Retraction

Retracted: Research on Teaching Quality Evaluation Model of Physical Education Based on Simulated Annealing Algorithm

Mobile Information Systems

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope

(2) Discrepancies in the description of the research reported

(3) Discrepancies between the availability of data and the research described

(4) Inappropriate citations

(5) Incoherent, meaningless and/or irrelevant content included in the article

(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Duan and P. Hou, "Research on Teaching Quality Evaluation Model of Physical Education Based on Simulated Annealing Algorithm," *Mobile Information Systems*, vol. 2021, Article ID 4407512, 8 pages, 2021.

Research Article

Research on Teaching Quality Evaluation Model of Physical Education Based on Simulated Annealing Algorithm

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One of the most significant components of the teaching department is the evaluation of teaching quality. The traditional teaching quality evaluation model has the problems of low weight calculation accuracy and long evaluation time. With the development of educational informatization, modern information processing technology can be used to effectively evaluate teachers' teaching quality. In this article, a physical education teaching quality evaluation model based on the simulated annealing algorithm is proposed. An evaluation index system is established based on the construction principles of the evaluation index system followed by the construction of a judgment matrix to calculate the weight of the evaluation index. The simulated annealing algorithm is employed to effectively optimize the weight of the evaluation index and improve the evaluation accuracy. In addition, the analytic hierarchy process (AHP) is used to test the consistency of the judgment matrix, and the weight ranking results of the evaluation indexes are obtained to complete the teaching quality evaluation of physical education. The experimental results show that the performance of the proposed model in terms of evaluation weight calculation accuracy and evaluation calculation time is higher than that of the existing models. Therefore, the proposed model can better meet the requirements of physical education teaching quality evaluation.

1. Introduction

The rapid advancement of computer and information technology has brought about a fundamental revolution in teaching methods, overcoming the limitations of conventional teaching in time and space and improving the communication among the teachers and students [1]. Physical education (PE) is a highly practical and typical two-sided educational activity [2]. The purpose of PE in colleges and universities is to improve students' physique and cultivate their awareness about the importance of physical exercise. PE has been extensively recognized as an essential driving force for improving physical education among children. In PE, the physical, mental, and social benefits of PE are well recognized, and it provides the opportunity for students to improve learning and skills to lead a physically active lifestyle.

In China, the Ministry of Education issued the guidelines for the teaching of PE courses in national colleges and universities in 2002 and pointed out that PE courses are the main sources for college students to exercise. Through reasonable PE and scientific physical exercise processes, the students can strengthen their physique, improve their physical and mental health, and improve their physical literacy [1–3]. As an important part of physical educational activities, PE teaching evaluation plays a central role in the process of carrying out quality education and promoting healthy development. PE teaching evaluation cannot only encourage students to actively participate in physical exercise but also timely monitor and provide feedback on students' learning effects, physique, and health status, to achieve the goal of promoting students' physical and mental development and realizing health.

For many years, Chinese educational institutes generally use the scoring method of students' PE qualification as the standard in the evaluation of college students' physical education learning. This not only leads to the failure of

effectively assessing the teaching quality of the PE curriculum but also ignores the impact of curriculum standards on students' PE learning outcomes [4]. Therefore, the evaluation of PE teaching quality can make up for this shortcoming.

