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Application Model for Innovative Sports Practice Teaching in Colleges Using Internet of Things and Artificial Intelligence

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Abstract: The Internet of Things (IoT) and artificial intelligence (AI) have promoted teaching reform while improving people's lives. Under the new teaching environment, the position of physical education (PE) teaching in the teaching work has become increasingly prominent. At present, there are some problems in the PE teaching mode of most colleges and universities, such as poor teaching environment, unstable teaching data, and lack of technical support for the teaching system. This also leads to the low quality of PE teaching and unsatisfactory teaching results. In this paper, IoT and AI are combined to study the application mode of innovative practical teaching in college PE. This paper first constructs a physical education teaching system based on the Internet of Things, then summarizes the necessity of artificial intelligence technology participating in the reform of physical education classroom teaching, and gives a specific teaching application model. Finally, based on the golden sine algorithm-optimization neural network, the application model of college physical education in this paper is evaluated. Through experiments and investigations, the new teaching mode improves the teaching efficiency by 14.7%, improves the teaching quality, and provides reference for the next development of IoT and AI in teaching.

Keywords: physical education; artificial intelligence; Internet of Things technology; golden sine algorithm

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1. Introduction

Under the background of the new era, the traditional PE teaching model is on the verge of elimination. With the constant change of learning needs, it is urgent to innovate and reform the teaching model. The appearance of IoT and AI has broken the deadlock of teaching mode reform. How to apply these two technologies to sports teaching activities and make mode innovations are the key works of all departments and the focus of this study.

With the improvement of the school's attention to students' physique, the research on PE teaching has become more and more in-depth. Silverman Stephen discussed the importance of PE teaching and then looked forward to the development prospect of current teaching work [1]. Casey Ashley applied managing by project (MBP) to the PE curriculum system and finally successfully improved the PE teaching effect [2]. Chng Lena S discussed the importance of formative assessment in PE teaching and elaborated on how it plays its role in teaching [3]. Lopatiev Anatolij analyzed the impact of PE teaching on physical fitness testing and finally verified its role in promoting students' physique by specific physical fitness experiments [4]. Norboev Nabijon Narzikulovich emphasized the importance of PE for young people. Finally, it is concluded that PE courses can not only exercise students' bodies but also play a great role in cultivating sports talents [5]. Palamarchuk Olha innovated the sports teaching indicators in combination with professional sports activities and proposed that sports teaching should not be limited to improving physical fitness but also be used to promote the undertaking of spots reform [6]. Kriellaars Dean J applied the concept of sustainable development to PE teaching. Practice shows that this

concept has improved the teaching quality to a certain extent [7]. The above research on PE teaching is more specific but has not been applied to IoT and AI.

The new curriculum reform promotes the application of IoT and AI in PE teaching. Wang Chenhang applied machine learning technology to the PE teaching and training system and finally found that the performance of the system is much better than the original system [8]. Wang Shuai has built a new sports teaching system with IoT technology. As a result, the new system showed great advantages in teaching work [9]. Kassab Mohamad summarized the benefits and challenges of integrating IoT into the PE curriculum and then proposed specific measures on how to upgrade and innovate the teaching curriculum [10]. Banica Logica applied AI to the PE teaching environment. Research showed that the new teaching environment can attract more students to participate in sports activities [11]. Terzieva Valentina used sensors in IoT to analyze the physical fitness status of each student in PE teaching activities and then proposed a targeted physical fitness training plan [12]. Vlasov Andrey I used sensor technology in IoT technology to monitor the whole sports teaching activity and then evaluated the teaching effect according to the monitoring data [13]. YanRu Liu applied AI to the evaluation model of PE teaching quality and finally found that the evaluation effect of the newly proposed model was good [14]. These studies on the application of IoT and AI in PE teaching are relatively detailed, but there is no mention of an innovative practical teaching mode.

