

Effect of Interactive Multimedia PE Teaching Based on the Simulated Annealing Algorithm

Mingfeng Zhao*

Abstract

As traditional ways of evaluation prove to be ineffective in evaluating the effect of interactive multimedia physical education (PE) teaching, this study develops a new evaluation model based on the simulated annealing algorithm. After the evaluation subjects and the principle of the evaluation system are determined, different subjects are well chosen to constitute the evaluation system and given the weight. The backpropagation neural network has been improved through the simulated annealing algorithm, whose improvement indicates the completion of the evaluation model. Simulation results show that the evaluation model is highly efficient. Compared with traditional evaluation models, the proposed one enhances students' performance in PE classes by 50%.

Keywords

Evaluation Model, Interactive Physical Education, Multimedia Interaction, Simulated Annealing Algorithm, Teaching Effectiveness Assessment

1. Introduction

Teaching effect evaluation is an important part to evaluate the teaching of teachers in higher education. The evaluation should be scientific-based, fair and objective, and contribute to educational development. It aims at improving the quality of teaching and helping teachers understand better about the situation of students. As its influence can be extended to students, teachers and university administrators, its importance cannot be underestimated. However, the longstanding exam-oriented education in China limits students' abilities and produces those who are only good at taking exams. Against such a backdrop, students themselves have less willingness to get involved in the class. Fortunately, multimedia teaching, which takes the advantage of modern technology, combines sound, text and image. This enriched teaching method plays a key role in rising students' interest in learning, expanding their knowledge, and compensating for the lack of teachers to a certain extent [1]. However, if multimedia is abused, it may cause misunderstanding as well. Worse, the teaching may be counterproductive.

Interactive teaching always puts student before anything else. Interactive teaching and multimedia can complement each other and make teaching more scientific-based and effective. The application of multimedia in interactive teaching of physical education (PE) says goodbye to boredom and monotonousness.

※ This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Manuscript received September 27, 2021; first revision March 10, 2022; accepted March 25, 2022.

*Corresponding Author: Mingfeng Zhao (zjf550@163.com)

Dept. of Sports Teaching and Research, Nanyang Radio and Television University, Nanyang, China (zjf550@163.com)

At the same time, the use of multimedia technology on PE classes can rise students' learning enthusiasm, and interactive teaching can attract their attention, thus improve their learning efficiency.

By combining multimedia and interactive teaching, and according to the International Society for Technology in Education's (ISTE) National Educational Technology Standards for Teachers (NETS-T) standard, Hassan et al. [2] put forward a PE teacher technology standard in Egypt. Technology application and Internet service are significant developments in education, which has changed the role of teachers and the demand for technical competence (TC). Teachers must apply modern learning theories so that learning and evaluation plans are based on interactive electronic resources. The study aimed to put forward a PE teaching technology standard according to the standard of the ISTE (NETS-T). It then found out to what extent teachers are tech-savvies. A total of 812 teachers from the Egyptian Institute of Physical Education were involved in the study. Data were collected through a 90-item questionnaire given out online. Each item represents a technical ability from 20 areas under five criteria defined by NETS-T in 2008. The questionnaire was evaluated by 10 experts. By calculating the sum for each item, as well as the highest total score of the scale, it was found that the availability of the standard was between 45.2% and 56.6%, and the availability of TTC for each standard was between 29.7% and 68.9%. The standard could accurately measure the TTC of teachers in sport colleges and departments, and the result of which was lower than the average level of (NETS-T) standard. Rojo-Ramos et al. [3] proposed a study on the digital teaching ability of PE teachers in primary school in Spain. The study aimed to reveal the digital ability of these teachers working in Spanish public schools. Relevant data were sourced from the official *Journal of Extremadura* published on June 12, 2015. Results showed that PE teachers in Spanish public primary schools had abilities to use basic technologies, more specifically, they were at Level A2. The traditional ways to evaluate learning results proves it hard to find out students' learning demand in the teaching process. Using formative evaluation as the main part of a three-dimensional teaching evaluation system can help teachers to improve their teaching strategies, thus improving the teaching quality. It can also provide reference for students to improve their learning methods, and as a result improve their learning efficiency. In recent years, the evaluation on teachers' teaching quality have been applied widely, and there has emerged a considerable number of evaluation index systems. The evaluation on the teaching effect has become an important basis for educational decision-making and management. However, the traditional way of evaluation fails to take into account interactive multimedia teaching, so it is not reasonable or effective enough. For example, the evaluation model based on principal-component analysis ignores the fact that the goal of interactive teaching has been more than impart knowledge, which leads to the bias in the evaluation [4]. The original model based on hierarchical analysis was applied to evaluate the effect of interactive teaching with students being the evaluation subjects, but it did not take into account the interaction between teachers and students, which is also an important factor influencing the teaching effect [5]. The evaluation model based on the SEEQ index system focused too much on the technical aspects of indicators, and it mainly evaluated five aspects, including teaching attitude, teaching method, teaching content, teaching ability and teaching effectiveness. But it did not include indicators such as teaching characteristics, teaching strategies and ways of teaching in the interactive teaching model, nor did it highlight the evaluation of teachers' relevant abilities [6,7]. As the unexpectedness human may be ignored, if human is taken as the evaluation subject in the teaching process, the evaluation results may be undermined.