Jianli et al. [5] proposed a quality evaluation model based on hesitant fuzzy sets. Based on expert scoring, hesitant fuzzy sets and intuitive fuzzy sets were combined to obtain a comprehensive hesitant fuzzy evaluation matrix of quality characteristics. Then, the quality attribute score is obtained by calculating the hesitation fuzzy generalized comparison table. Finally, the quality ranking is given according to the score. Gomede et al. [6] proposed an adaptive learning method for computing student outcomes using a deep autoencoder. Their approach was significantly adaptive; however, the system was efficient only for the assessment of the student's outcomes. A method of the voting ensemble was presented in [7]. They showed that the voting ensemble technique combined with feature selection using chi-square shows better evaluation results than other classifiers. However, the attribute weights and sentiment analysis were not applied to improve the effectiveness of the evaluation. Yu et al. [8] classified teaching sentiment and provided a comparison between the performances of artificial neural network (ANN), support vector machine (SVM), and Naïve Bayes (NB). ANN was reported to provide high performance than NB. Zeng [9] proposed a hidden Markov model (HMM) for evaluating PE teachers. They investigated the standard of evaluation methods of PE and the applicability of data mining technology and HMM and proposed a mathematical model for assessing the value of PE. Rong [10] established an assessment forecast model for teaching quality valuation using an extreme gradient boosting algorithm and ResNet technique. A simulation was carried out using deep learning methods, and the results were obtained using different kernels and batches. The authors in [11] proposed a quality evaluation model based on active learning SVM. An evaluation index was constructed for evaluating classroom teaching quality. The active SVM was used to establish the classroom teaching quality evaluation model, and the results were analyzed. Caiyun [12] proposed a quality evaluation model and used AHP to calculate the collected data and provided decision support, synchronized the data platform with basic teaching data, and realized the sharing of teaching quality data. The analytic hierarchy process was used to construct the evaluation index system to complete the evaluation of teaching quality.

To further improve the consistency and rationality of PE teaching quality, this paper develops an improved PE teaching quality evaluation model based on a simulated annealing algorithm. Through the simulated annealing algorithm, the weight of the evaluation index was effectively optimized, to obtain more accurate teaching quality evaluation results.

The remaining sections of the manuscript are ordered as follows. In section 2, the proposed simulating annealing algorithm and weight calculation are presented. The results are illustrated in section 3. Finally, the conclusion and future work are given in section 4.

2. Development of PE Teaching Evolution Model Based on Simulated Annealing Algorithm

2.1. Construction of Evaluation Index System and Weight Calculation of PE Teaching Quality. The appraisal of teachers can be considered as a matter within the school. The objective of the teachers' assessment is to step into the student's class and partake in several social activities. The evaluation of teachers is a kind of social behavior. The quality of the teacher evaluation index will directly affect the evaluation process [13]. The establishment of the evaluation index system of physical education teaching quality should follow the following principles: scientific and systematic, the principle of goal consistency, the principle of stability and comparability, the principle of operability, and feedback and guidance principles [14]. Under the guidance of these principles, the analytic hierarchy process (AHP) was used to analyze the primary and secondary influencing factors of PE teaching quality evaluation, grasp the main factors, and discard the secondary factors, to complete the development of the evaluation index system. Table 1 provides the detail of primary and secondary indexes for PE teaching evaluation.

Based on the evaluation index system presented in Table 1, we compared the elements of the same layer, assigned the importance according to the 1–9 scale method, constructed the judgment matrix, and calculated the weight of the evaluation index. The meanings of 1–9 scales are shown in Table 2.

We surveyed relevant education experts, teachers, and students and established the corresponding judgment matrix. Assuming that the number of influencing elements in a layer is n, then the judgment matrix $n * n$ was computed as follows:

$$A = \left(a_{ij}\right)_{n*n}. \tag{1}$$

Based on the calculation of the judgment matrix $(a_{ij})_{n*n}$, the evaluation index weight can be computed using the following equation:

$$W_n = \frac{A_i}{\sum_{i=1}^{n} A_i}, \tag{2}$$

where W_n represents the index weight and A_i is the judgment matrix. Based on the evaluation index weight given in equation (2), the simulated annealing algorithm was employed to optimize the evaluation weight value and consequently improve the quality of PE teaching quality.

2.2. Optimization of Evaluation Weight Based on Simulated Annealing Algorithm. Simulated annealing is a general probabilistic heuristic algorithm for combinatorial optimization problems, widely used to find a global optimal solution and approximate optimal solution in a large global search space [15–17]. The simulated annealing algorithm is mostly used in the search of discrete space. The simulated annealing is more efficient than exhaustive search methods because its objective is to find an optimum solution in an acceptable time,

TABLE 1: Evaluation index system of PE teaching quality.