Different from other teaching activities, PE teaching is more intuitive and needs more abundant teaching content and teaching data. This paper first introduces the application of IoT and AI in teaching activities and then uses IoT technology to build a sports teaching system. Next, we analyze the importance of integrating AI into the teaching mode and give specific application strategies. Finally, combining the golden sine algorithm to optimize the neural network, an evaluation model of teaching quality is established. The research shows that the new teaching model has a good effect in improving teaching quality.

The innovation points of this paper are as follows: (1) The physical education teaching system of the Internet of Things is explained, and the necessity of integrating artificial intelligence technology into the reform of physical education classroom teaching is analyzed;.(2) This paper puts forward the evaluation model of physical education teaching quality in colleges and universities based on the golden sine algorithm-optimized neural network, and based on this, the experimental analysis of the new physical education teaching model is carried out.

2. Sports Teaching System Based on IoT

As the name implies, IoT is the network connecting things. Generally, it consists of three parts: the perception layer, the network layer, and the application layer. Its main role is to achieve barrier-free connectivity and information interaction between objects [15]. In order to upgrade and innovate the PE teaching mode, this paper constructs a new teaching system with the help of IoT.

(1) Overall architecture of teaching system

As shown in Figure 1, the teaching system collects the data in sports teaching activities in real time through IoT, sensors, and wireless networks and then transmits the collected data to the data center, where the data would be loaded into the intelligent computer for processing and analysis (including data mining, modeling and simulation, etc.). Finally, teachers design teaching activities according to the results.

(2) Main functions of teaching system

A. Data collection and upload

In the system, the IoT and wireless network play an irreplaceable role, and sensors must use these two networks to complete data collection and upload. Among them, data collection includes class time, students' location information, teaching environment information, and teaching screen information. Data upload means that the collected data re transmitted to the data processing center through the network.

B. Application of data mining and teaching management of global-wide area network

The main function of the system is to query personal information and score information. In addition, the simulation technology can be used to build an analysis model and then show students the most intuitive and comprehensive teaching content. For example, when explaining soccer, students can be provided with more vivid techniques of kicking the ball and passing to people through action simulation. In this way, it is easier for students to master the action essentials. Data mining is mainly used to analyze the changing trend of students' physical condition and the situation in which students master the teaching content. In addition, thanks to the teaching system and data model, teachers can fully understand the teaching effect and student status, thus facilitating management.

C. Obtain dynamic data for personalized teaching guidance

With the IoT and wireless network, teachers can collect more dynamic teaching data so that they can analyze the gap from the perspective of classroom teaching and students' learning and then develop personalized courses for students. The application of the Internet of Things and related data ensures the accuracy, pertinence, and scientificity of PE courses and helps schools successfully carry out sports activities and improve the classroom teaching environment [16].

D. Real-time interaction and query

The new teaching system can display the real-time interactive scene of PE. Teachers can easily obtain the information of students' activities through intelligent terminals and wireless networks. After obtaining the information, they can transmit it to the teaching equipment in real time for use in class. The system also adds a search function so that students can find their own data and understand their own learning situation by using mobile devices in the classroom.

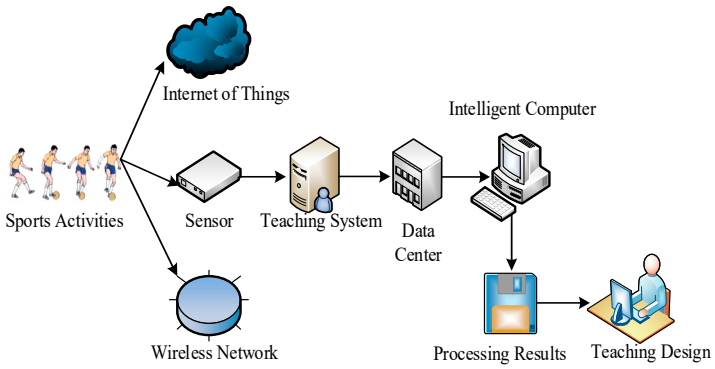

Figure 1. Overall architecture of teaching system.