The simulated annealing algorithm, first proposed by Metropolis et al. [8] in 1953 and used for is a

heuristic stochastic search method. The basic idea of the algorithm is based on the similarity between the annealing process of solids in physics and the general combinatorial optimization, which can be used to seek for the optimal solution. The simulated annealing algorithm is determined by the transfer probability corresponding to the Metropolis criterion to find out whether a transition from the existing solution to a new one is accepted. It starts by setting a large value for the control parameter, and once the transition is made, the value of the control parameter decreases slowly with the process repeated until the algorithm ends when some stopping criterion is satisfied [8]. Therefore, the simulated annealing algorithm can be viewed as an iteration of the Metropolis algorithm. The simulated annealing algorithm can ensure that the optimization process will not fall into local minima and improve the learning speed and approximation accuracy. Therefore, considering the characteristics of interactive multimedia teaching, this paper will use the simulated annealing algorithm to build an evaluation model which will be used to evaluate the effect of interactive multimedia PE teaching. Interactive multimedia is on the basis of the traditional media, and through the interaction of the two, audiences can receive information from all sensory channels, such as seeing, hearing, touring, feeling, smelling. The new media form brings with it new experience. With the widespread application of information technology, human-computer interaction becomes a reality through the keyboard, monitor, mouse, data gloves, cameras, microphones and other peripheral input devices as well as the corresponding software.

2. An Evaluation Model for Interactive Multimedia PE Teaching Based on the Simulated Annealing Algorithm

2.1 Principles for Determining the Teaching Effect Evaluation System

To evaluate the teaching effect, the first thing to bear in mind is the goal. A scientific-based, reasonable and applicable evaluation system is the basis for ensuring an accurate and comprehensive evaluation. Fig. 1 shows the framework of the evaluation model for evaluating the teaching effect of PE classes [9].

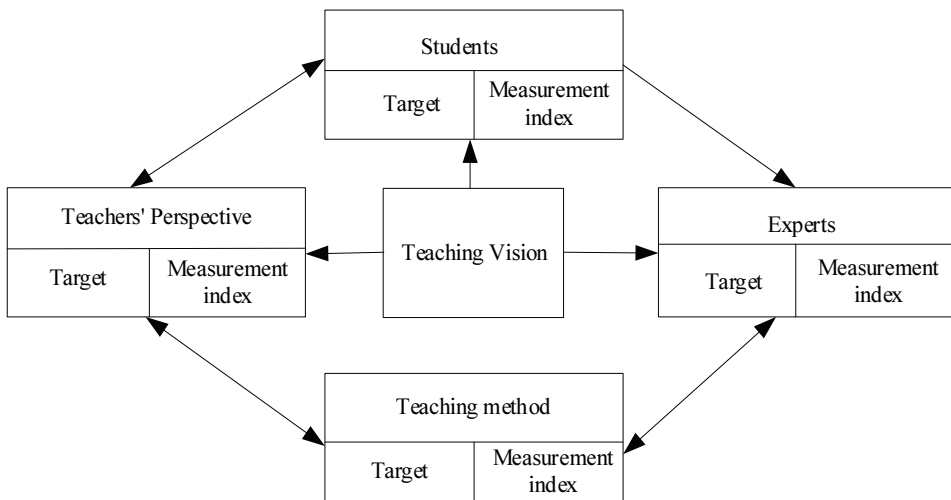


Fig. 1. Framework of the evaluation model for evaluating the teaching effect.

At the same time, clarifying the principles for building such a system is also a key step. Once the indicators are determined, the principle of goal consistency should be met. The evaluation index system is built to reify the evaluation subjects as a result of the layer-by-layer decomposition [10]. Specifically, this equation contains two layers. The total sum of all indicators should be exactly the number of the evaluation subject. It should neither be smaller nor larger than the number of the latter. If there is less indicators than the number of the evaluation subject, it means that some important indicators are missed. If there is more indicators, then some indicators are redundant or occur repeatedly [11].