Primary index	Secondary index
Teaching attitude U_1	The teaching style is rigorous and exemplary U_{11} Abide by teaching discipline, be serious and responsible in teaching, and strictly require students U_{12} Class spirit, enthusiasm, appeal, can attract students' attention U_{13}
Teaching link U_2	Adequate lesson preparation U_{21} Quality of extracurricular training homework U_{22} Be able to properly use advanced teaching technology U_{23}
Teaching contents U_3	The teaching content is skilled and applied freely U_{31} The teaching content is rich, the amount of information is large, the key points are prominent, and it is difficult to be appropriate U_{32} Be able to properly introduce the new trends and achievements of discipline development U_{33} The selected teaching content is appropriate and of good quality U_{34}
Teaching effect U_4	Explain clearly, students understand, and absorb well U_{41} Extracurricular homework helps to deepen and expand the teaching content U_{42} Through learning, I feel very fruitful, learned knowledge, developing thinking, and improved ability U_{43}
Teaching methods U_5	The teaching is organized, clear, concise, and accurate U_{51} Be good at organizing teaching, mobilizing students' emotions, and active classroom atmosphere U_{52} Inspire students to think and pay attention to developing students' thinking and cultivating students' ability U_{53}

TABLE 2: 1–9 meaning of the scale method.

Scale	Meaning
1	The two elements have the same importance
3	Comparison of two elements, the first element is slightly more important than the second
5	Comparison of two elements, the first element is obviously of more importance than the second
7	Comparison of two elements, the first is of more importance than the second
9	Comparison of two elements, the first is extremely important than the second
2, 4, 6, 8	Indicates the intermediate value of the above adjacent judgment
Reciprocal	If the importance ratio of element i to element j is a_{ij}, the importance ratio of element j to element i is $a_{ji} = 1/a_{ij}$

rather than the best solution. The idea and name of simulated annealing come from physical annealing in metallurgy. It is a technique of heating and controlling the cooling of crystalline materials to increase the size of crystals and reduce their defects. When the temperature is high, atoms can leave their initial position and move randomly in a higher energy state. With the slow decline of temperature, atoms have more opportunities to reach a lower energy state than at the beginning. Through the description of the annealing physical process, each step of the simulated annealing algorithm replaces the current solution with a new solution (the new solution is selected according to the distribution of candidate solutions, generally from the solution set adjacent to the current solution). The probability that the new solution may be accepted depends on the value of the corresponding fitness function and the size of a temperature parameter, which will gradually decrease during annealing. When the temperature is high, the new solution may be accepted, which is almost random. With the decrease in temperature, more and more people tend to choose a better solution [18–20].

To optimize the evaluation weight for PE teaching, the most significant factors are teaching time, course distance, and teaching cost. These factors are described in the following section.

2.2.1. Teaching Time. In today's information age, students' time concept is becoming stronger and stronger, forcing schools to strengthen the management of teaching time to meet students' learning needs; that is, the teaching time T can be represented as follows:

$$T = \sum_{k=1}^{m} \sum_{i=0}^{n} \sum_{j=0}^{n} t_{ij} x_{ijk},$$

$$t_{ij} = \frac{\hat{d}_{ij}}{v_1} + \frac{\overline{d}_{ij}}{v_2}, \tag{3}$$

where T represents the total time of physical education teaching, t_{ij} is the interval between two courses, $\hat{d}_{ij}$ represents the place interval between courses, $\overline{d}_{ij}$ shows the average value of course place interval, and v_1 and v_2 are the speed of different physical activities.

2.2.2. Course Distance Analysis. In the process of PE teaching, with the continuous improvement of infrastructure, different PE courses gradually tend to be diversified. Therefore, the school will readjust the teaching course distance to improve the teaching quality. The course distance L can be computed using equation as follows:

$$L = \sum_{k=1}^{m} \sum_{i=0}^{n} \sum_{j=0}^{n} d_{ij} x_{ijk}, \tag{4}$$

where d_{ij} represents the distance between sports courses and training venues.