With the development of the Internet of Things, its unique advantages in the field of education will become increasingly prominent. At present, IoT devices have been widely used to provide a better learning environment for students of all ages.

3. The Necessity of Integrating AI Technology into PE Classroom Teaching Reform

In recent years, influenced by the educational reform, many schools have paid more and more attention to PE. In order to better train sports talents for the country and society, schools should take the initiative to break the shackles of traditional teaching concepts and make changes in teaching courses and teaching models in a timely manner in combination with modern concepts [17]. In the era of science and technology, various fields pay more attention to the application of technology, and so does the teaching field. The emergence and mature application of AI has brought new opportunities to schools. Applying AI to PE teaching is an important measure to deepen teaching reform and would certainly promote the development of the whole teaching work [18].

At this stage, the PE teaching mode is deeply affected by the traditional teaching concept, and the teaching activities also lack the support of technology and equipment, which causes students to only imitate when learning actions so as to learn for the sake

of learning. Gradually, students lose interest in sports activities, and the teaching effect remains low. In such an environment, the integration of AI technology into classroom teaching can achieve complete and accurate video interpretation, even machine simulation, which fully mobilizes students' enthusiasm for learning. Students can personally control these teaching contents and then carve a memory in their minds so that they can master the action essentials in the future. This change of teaching mode not only changes the boring teaching environment but also provides some reference data for PE teachers to provide personalized guidance for students in the future, which also has great potential in promoting the training of sports talents.

4. Innovative Application of AI Technology in PE Classroom Teaching

(1) Combine AI virtual technology to strengthen tutorship in and out of class

Sports is a subject that requires high learning ability. To accurately master the action essentials in various sports, students must learn for a long time, such as the passing action in basketball, the run-up action in running, and the bouncing action in soccer. Students cannot master it in a short PE class, which leads to poor teaching effect. As shown in Figure 2, teachers can strengthen the application of AI, simulate these actions through computer simulation technology, and explain the action essentials through slow video playback. After the completion of the explanation, the teacher can also set up action learning tasks through the computer so that students can master various motor skills independently through the computer, which also indirectly realizes human–computer interaction. Outside the school, teachers can use AI modeling technology to prepare learning models for students and demonstrate 3D learning assignments so that students can learn by themselves. Teachers can observe the students' movement process in the system terminal, record the changes of students' physical conditions with the exercise intensity, and provide personalized guidance to students by collecting data. If some students cannot complete the tasks set, the teacher can change the settings of the simulation system to reduce learning difficulties to ensure learning efficiency. The application of AI technology in class and extracurricular environments can enable students to understand sports knowledge well, improve their self-confidence and sports skills, and lay a solid foundation for students to develop towards sports majors.

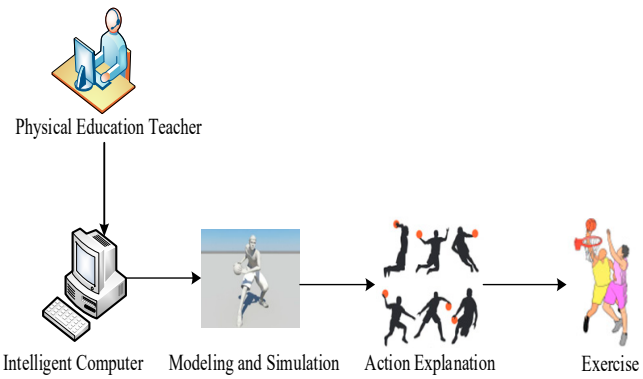

Figure 2. Application example of AI technology in classroom teaching.

(2) Establish micro courses and group chat

With the rapid development of AI technology, it has become a reality to use information technology, databases, and multimedia equipment to create an educational environment that combines technology with education. Through design and processing, teachers can provide students with micro courses that integrate images and words, thus making the teaching content more intuitive and vivid. This not only arouses the students' enthusiasm for learning but also deepens their understanding of sports knowledge. In addition, teachers can establish a group chat about micro courses for students to join. Before and after class, they can send the prepared AI teaching courseware to the group chat so that students

can preview and consolidate. If there is something they do not understand, they can also notate it. The teacher would respond in time when they see it, which also strengthens the interaction between teachers and students.