Second, the evaluation index system should follow the principle of being direct. It should reflect the correct view of teaching, and make breakthrough compared with traditional ways of teaching. It should embody the modern teaching concept that is compatible with internationalization, IT-application, a social-based approach, lifelong learning and all-round individual development. As far as the student is concerned, the evaluation index system puts an emphasis on understanding and respecting students and providing equal opportunities for each one to express himself, create and succeed. As far as the teacher is concerned, it emphasizes that teachers should have modern educational ideals and high professionalism to meet the diverse needs of students. In terms of teaching objectives, it shifts from a focus on the knowledge-based approach to a development-based method and truly reflects the organic integration of knowledge, ability and attitude. In terms of the curriculum, it highlights that students are the subject of the class, so the content of the curriculum should be close to students' life and hold meaning for students, and learning should be based on understanding, experience, reflection and inquiry. The evaluation aims at reifying educational goals [12]. Therefore, when designing the evaluation index system, it is important to bear in mind the educational goals.

The evaluation index system should also be designed in a way that ensures the holistic nature of index selection. As a system, it must have a certain structure, which should be hierarchical and composed of a closely related organic whole [13]. The principle of wholeness requires that evaluation indicators should be chosen in line with the evaluation goals, while considering the status and role of each indicator. When decomposing the evaluation goals from the abstract to the practice, the more segments are decomposed, the more evaluation indicators are needed, and the greater the interference may be. This requires us to examine the evaluation index system as a whole.

In addition to the above-mentioned principles, the evaluation index system needs to meet the principle of measurability. It means that the lowest-level indicators in the evaluation index system must be measurable, specific, practical, and easy to understand. It must be clearly expressed in quantitative statistical parameters. The evaluation subject is taken as a complete and complex system, by doing which metaphysical quantification is avoided, the objective evaluation with quantitative criteria is combined with the subjective one, and quantitative results are combined with observation and interview results [14].

In order to ensure the reliability of the final evaluation results for evaluating the interactive multimedia PE teaching, this paper also focuses on the independence of the indicators at the same level when building the evaluation index system of the evaluation model. In other words, there should be no cause-effect relationship between peer indicators, and each indicator should represent an independent aspect without any overlap between them. These indicators should not include one or another, or have any cross relationship. Otherwise, confusion and repetition will occur, which will directly affect the objectivity, accuracy, fairness, and rationality of the evaluation results.

2.2 Design of Evaluation Index System

2.2.1 Selection of evaluation subjects

According to Johari effect, it is known that the evaluation should involve people from different background as they have their own strengths and weaknesses, and specific analysis on such strengths and weaknesses is an important way to improve the evaluation quality and effectiveness. When designing the evaluation index system for multimedia classroom teaching, the commonality and individuality between evaluation subjects should be well defined and reflected in the evaluation system and given appropriate weights at all levels according to the differences among evaluation subjects, and the differences of methods in their nature and objective. In this study, four levels of evaluation subjects are chosen, all of which are closely related to the teaching effect: students, peer teachers, experts, and lecturers themselves [15].

Student evaluation refers to the effective value of the classroom teaching. It is the student that evaluates how he gets involved in the teaching practice. Such evaluation is the most valuable evaluation for classroom teaching. How the teaching serves its purpose and the demand of students, how students get involved in class activities and adapt to learning, and how the teaching contributes to students' development, all of these can be reflected from the evaluation results. The improvement of students' learning ability cannot realize unless the teacher gives them proper instruction. The evaluation on the student is generally objective. It is the student that bears the teaching effect. Also students' opinions are a direct reflection of the real teaching situation [16].

Peer evaluation on a teacher's teaching, academic awareness, and other competencies should be carried out by teachers with the same or similar professional background as his. Moreover, peer teacher evaluation embodies the democracy in teaching. Peer teachers often evaluate from the followings: the subject he teaches, his mastery of new knowledge, his teaching style, and teaching ideology. However, the final evaluation results can be one-sided, and peer evaluation has its drawbacks [17].

The expert evaluation refers to connoisseurs specially hired by the school to evaluate the quality of teaching and the lecturer by auditing the class. Experts generally have a higher academic and teaching level and a broader vision. They can rationally evaluate a teacher's performance from the perspective of subject development and the overall nurturing of students' quality. That's why expert evaluation on the teaching quality is feasible and necessary [18].

Self-evaluation of a teacher means that the teacher is asked to evaluate his or her own performance according to certain principles and criteria. It is a more effective evaluation system. In modern days, more and more attention is paid to the role of self-evaluation. Only when a teacher's active participation is valued and his enthusiasm is tapped, can he be able to motivate himself, perform well and have better self-management through self-evaluation [19].

2.2.2 Indicators for evaluating the effect of interactive multimedia PE teaching

According to the analysis, from the perspective of four types of evaluation subjects, this paper chooses four primary evaluation indicators, namely, learning results, teaching interaction, multimedia resources utilization, and interactive multimedia PE teaching, and several secondary evaluation indicators that are more specific under each primary-level one. Below the secondary evaluation indicators are tertiary ones that are convenient for quantitative analysis. These three-level indicators compose an evaluation index system for evaluating the effect of interactive multimedia PE teaching.