2.2.3. Teaching Cost Analysis. The fixed cost of PE teaching includes the site cost, teacher cost, and other related costs within a certain range. Teaching cost C_1 is calculated as follows:

$$C_1 = \sum_{k=1}^{m} \sum_{i=1}^{n} f_k x_{i0k}, \tag{5}$$

where f_k represents the fixed cost of physical education courses in section k, m shows the total number of physical education courses, $x_{i0k} = 1$ represents the end of the course, and $x_{i0k} = 0$ represents the end of the course.

By analyzing the above factors affecting the teaching quality of PE courses, the simulated annealing algorithm is used to construct the objective function of evaluation weight optimization.

$$\min Z = w_1 T + w_2 L + w_3 C_1, \tag{6}$$

where T is the teaching time, L is the course distance, C_1 shows the teaching course analysis, and w_1, w_2, and w_3 represent the target weights of time, distance, and cost, respectively. The problems solved by SA are usually formulated by an objective function of several variables based on different constraints. These constraints can be penalized as part of the objective function. The major constraints are as follows:

$$\sum_{i=1}^{n} x_{i0k} = \sum_{j=1}^{n} x_{0jk} = 1, \quad \forall k \in K,$$

$$\sum_{k=1}^{m} \sum_{i=1}^{n} x_{i0k} = \sum_{k=1}^{m} \sum_{j=1}^{n} x_{0jk} = m,$$

$$\sum_{i=1}^{n} w_i y_{ik} \leq W, \quad \forall k \in K,$$

$$\sum_{i=0}^{n} x_{ijk} = y_{ij}, \quad j \in A, j \neq i, \forall k \in K, \tag{7}$$

$$\sum_{j=1}^{n} x_{ijk} = y_{ij}, \quad i \in A, j \neq i, \forall k \in K,$$

$$\sum_{k=1}^{m} \sum_{i=0}^{n} x_{ijk} = 1, \quad j \in A,$$

$$\sum_{k=1}^{m} \sum_{j=0}^{n} x_{ijk} = 1, \quad i \in A.$$

The evaluation weight constraint function is constructed by the simulated annealing algorithm to evaluate the teaching quality of physical education more effectively.

2.3. Construction of Teaching Quality Evaluation Model of PE. According to the weight optimization given in equation (6), the analytic hierarchy process is used to construct the evaluation model of PE teaching quality. The characteristic root is calculated using the judgment matrix A as follows:

$$A\omega = \lambda_{\max}\omega, \tag{8}$$

where $\lambda_{\max}$ represents the maximum eigenvalue and ω represents the corresponding eigenvector.

Based on the results of the maximum characteristic root, the consistency test is carried out using the calculation index (CInd) as follows:

$$\text{CInd} = \frac{\lambda_{\max} - n}{n - 1}. \tag{9}$$

After calculating the consistency index, the average random consistency index RInd is calculated.

$$\text{CR} = \frac{\text{CInd}}{\text{RInd}}. \tag{10}$$

When the value CR is less than 0.1, it shows correct consistency; otherwise, the judgment matrix should be corrected. The order of the average random consistency index is shown in Table 3.

Finally, the combination weight vector is calculated and sorted, and the decision reference or evaluation results are given according to the sorting results.

Suppose that the sorting weight vector of n_{k-1} elements on the layer $k - 1$ for the total target is

$$w^{(k-1)} = \left(w_1^{(k-1)}, w_2^{(k-1)}, \ldots, w_{k-1}^{(k-1)} \right)^T. \tag{11}$$

The sorting weight vector based on the n_k elements on layer k and the j element on layer $k - 1$ is set as follows:

$$p_j^{(k)} = \left(p_{1j}^{(k)}, p_{2j}^{(k)}, \ldots, p_{n_k j}^{(k)} \right)^T. \tag{12}$$

The weight of the element not dominated by j is 0; therefore,

$$p^{(k)} = \left(p_1^{(k)}, p_2^{(k)}, \ldots, p_{n_{k-1} j}^{(k)} \right). \tag{13}$$

This is a $n_k * n_{k-1}$ matrix and shows the ranking of the influence degree of the elements on layer k on the elements on layer $k - 1$. Then, the total ranking vector of the elements on layer k on the overall goal can be expressed as follows:

$$w^{(k)} = \left(w_1^{(k)}, w_2^{(k)}, \ldots, w_k^{(k)} \right) = P^{(k)} w^{(k-1)}. \tag{14}$$

In general, there are always

$$w^{(k)} = P^{(k)} P^{(k-1)} \cdots w^{(2)}, \tag{15}$$

where $w^{(2)}$ represents the sorting vector of elements on the second layer to the total target.