(3) Introduction of expert system

AN expert system is an important branch of AI system. At present, the system is at a mature stage. Integrating the system into PE teaching activities can improve the teaching effect [19]. Reasonably introducing sports expert knowledge is the main application principle of the expert system. By integrating professional sports knowledge and expert experience into the computer intelligent program system, teachers and students can directly solve problems through the system. During the teaching period, teachers can reasonably carry out sports training in combination with the expert system, guide students to effectively master intelligent technology, assist students in improving their sports performance and ability in sports training, increase students' understanding of sports knowledge, and constantly play the role of the expert in sports training. If students encounter relevant problems in the process of sports training, they can also use expert systems to help themselves solve them so that students' ability to solve problems themselves can be improved.

5. Evaluation of Application Model of Innovative Physical Education Practice Teaching in Colleges and Universities Based on Golden Sine Algorithm-Optimization Neural Network

This paper combines the golden sine algorithm (Gold-SA) and back-propagation neural network (BPNN) model to evaluate the application model of innovative physical education practice teaching in colleges and universities. The model architecture is shown in Figure 3.

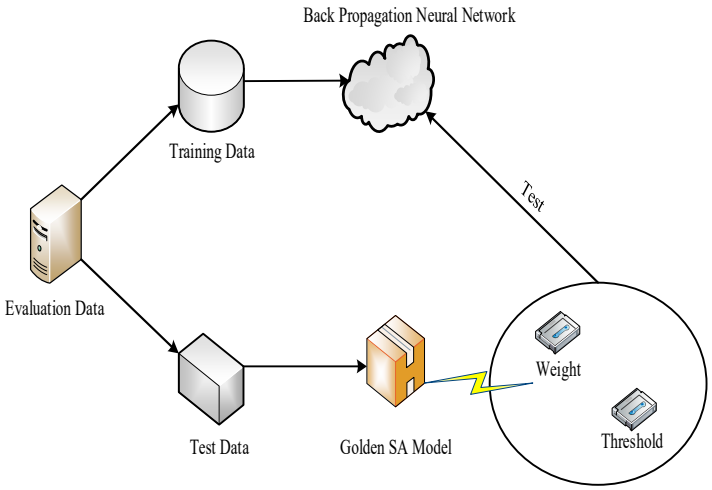

Figure 3. Teaching quality evaluation model architecture based on Gold-SA and BPNN model.

First, the teaching quality evaluation dataset is divided into training set and test set. The training set is trained and processed through the BPNN model, and the test set is calculated through Gold-SA. Then the optimal threshold and weight values obtained are input into the BPNN model for testing. The specific calculation process is as follows:

Normalize the training set and test set data [20]:

$$m_{new} = La + \frac{m - m_{min}}{m_{max} - m_{min}} \times (Lb - La) \quad (1)$$

In Formula (1), m is the original data, and m_{new} is the data after normalization; $m_{\min}$, $m_{\max}$ are the minimum and maximum value in the original dataset. La is the minimum value after normalization, and Lb is the maximum value after normalization. Set La to -1 and Lb to 1.

The weight value and threshold value are obtained by initializing the population individual through Formula (2):

$$W_i = lb + rand(0,1) \times (ub_i - lb_i) \tag{2}$$

In Formula (2), ub_i and lb_i are the upper and lower search limits of the i individual, respectively [21,22]; W_i is the initial value of the i individual.

Use Formulas (3) and (4) to calculate the golden section coefficients m_1 and m_2.

$$m_1 = a \times (1 - v) + b \times v \tag{3}$$

$$m_2 = a \times v + b \times (1 - v) \tag{4}$$

In Formulas (3) and (4), v is the golden section coefficient, and $v = \left(\sqrt{5}-1\right)/2$; $a = -\pi$, and $b = \pi$ in the text [23].