The learning results are divided into four secondary indicators: namely, the completion of learning goals, the improvement of independent learning ability, and the improvement of students' sports ability. The indicator of the completion of learning goals includes whether students can understand and master the teaching content, and whether they can follow the teacher to complete the predetermined learning goals. The indicator of the improvement of independent learning ability includes whether the independent learning ability has been improved compared with that in the past [20]. The indicator of the improvement of students' sports ability includes whether students' sports ability and physical movement standards have been improved.

Teacher-student and student-student interactions are crucial to teaching in any forms. As Otto Pieters pointed out, *“if we are to take remote education seriously, we must clearly understand that education not only means to deliver content to students and have them read various learning materials. At the same time, ample opportunities must be provided for students to interact with teachers and other students. Furthermore, if we recognize that the ultimate goal of teaching as a process is to educate students through the transfer of knowledge, then great attention must be given to teacher-student communication and individual student interactions in the process of interactive multimedia physical education [20].”* In multimedia PE interactive teaching, the interaction behavior includes the interaction between the teachers and the students, the interaction between the students and the interaction between the students and the learning resources. Since the interaction between students and learning resources overlaps with the other 1 secondary index: the utilization of multimedia learning resources. Not having been established under the teaching interaction situation index, this secondary index mainly takes the interaction between the participating subjects of PE learning activities as the object of investigation. The evaluation on interactive teaching interaction of multimedia sports can be divided into 2 secondary indicators, namely: teacher-student interaction and student-student interaction. The content of teacher-student interaction includes whether students respect the teacher, a whether they are willing to communicate with teachers, whether they often ask teachers questions, and whether they respond to teachers' questions in time in class. Student-student interaction includes whether students respect their learning partners, whether they actively participate in group learning activities, whether they communicate with their classmates smoothly, and whether they often take the initiative to communicate and discuss with each other.

It is one of the main advantages of multimedia teaching that students use rich multimedia curriculum resources to study. Students' use of resources not only refers to the use of resources provided by teachers or the Internet, but also reflects the learners' learning process and meaning construction process. It also includes the data uploaded by students in the learning process, such as the parameters and information about students' online learning time, learning scope, progress using multimedia devices, the depth and breadth of learning, understanding of learning topics, problem solving, adjustment of learning strategies, and information related to meaning construction. In terms of the utilization of multimedia learning resources, more focus was placed on whether students increased their independent learning ability and extracurricular knowledge after learning in this study [21]. Therefore, the indicators of multimedia learning resources utilization were divided into two items: frequency of resource use and efficiency of resource use. The index of resource use frequency includes whether students often download courseware and teaching materials on the multimedia teaching platform, and whether they often use information resources to solve problems in learning. The index of resource utilization efficiency includes whether students increase their extracurricular sports knowledge by reading learning materials and e-books, and whether they can use online learning resources to solve problems met in learning.

When it comes to the primary index of interactive multimedia sports teaching, this paper selects teaching plan formulation, teaching method and teaching attitude as the secondary assessment indexes according to the actual teaching process of interactive multimedia sports. The formulation of teaching plan is quantified by whether the teaching content is scientific and reasonable, whether the teaching plan can be changed flexibly, and whether the teaching can be completed on time according to the overall requirements; The teaching method is quantified through the application of multimedia teaching equipment and the diversification of teaching methods; The teaching attitude is quantified by whether the teaching content prepared by the teachers meets the requirements of the curriculum, whether the form is diversified, whether the teaching content setting is diversified. The teaching attitude is quantified by whether the teaching contents prepared by teachers meet the requirements of the curriculum, whether the forms are diverse, whether the teaching contents can stimulate students' interest in PE, and whether the classroom teaching time is reasonable.

After determining the above evaluation indexes on the interactive multimedia PE teaching effectiveness, an evaluation index system of multimedia interactive PE teaching effectiveness with three levels of evaluation is established. The evaluation index system of multimedia PE interactive teaching effectiveness has 4 primary evaluation indexes, 11 secondary evaluation indexes and 26 tertiary evaluation indexes. After the teaching effect evaluation index system is established, the weight of the assessment indexes is calculated according to the different assessment subjects.

2.2.3 Calculation of evaluation index weights

In this study, the weights of the indicators were determined based on the Telfer method in the following steps [22].