According to the ranking vector calculation results of the first and second evaluation elements, the ranking of evaluation indexes is completed, to realize the evaluation of PE teaching quality.

3. Experimental Verification

To verify the assessment performance of the proposed evaluation model, a comparative verification was carried out. The evaluation system was comprised of the system database that adopts the distributed architecture technology, B/S three-tier architecture, and SpringMVC platform to complete the development of the model operation system. In physical education teaching, the common project types are shown in Figure 1.

TABLE 3: Average random consistency index.

Matrix order n	1	2	3	4	5	6	7	8	9
RInd	0	0	0.57	0.90	1.13	1.24	1.32	1.42	1.45

(a)

(b)

(c)

FIGURE 1: Teaching view of physical education curriculum: (a) sit ups; (b) football; (c) long jump.

The valuable sample data that were used for implementation were selected from the physical education curriculum teaching data of a school in this city and stored in the database for subsequent evaluation calculation.

In the process of model performance assessment, the key step is to set the performance evaluation index of the model, to comprehensively verify the evaluation performance of the model. Taking the calculation accuracies of the evaluation weight, evaluation score, and evaluation time as the comparison indexes, the model in this paper is compared with the quality evaluation model based on the hesitation fuzzy set proposed in [5] and the quality evaluation model based on active learning support vector machine (SVM) proposed in reference [11].

3.1. Evaluation Weight Calculation Accuracy.
Evaluation weight calculation accuracy refers to the similarity between the evaluation weight calculation results of different models and the actual weight results of evaluation indicators. The higher the evaluation weight calculation accuracy, the stronger the evaluation performance of the model. The evaluation weight has a key impact on the evaluation results of physical education teaching quality. Therefore, taking the accuracy of evaluation weight as the experimental comparison index, the weight of different models is compared with the actual weight results. The comparison results of evaluation weight calculation accuracy of the three models are shown in Figure 2.

It can be seen that the weight value calculation results of the proposed model are the same as the actual weight values of each evaluation index, while there is a large gap between the actual value and the weight value calculation accuracy based on the hesitation fuzzy set model and active learning support vector machine model. The maximum weight difference for the hesitation fuzzy set model is 0.45 while that for the active learning support vector machine model is 0.59. Therefore, it shows that this model can accurately calculate the weight of evaluation indicators. This is because this model uses the simulated annealing algorithm to optimize the evaluation index weight, to obtain more accurate weight calculation results.

3.2. Evaluation Score Verification.
Evaluation score calculation accuracy refers to the consistency between evaluation scores of different models and expert evaluation scores. The higher the
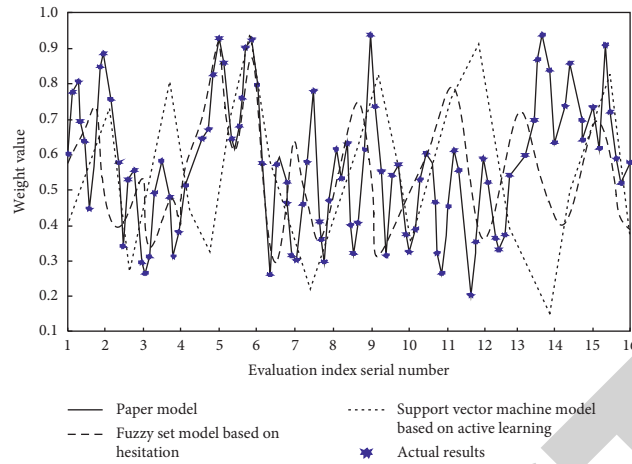
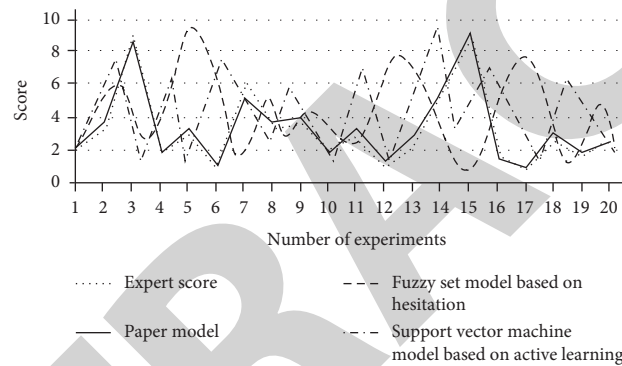Figure 2: Comparison results of calculation accuracy of evaluation weight.