Calculate the best fitness value ACC of each individual in the population by Formula (5) and retain the best individual W_{best}.

$$\begin{aligned} &\max ACC(C,g) = \frac{\sum_{k=1}^{K} acc_k}{K} \\ &s.t \begin{cases} C \in [C_{\max}, C_{\min}] \\ g \in [g_{\max}, g_{\min}] \end{cases} \end{aligned} \tag{5}$$

Among them, ACC is the average accuracy value obtained by K-fold cross-validation, and acc_k is the accuracy value obtained after k-fold calculation [24,25].

The final output formula of the dataset is as follows [26,27]:

$$W_i^{t+1} = W_i^t \times |\sin(r_1)| - r_2 \times \sin(r_1) \times \left| m_1 \times D_i^t - m_1 \times W_i^t \right| \tag{6}$$

In Formula (6), W_i^{t+1} and W_i^t are the positions of the $t+1$ and t iterations of the i individual, respectively; D_i^t is the optimal position for the t iteration of the ith individual; r_1 and r_2 are random numbers between $[0, 2\pi]$ and $[0, \pi]$. Finally, according to the output of the formula and the test dataset, it can evaluate the quality of college PE teaching [28,29].

With the support of Gold-SA, the effect of the application model of innovative sports practice teaching in colleges and universities can be effectively quantified, and the intelligent development of sports teaching can be promoted.

6. Experimental Results of New PE Teaching Model

In order to verify the effect of the application model based on the Internet of Things and artificial intelligence in innovative physical education practice teaching in colleges and universities, this paper carried out verification under the Gold-SA and BPNN models. In order to ensure the contrast of the experimental results, this paper compares the application model of innovative physical education practice teaching in colleges and universities based on the Internet of Things and artificial intelligence with the traditional teaching application model and investigates the impact of the traditional model and the new model on the results of students' physique test. The subjects were 400 students in a sports department. The specific purpose of the survey was to obtain the number and proportion of excellent, good, medium, and poor physical test results under the two models. The survey results are shown in Table 1.

According to the data in Table 1, under the traditional model, the number of people with moderate and poor physical test results accounts for a large part of the total number, namely accounting for more than 70%, which means that less than 30% of people had excellent and good results. In contrast, under the new model, the number of people with good performance was the largest, followed by moderate performance, and followed by excellent performance, while the number of people with poor performance was much lower

than the traditional model. The number of excellent performers accounted for 24.25%, and the number of good performers accounted for 32.25%. Therefore, the total number of good performers accounted for 56.5%. From these data, it can be concluded that the implementation of the new model can improve students' physical test results.

Table 1. Number and Proportion of Four Physical Test Results under Two Models.

Grade Type	Traditional Model		New Model	
	Number of People	Proportion	Number of People	Proportion
Excellent	39	9.75%	97	24.25%
Good	68	17%	129	32.25%
Medium	165	41.25%	98	24.5%
Bad	128	32%	76	19%

Sports include basketball, football, running, long jump, etc. In order to make the experiment more objective and specific, the routine and new models of basketball, football, running, long jump, and other events were tested. The new model uses the Internet of Things and artificial intelligence technology to collect the physical fitness test results of students. The survey sample underwent the performance test of a sports department in the first half of the year, and the survey results are shown in Figure 4.