Twenty-five experts were selected and asked to provide their own indicator weights and opinions for each scale. The indicator weight values given by each expert were counted, the average weight value of each indicator and the deviation of the indicator weight value given by each expert from the average weight value were calculated, and this result was fed back to the experts for a second round of opinion collection. After the second round of opinion collection, the weight values of each indicator given by the experts were close to each other, and then a third round of consultation was carried out [23]. The evaluation scale corresponds to the evaluation index system, and the weights vary according to the evaluation subject. In the above weight calculation process, the formula for calculating the weights of the three-level assessment indicators is shown as follows.

$$C_i = \frac{\sum_{j=1}^i a_j n_j}{5N} \quad (1)$$

In formula (1), a_j is the corresponding score of the assessment subject's rating of the importance of the assessment index. n_j is the number of people corresponding to the rating level of importance of the indicator. N is the total number of participants in the assessment. Similarly, after calculating the weights of other assessment subjects on the teaching effectiveness assessment index system according to the above process, the final assessment index weights are obtained according to the assessment reliability of the four assessment subjects, and the index weights are calculated and determined for the four assessment subjects according to the weighted calculation. In this study, the weighting coefficients of the four assessments of experts, students, peers and teachers are set as 0.3, 0.25, 0.25 and 0.2, respectively. After

determining the weight of the teaching effect evaluation index, the simulated annealing algorithm is used to build the teaching effect evaluation model.

2.3 Completion of the Simulated Annealing Algorithm Teaching Effectiveness Evaluation Model Construction

In this study, the simulated annealing algorithm based on the backpropagation (BP) neural network model is used to evaluate the interactive teaching effect of multimedia sports. Firstly, a BP neural network model is constructed for evaluating the effectiveness of interactive multimedia sports teaching.

In 1989, Robert-Hecht-Nielson proved that any continuous function in the closed interval can be approximated by a BP neural network model with one implicit layer, i.e., a three-layer BP neural network can complete any n -dimensional to m -dimensional mapping [23]. Therefore, a three-layer structure is adopted for the BP neural network model of multimedia sports interactive teaching effect evaluation, including input layer, single implicit layer and output layer.

When applying BP neural network model to evaluate the effect of multimedia sports interactive teaching, the input layer neurons correspond to the evaluation indexes one by one. The evaluation index system of multimedia sports interactive teaching effect assessment contains 26 indicators, so the number of input neurons is set to 26. The evaluation index system of this paper adopts a single indicator to reflect the level of multimedia sports interactive teaching effect assessment, so the number of neurons in the output layer is set to 1, which represents the output result of the model, i.e., the multimedia sports interactive teaching effect result. For the number of neurons in the implicit layer, the following formula is used to determine.

$$n_1 = \sqrt{n + m} + a \quad (2)$$

In Eq. (2), n_1 is the number of neurons in the hidden layer. m is the number of neurons in the input layer. n is the number of neurons in the output layer. a as a constant between [1, 10]. According to the determined number of neurons in the input and output layers, the number of neurons in the hidden layer of the BP neural network in this design should be kept constant between [6, 15], and the optimal number of neurons in the hidden layer is obtained by selecting the a value with the best approximation effect through the training of the BP neural network. The analysis of commonly used recursive functions has its advantages and disadvantages. The logarithmic transfer function logsig is adopted and its expression is as follows:

$$y = \frac{1}{1 + e^{-x}} \quad (3)$$

In the BP algorithm, the network weights depend on the information of the first-order derivatives of the transfer function to make corrections. When there are multiple local minima in the solution space, the initial network weights generated randomly will fall into local convergence once they are not set properly. In the process of applying the BP neural network model to evaluate the effect of interactive multimedia sports teaching, if the BP algorithm falls into the local minima, the network model is unable to get the correct result. In addition, when the output of a neuron approaches saturated, the output of that neuron will be insensitive to weight adjustment and the convergence speed will be greatly reduced. In order to overcome this drawback, the simulated annealing algorithm is introduced in this paper to improve the process of building the neural network model for interactive multimedia sports teaching effect evaluation.

The specific steps of simulated annealing algorithm are as follows:

Step 1: Determine the initial values. Given initial solution $X_0 (X_0 \in \Omega)$, initial temperature $T_0 > 0$, basic step V_0 , set test accuracy ε , threshold value N_T for testing Metropolis sampling stability, and threshold value I related to end annealing. Calculate $f(X_0)$, set $X_{opt} = X_0$, $f_{opt} = f(X_0)$, initialize BP neural network weights to 0.

Step 2: Generate new state trial point. The new state trial points are generated according to the following equation.

$$Y_i = X_i + \eta\gamma V_0 \quad (4)$$

In Eq. (4), η is the constant of proportionality controlling the size of the perturbation; γ is the random perturbation, obeying the Cauchy distribution; V_0 is the step value related to the initial value and the range of values.

Step 3: The new state is generated.

If $f(Y_i) \leq f(X_i)$, then let $X_{i+1} = Y_i$;

If $f(Y_i) > f(X_i)$, then by the following equation.

$$P = \exp\left[\frac{f(X_i) - f(Y_i)}{T_k}\right] \quad (5)$$

If $PP \leq P$, then let $X_{i+1} = Y_i$, $f(X_{i+1}) = f(Y_i)$ otherwise let $X_{i+1} = X_i$, $f(X_{i+1}) = f(X_i)$; PP in Eq. (5) is uniformly distributed between $[0, 1]$.