Figure 3: Comparison results of evaluation scores.

Table 4: Comparison results of evaluation time.

No. of experiments/time	Evaluation time (s)		
	Proposed model	Fuzzy set model based on hesitation	SVM-based model based on active learning
2	2.6	9.8	12.4
4	2.8	10.4	12.6
6	2.7	9.9	13.1
8	2.5	10.2	12.9
10	2.9	8.9	12.3
12	3.0	10.5	14.6
14	3.1	12.3	15.1
16	2.9	10.7	14.5
18	2.7	11.8	13.8
20	2.8	10.4	13.5
Mean value	**2.8**	**10.49**	**13.48**

Bold values indicate average experimental results.

evaluation score accuracy, the stronger the evaluation effectiveness of the model. The evaluation score can directly reflect the results of physical education teaching quality evaluation, and the evaluation score results of experts are more objective and accurate. Therefore, the evaluation score results of different models are compared with those of experts. The evaluation score

results of this model, hesitation fuzzy set model, and active learning support vector machine model are shown in Figure 3.

By observing the evaluation score results shown in Figure 3, it can be seen that in many experiments, the evaluation results of the model scores of the proposed evaluation model are consistent with the expert scores. The maximum

difference between the scores of the proposed model and that of the expert scores is only 0.2 points, while the scores of the other two comparison models are quite different from the expert scores. Therefore, the evaluation results of the two traditional models need to be further verified.

3.3. Comparison of Evaluation Time. The evaluation time consumption refers to the time consumed by different evaluation models to complete the whole evaluation process until the evaluation results are obtained when the amount of evaluation data is the same. The shorter the evaluation time consumption, the higher the evaluation efficiency of the model. Due to a large amount of data in physical education teaching, when designing a new evaluation model, higher requirements are put forward for the evaluation efficiency of the model, and the evaluation time should be further shortened under the condition of ensuring the evaluation accuracy. Therefore, in the process of model performance verification, the evaluation time of the three evaluation models is verified. The comparison results of the evaluation time of the three models are shown in Table 4.

The evaluation time of the proposed model is significantly lower than that of the two other models. The average evaluation time of the proposed model is 2.8 s, the average evaluation time based on the hesitation fuzzy set model is 10.49 s, and the average evaluation time based on the active learning SVM model is 13.48 s. Therefore, this model can effectively shorten the evaluation time and improve evaluation efficiency.

4. Conclusion

To improve the teaching quality of PE, this study proposed a physical education teaching quality evaluation model. The simulated annealing algorithm was employed to effectively optimize the weight of the evaluation index and improve the evaluation accuracy. The performance of the model was verified based on theoretical and experimental aspects. While evaluating the teaching quality of physical education, the proposed model obtained high weight calculation accuracy and low evaluation time. The calculation accuracy of evaluation weight was significantly improved, and the calculation results of this model are consistent with the actual results. We compared the present model with the evaluation model based on hesitation fuzzy set and SVM-based active learning model, and the evaluation time of the proposed model was significantly reduced with an average evaluation time of 2.8 s. The prominent results of the proposed model confirm that the proposed evaluation model based on the simulated annealing algorithm can better meet the requirements of PE teaching quality evaluation. In future research work, we are planning to further improve the accuracy of evaluation scores to more accurately evaluate the teaching quality of physical education courses.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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