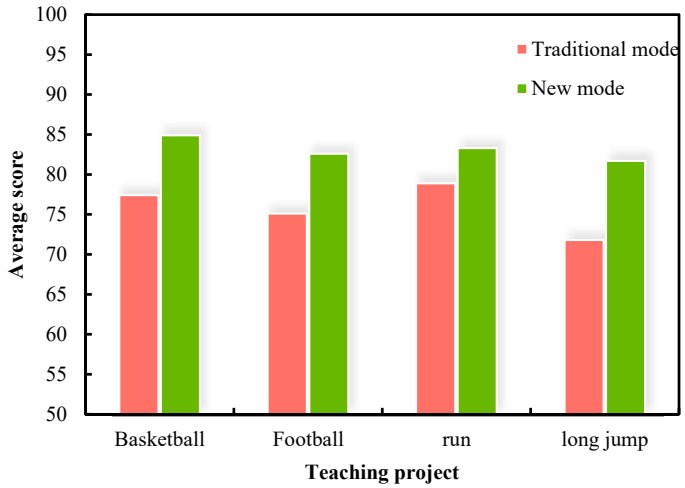

Figure 4. Average Scores of Four Sports under Two Models.

It can be seen from the histogram in Figure 4 that under the traditional model, the average score of the four sports was maintained between 70 and 80 points, and the highest average score was running, at nearly 79 points. Under the new model, the average score of the four sports was maintained between 80 and 85, and the highest average score was nearly 85 for basketball. In vertical comparison, the biggest difference between the average scores of the two models was the long jump, which was nearly 10 points. According to the changes in the average scores of four sports activities under the two models, the new model is effective in improving sports results. There is no significant difference.

Teaching quality is the key to implementing the teaching model. An excellent teaching model can continuously improve the teaching quality. Figure 5 shows the five-week teaching quality scoring under the two models. The scores were given by the college leaders and professional PE teachers, and the full score was 100.

It can be concluded from the scoring in the above figure that in the traditional model, the teaching quality score was between 70–85 points. In the first two weeks, the teaching quality was still higher, while in the last three weeks, the score fell below 80 points. Under the new teaching model, the teaching quality in the first week reached more than 80 points, and the

scores in the next four weeks were constantly rising. By the fifth week, the scores exceeded 88. These ratings also show that the new model is constantly improving the quality of teaching.

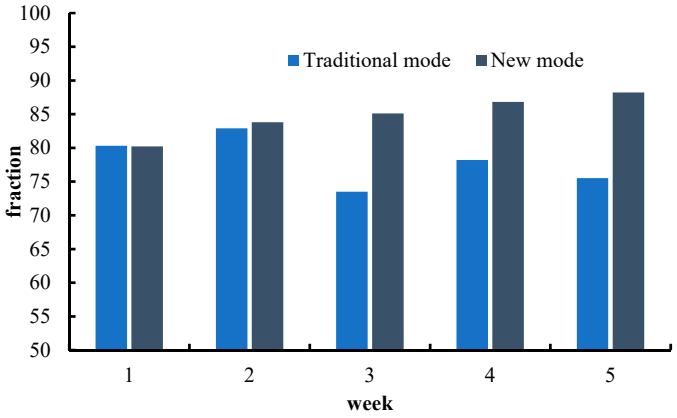

Figure 5. Scoring of 5-week teaching quality under two modes.

In the method part, this paper mentions that the virtual technology and micro curriculum in AI are applied to the new PE teaching mode. These new contents enrich the teaching environment and innovate the PE curriculum, but whether they can affect the students' classroom participation rate still needs to be investigated. This paper investigates the students' classroom participation rate within 7 weeks under the application of new models and traditional models. The change results of the participation rate are shown in Figure 6.

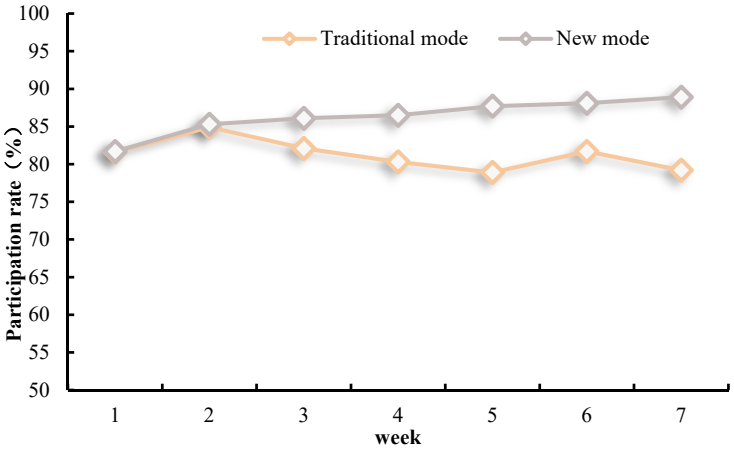

Figure 6. Changes of students' classroom participation rate in 7 weeks under the two models.