Step 4: The optimal solution is updated and Metropolis sampling stability discriminant is generated to anneal the solution. When f_{opt} is greater than the given threshold, the annealing scheme is executed otherwise turn to step 2 to continue the computation.

After the BP neural network is optimized using simulated annealing algorithm, the input evaluation data set is used in the optimized improved BP network to evaluate the effectiveness of multimedia sports interactive teaching. The output of the improved BP network is the result of the evaluation of the teaching effectiveness. At this point, the evaluation model of multimedia sports interactive teaching effect based on simulated annealing algorithm is completed. In order to verify the feasibility of the model, experimental validation of the model is carried out as follows.

3. Assessment of Model Feasibility Validation and Analysis

The paper analyzed the problems of the traditional teaching effect evaluation model and constructed a multimedia sports interactive teaching effect evaluation model based on simulated annealing algorithm. In this section, the feasibility of the multimedia sports interactive teaching effect evaluation model based on simulated annealing algorithm constructed in the paper will be verified. In the simulation experiment, the CPU is Intel Core i5-2410m, 2.5GHz, 2GB memory, the operating system is the flagship 64-bit Windows 8, C++ language computer, the test platform is MATLAB 2017b for simulation experiment, and the simulation test of multimedia sports interactive teaching effect evaluation model based on simulated annealing algorithm is carried out by using MATLAB R2016a software.

3.1 Brief Description of Experiment Content and Process

This experiment is a comparison experiment and is divided into two parts. In the first part, the unimproved BP neural network model and the improved neural network model of particle swarm optimization algorithm are selected for comparison, and the simulated annealing method is used to compare with the improved BP neural network model studied in this paper. The comparison index of this part of the experiment is the number of iterations of the model when the same optimal solution is reached. In the second part of the experiment, the teaching effectiveness evaluation model based on principal component analysis and the teaching effectiveness evaluation model based on hierarchical analysis were selected as the control group to compare with the evaluation model constructed in this paper. The comparison index of this part of the experiment is the improvement of students' PE learning effect in different grades when applying the three assessment models.

In the first part of the experiment, the same data sample set was selected as experimental data for the model iterative performance test. The same optimal solution objective was set, and the three models were used to solve the data sample set iteratively. The experimental software in the computer simulation platform counted the iteration times and iteration time of each model in the solution process, and drew the relationship diagram. The information in the image is analyzed and the corresponding conclusions are drawn.

In the second part of the experiment, an equal number of students were randomly selected from different grades in the same school. The students were divided into three groups by grade, and the PE teachers with rich teaching experience were invited to teach the students in the three groups using multimedia interactive teaching method. In the teaching process, three evaluation modes are used to evaluate the teaching effect, and three teachers change their teaching strategies according to the evaluation results. In the course of the experiment, students' PE learning was observed and analyzed, and the practical application effect of the evaluation model was evaluated.

3.2 Experimental Data and Analysis

3.2.1 Part 1 Experimental results and analysis

The recorded data of the iterative process when solving the three models are shown in Fig. 2, and the relationship between the curves in Fig. 2 is analyzed to draw experimental conclusions.

The analysis in Fig. 2 shows that when the model iteration reaches the optimal, the iteration times and iteration time of the model improved by simulated annealing algorithm are less than those of the other two groups of models. This means that compared with the other two groups, the improved model using simulated annealing algorithm requires less time and iteration to provide the optimal solution.

3.2.2 Part 2 Experimental results and analysis

After assessing the effectiveness of PE learning of different students, the comparison of the practical application effects of the three evaluation models is shown in Table 1, which characterizes the students' learning in terms of the increased proportion (%) of students' PE test scores as good.

The analysis of the data in Table 1 shows that under the influence of subjective factors, students' self-control, the actual application of the three models is similar when students are at a lower grade level. As the students' grade level improves, the interference of external factors on students' PE learning is reduced. The number of students with good physical examination results using this model increases more

than the number of students using the other two groups of models. Numerically, the average increase in overall student performance after applying the model in this paper is about 1.5 times higher than that of the other two groups. This indicates that the model constructed in this paper has better practical application value.

Compared with the traditional evaluation model, the simulated annealing algorithm-based interactive multimedia PE teaching effect evaluation model built in this paper has fewer iterations and shorter computation time. In practice, it can provide more targeted guidance for optimizing PE teaching effect and significantly improve students' learning effect.

