contour coefficient S_k under different k values.

k value	S_k coefficient	k value	S_k coefficient
2	1.622	5	1.892
3	0.811	6	1.692
4	1.892	7	1.687

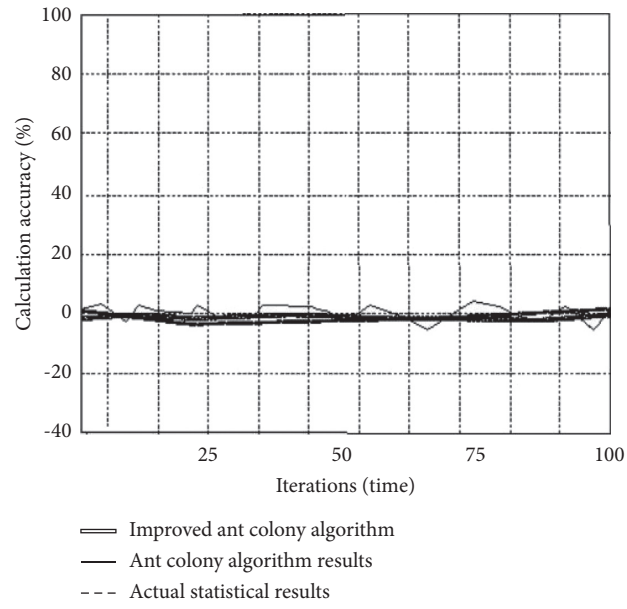

Figure 2: The error comparison of three methods.

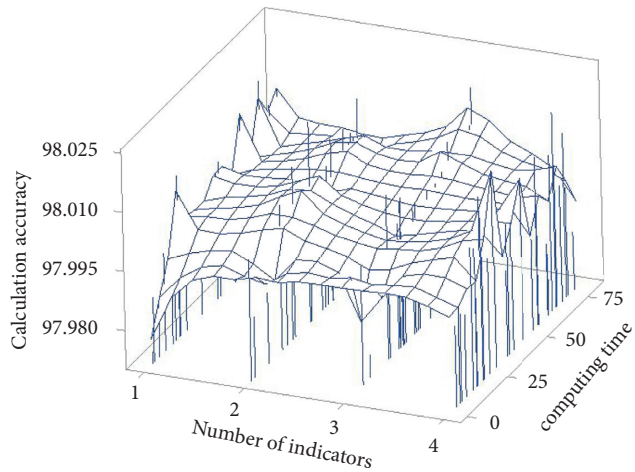

Figure 3: The comprehensive results of teaching effect evaluation of sports.

The relationship between each index is also an important evaluation index of the algorithm and another important content to verify the effectiveness of the improved algorithm. In order to verify the effectiveness of the algorithm, the relationship between each index should be analyzed. By calculating the number of iterations from 0 to 1200, the change

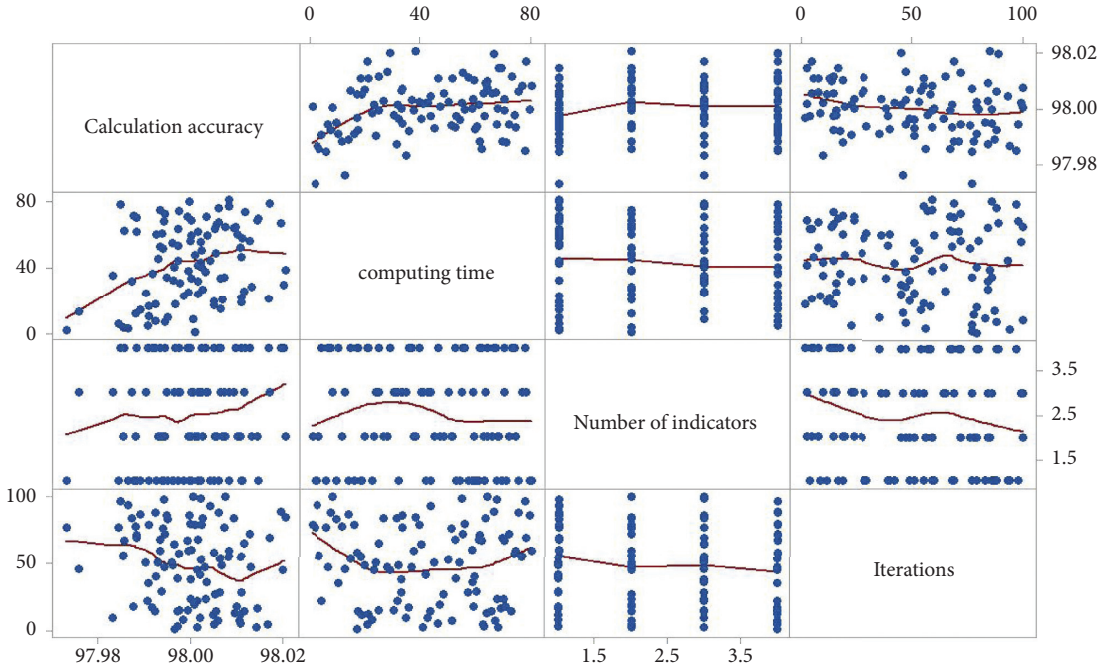

Figure 4: Relationship between iteration times and calculation accuracy, index number, and calculation.

values of the index number, calculation time, and calculation accuracy can be obtained. The result is shown as Figure 4.

It can be seen from the above analysis that with the increase of the number of iterations, the calculation accuracy of the teaching reform model of sports industry has not changed significantly, which is still between 97.5% and 98.5%, maintained at about 30, and the calculation time is maintained at about 17 seconds. Therefore, the overall effect of the sports industry teaching evaluation model based on the improved ant colony algorithm constructed in this paper is higher, which is better than the 90% accuracy of the previous genetic algorithm.

6. Conclusions

This paper analyzes the influence of physical education industry teaching on overall fitness effect [11], social function, and local economy. The collected sample data are normalized to reduce the impact of data attributes on the results [12]. Using MATLAB simulation analysis, the results show that, sports for the social function of national fitness [13], the role of local economy is more obvious. Through the convergence of the model, we can see that sports have a greater impact on national fitness [14]. At the same time, the function system constructed in this paper does not extend the calculation time with the increase of the number of iterations [15], which indicates that the effect of physical education industry teaching on national fitness is continuous [16]. Therefore, this paper believes that physical education industry teaching has a strong comprehensive role, can be used as an important part of the overall fitness, and promote the development of local economy, giving full play to the social function of national fitness.

Data Availability

The data used to support the results of this research are concealed and so cannot be provided.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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