It can be seen from the broken-line chart in Figure 6 that in the first two weeks, the classroom participation rate under the new model exceeded the traditional model, but the gap is very small. From the third week to the fifth week, the participation rate under the traditional mode showed a continuous downward trend. It rose slightly in the sixth week and then fell again in the last week. On the other hand, the participation rate in the new model rose steadily from the third week to the seventh week, and the participation rate was also at a relatively high level. In the seventh week, the participation rate even exceeded 88%. In general, the participation rate of the new model was higher than that of the traditional model within 7 weeks, and it was relatively stable. It shows that the classroom under the new model is higher than the traditional model in significance and innovation.

The application of IoT and AI to the innovative practical teaching mode of PE is not only able to improve the teaching quality but also able to improve the teaching efficiency. In order to verify whether the new sports teaching model can improve the teaching efficiency, the 12-week teaching efficiency was tested under the new mode and compared with the

teaching efficiency under the traditional sports teaching model. The specific test results are shown in Figure 7.

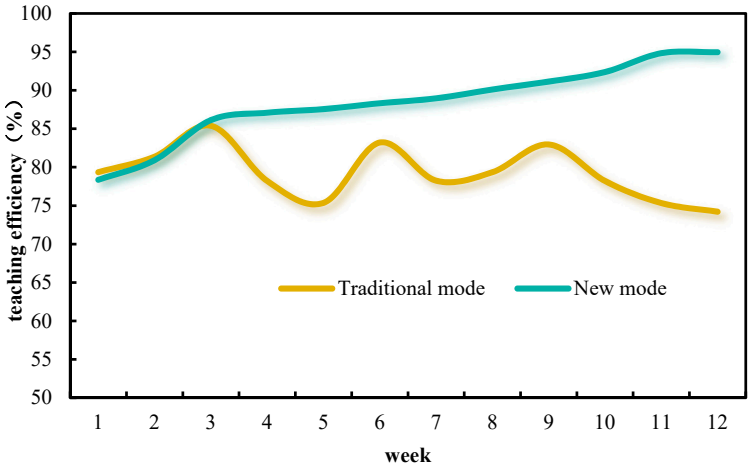

Figure 7. Teaching efficiency of 12 weeks under two modes.

According to the trend of the curve in Figure 7, there is still a big gap between the teaching efficiency of the two models within 12 weeks. In the adaptation stage of the first two weeks, the teaching efficiency under the new model was lower than that under the traditional model. In the third week, the teaching efficiency of the new model exceeded that of the traditional model, but the gap was not very large. After the fourth week, the teaching efficiency under the new model rose rising steadily. In the twelfth week, the teaching efficiency reached nearly 95%. In contrast, the teaching efficiency under the traditional model was higher than that under the new model except for the first two weeks. The rest were lower than the new model, and the fluctuation trend is obvious. By comparing the teaching efficiency of the two models, it can be concluded that the new model is 14.7% higher than the traditional model. It shows that there are significant differences between the new model and the traditional model.

7. Conclusions

Under the new educational environment, the traditional teaching model obviously cannot meet the requirements of educational reform. As new teaching aids, IoT and AI technologies have laid a foundation for the development of education. With the increasing status of PE teaching, the application of IoT technology and AI technology to the innovation of teaching mode has great potential to improve the teaching quality and teaching effect and also can play a great role in promoting the cultivation of outstanding sports talents. However, due to the limitations of time and technology, this paper did not carry out a detailed analysis of the problems encountered in physical education practice teaching, which we will further explore in the future.

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