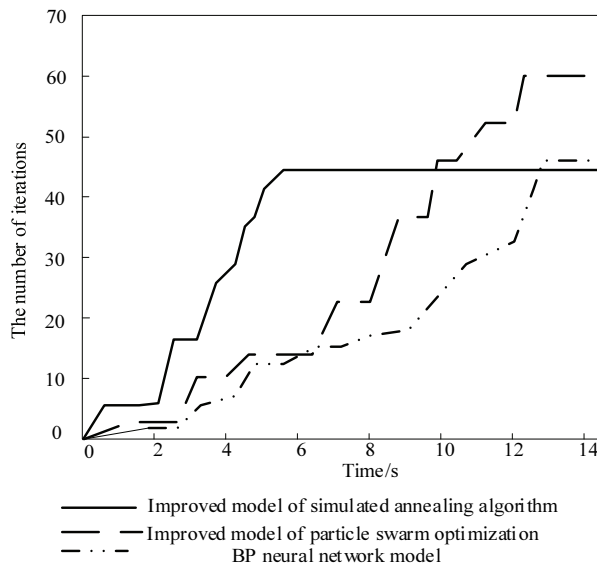


Fig. 2. Comparison of model iteration time.

Table 1. Comparison of student learning

Student grade	Model in the text	Principal component model	Hierarchical analysis model
3	4.6	3.9	3.6
4	4.8	4.6	4.5
5	5.2	4.7	4.8
6	7.3	5.2	5.0
7	8.5	5.9	5.7
8	10.7	5.9	5.9
9	14.4	6.7	6.5

4. Conclusion

The modern teaching is transformed from imparting single knowledge to cultivating ability, that is, taking quality education as the core and competency-based education training mode. The transformation of educational model inevitably requires teachers to make corresponding changes. Teachers engaged in higher education should not only have good moral quality and skilled professional knowledge, but also have the ability to innovate, research and practice. At present, interactive teaching has been recognized by many experts and scholars as one of the most effective ways to solve the current contradictions in

school teaching. Multimedia teaching refers to the whole process of participating in teaching through teaching design, reasonable selection and use of modern teaching media, and organic combination with other teaching means, according to the characteristics of teaching objectives and teaching objects. The goal of interactive teaching has changed from teaching to teaching and learning, from imparting knowledge to cultivating ability, which is an education mode based on ability with quality-oriented education as its core. It takes quality-oriented education as the core and ability-based education and training mode. The combination of multimedia technology and interactive teaching can realize complementary advantages and further improve the teaching effect. In order to guide the improvement and improvement of multimedia interactive PE teaching, this study aimed at the problems existing in the traditional teaching evaluation model and the simulated annealing algorithm was used to design and construct the evaluation model of multimedia PE interactive teaching effect. Then, the feasibility of the model was verified by the comparative experiment. Through the comparison of simulation experiments, it is found that the evaluation model has high processing efficiency, and the improvement of students' PE learning in practical application is about 1.5 times that of the traditional evaluation model.

References

- [1] O. I. Krivorot'ko, S. I. Kabanikhin, N. Y. Zyat'kov, A. Y. Prikhod'ko, N. M. Prokhoshin, and M. A. Shishlenin, "Mathematical modeling and forecasting of COVID-19 in Moscow and Novosibirsk region," *Numerical Analysis and Applications*, vol. 13, no. 4, pp. 332-348, 2020.
- [2] A. Hassan, M. Najib, and A. Hassan, "A standard for teaching technical competencies of physical education in Egypt according to ISTE (NETS-T) standards," *Journal of Human Sport and Exercise*, vol. 16, no. Proc2, pp. S221-S238, 2021. <https://doi.org/10.14198/jhse.2021.16.Proc2.07>
- [3] J. Rojo-Ramos, J. Carlos-Vivas, F. Manzano-Redondo, M. R. Fernandez-Sanchez, J. Rodilla-Rojo, M. A. García-Gordillo, and J. C. Adsuar, "Study of the digital teaching competence of physical education teachers in primary schools in one region of Spain," *International Journal of Environmental Research and Public Health*, vol. 17, no. 23, article no. 8822, 2020. <https://doi.org/10.3390/ijerph17238822>
- [4] A. Chakraborty and O. Prakash, "Identification of clandestine groundwater pollution sources using heuristics optimization algorithms: a comparison between simulated annealing and particle swarm optimization," *Environmental Monitoring and Assessment*, vol. 192, article no. 791, 2020. <https://doi.org/10.1007/s10661-020-08691-7>
- [5] A. Nafidi and A. El Azri, "A stochastic diffusion process based on the Lundqvist–Korf growth: computational aspects and simulation," *Mathematics and Computers in Simulation*, vol. 182, pp. 25-38, 2021.
- [6] A. Gupta, S. Agrawal, and Y. Pal, "Performance evaluation of hybrid photovoltaic thermal thermoelectric collector using grasshopper optimization algorithm with simulated annealing," *Journal of Solar Energy Engineering*, vol. 142, no. 6, article no. 061004, 2020. <https://doi.org/10.1115/1.4046832>
- [7] G. Keerthana, P. Anandan, and N. Nandhagopal, "Robust hybrid artificial fish swarm simulated annealing optimization algorithm for secured free scale networks against malicious attacks," *CMC-Computers Materials & Continua*, vol. 66, no. 1, pp. 903-917, 2021.
- [8] N. Metropolis, A. W. Rosenbluth, M. N. Rosenbluth, A. H. Teller, and E. Teller, "Equation of state calculations by fast computing machines," *The Journal of Chemical Physics*, vol. 21, no. 6, pp. 1087-1092, 1953.
- [9] J. Marlowe and G. Tsilomelekis, "Accessible and interactive learning of spectroscopic parameterization through computer-aided training," *Journal of Chemical Education*, vol. 97, no. 12, pp. 4527-4532, 2020.
- [10] Z. Xu, "An analysis of school physical education teaching strategies under the background of living," *International Journal of Social Science and Education Research*, vol. 3, no. 3, pp. 29-33, 2020.

- [11] P. Manimaran and M. K. Marichelvam, "Ant lion optimisation algorithm for two stage supply chain network associated with fixed charges," *International Journal of Services and Operations Management*, vol. 37, no. 3, pp. 407-425, 2020.
- [12] N. Y. Meitei, K. L. Baishnab, and G. Trivedi, "3D-IC partitioning method based on genetic algorithm," *IET Circuits, Devices & Systems*, vol. 14, no. 7, pp. 1104-1109, 2020.
- [13] M. Saadatpour, A. Afshar, H. Khoshkam, and S. Prakash, "Equilibrium strategy based waste load allocation using simulated annealing optimization algorithm," *Environmental Monitoring and Assessment*, vol. 192, article no. 612, 2020. <https://doi.org/10.1007/s10661-020-08567-w>
- [14] P. Stodola, K. Michenka, J. Nohel, and M. Rybansky, "Hybrid algorithm based on ant colony optimization and simulated annealing applied to the dynamic traveling salesman problem," *Entropy*, vol. 22, no. 8, article no. 884, 2020. <https://doi.org/10.3390/e22080884>
- [15] W. Odziemczyk, "Application of simulated annealing algorithm for 3D coordinate transformation problem solution," *Open Geosciences*, vol. 12, no. 1, pp. 491-502, 2020.
- [16] A. Pricilia, A. Abdurrahman, and K. Herlina, "Teacher expectation towards interactive multimedia integrated with STEM in learning physics: preliminary study on geometry optic learning material," *Journal of Physics: Conference Series*, vol. 1572, no. 1, article no. 012065, 2020. <https://doi.org/10.1088/1742-6596/1572/1/012065>
- [17] D. Robles and C. G. Quintero M, "Intelligent system for interactive teaching through videogames," *Sustainability*, vol. 12, no. 9, article no. 3573, 2020. <https://doi.org/10.3390/su12093573>
- [18] M. Irfan and Z. Fadli, "Development of interactive learning media based on teaching multimedia scouting faculty of sports science," *International Journal of Science and Research*, vol. 8, no. 1, pp. 328-333, 2019.
- [19] A. Ayob, "Teacher's opinion towards constructive thinking for teaching essay writing based on interactive multimedia integration," *Research in World Economy*, vol. 10, no. 2, pp. 102-107, 2019.
- [20] M. Irfan, S. Damanik, Z. Fadli, and K. Usman, "Development of multimedia based learning media in scouting learning faculty of sport science," in *Proceedings of the 1st International Conference on Social Sciences and Interdisciplinary Studies (ICSSIS)*, Medan, Indonesia, 2018, pp. 97-100.
- [21] K. Konowalik and A. Nosol, "Evaluation metrics and validation of presence-only species distribution models based on distributional maps with varying coverage," *Scientific Reports*, vol. 11, article no. 1482, 2021. <https://doi.org/10.1038/s41598-020-80062-1>
- [22] M. Shimizu, T. Fukami, H. Ogawa, T. Taniguchi, Y. Nomura, and M. Nakajima, "Systematic approach for screening of prodrugs: evaluation using oseltamivir analogues as models," *Journal of Pharmaceutical Sciences*, vol. 110, no. 2, pp. 925-934, 2021.
- [23] B. P. Yuhas, "Interpreting visual speech signals using neural networks," *The Journal of the Acoustical Society of America*, vol. 85, no. Suppl S1, pp. S138-S138, 1989.



Mingfeng Zhao <https://orcid.org/0000-0001-6065-002X>

In 1991, he entered Henan University Physical Education Institute, and in 1995, he graduated from Nanyang Radio and Television University to engage in physical education teaching and sports training. In 2006 promoted to lecturer title. He currently works at Sports Teaching and Research Department of Nanyang Radio and Television University. In many years of teaching practice, there is a strong capacity of classroom organization and curriculum innovation. At the same time actively participate in teaching and research activities, wrote a number of papers published in domestic CN publications, participate in the creation of academic monographs have been praised by experts.