Optimizing College Physical Education Theory Instruction with The Help of Big Data

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Abstract. In order to improve the teaching effect of physical education (PE)theory courses in colleges and universities (CAU), this paper combines big data (BD)technology to construct a teaching model (TM)system for PE theory courses in CAU. In this paper, the sensor information is filtered to remove noise and outliers, and the initial simple fusion of sensor information is realized. Moreover, this paper fuzzies the partitioned data, which effectively avoids the problem of too large sample space caused by the direct input of ultrasonic data into the neural network (NN). In addition, this paper analyzes the sensor information fusion process based on BP NN (BPNN), and constructs the sample space by encoding the data. Finally, this paper uses the L-M optimization algorithm instead of the gradient descent method to train the NN to improve the iterative efficiency. The experimental research shows that the teaching mode system of PE theory course proposed in this paper can effectively improve the teaching effect of PE theory course.

Keywords: BD; sports theory; teaching mode; system
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1 INTRODUCTION

At present, the PE theory class has not played its due role, and has not reflected the guiding ideology of "health first" advocated by the new curriculum standard. To reflect this guiding ideology, students can truly appreciate the role of PE in ordinary CAU [1]. The study of PE theory is an essential means to cultivate students' ability and improve their PE. Moreover, through the understanding of sports theory, students can not only have a deeper understanding of the mechanism and principle of sports, but also lay a foundation for the improvement of sports technology level. For quality education, the teaching of PE theory is also essential [2].

Quality education is a kind of educational thought and form, which refers to the development and cultivation of various qualities of students by means of education. The reason why the teaching of theoretical courses, as one of the contents of public PE in CAU, plays an important role in the overall quality training of college students is that PE is an important content and means of

quality education in CAU [3]. Therefore, the teaching of PE theory can effectively promote the ideological and moral education, intellectual development, improvement of psychological quality, cultivation of sentiment, development of personality and socialization of students. To sum up, to achieve the ultimate goal of substantive education, it is necessary to enable students to comprehensively and systematically master sports theoretical knowledge, enhance their sports awareness, improve their sports ability, establish the concept of lifelong sports, and develop the habit of regular exercise to achieve the ultimate goal [4].

In the eyes of most people, the task of PE teaching in CAU is just to let students master simple sports technical skills, but they ignore these more important roles of improving their understanding of sports, cultivating their personality, and laying a solid foundation for lifelong sports. It is the implementation of the concept of lifelong sports that determines the increase in the number and quality of sports population [5]. If you want to pave the way for the development of lifelong sports for the educates in the future, you need to make the educates fully understand sports from the time they systematically contact sports in CAU, and lay a solid foundation during efficient learning [6]. The formation of the concept of lifelong PE is, on the one hand, to master the basic knowledge and skills of PE and learn how to exercise; on the other hand, to let students master the scientific theoretical knowledge of PE and form a good habit of consciously participating in exercise. The realization of this goal requires us to pay more attention to the teaching of PE theory in PE. Therefore, the study of PE theory class will play a major role in establishing the concept of lifelong PE in a certain way [7].

Sports has an understanding in people's mind, which can be simply called physical exercise, but people often neglect its core, that is, the theoretical link. Only through the teaching of theoretical knowledge can the students have a deep understanding of the whole technical link, can the PE class achieve the goal of enhancing physical and mental health through correct physical exercises. Therefore, the PE curriculum not only has practical content, but also includes theoretical content. To achieve the purpose of physical and mental health through PE, we should not only take the form of exercise, but also master theoretical knowledge to guide physical exercise [8]. Theory teaching is as important as practice teaching. However, PE has its unique characteristics - activity, so its theoretical teaching hours are limited. In order to better handle the relationship between the two, certain forms can be taken to enable students to master the theoretical knowledge of sports. For example, when there are sports theory lectures, students can consciously go to the lecture hall or classroom to learn the theoretical knowledge of sports, and count the number of lectures into credits. In this way, the teaching of theoretical courses can be taught normally on the premise of ensuring the teaching of practical courses [9]. It pays attention to the teaching of theoretical teaching content, ensures the smooth implementation of practical teaching content, and provides theoretical guidance for students to carry out independent sports learning. [10].

The examination of PE theory course is not only an examination of the teaching effect of PE theory, but also an important means to test the teaching quality. Judging from the form of examination, most of them mechanically imitate the examination form of other disciplines, which is relatively rigid. The content of the exam is not closely related to what students have learned, and some of them even have knowledge points that students have never learned. In this way, rote learning is the only choice for students, but it is often forgotten quickly after the exam [11]. In order to enable students to better master the PE theory course, the following methods can be adopted in the assessment: for the framework type theory course, oral narration is a good method, which can truly show the students' understanding of the PE theory knowledge, and eliminate the possibility of students preparing in advance; For the assessment of technical theory, the method of combining written examination with oral examination can be adopted, which can not only enable students to systematically understand the technology, but also stimulate their potential and creatively put forward some ideas [12]; In the practice class, students are asked questions on the spot for some problems, which can make students have a more specialized understanding, and also can make students have an interest in theory and consciously learn the theory class [13].

Whether the teaching content is reasonable or not directly restricts the students' interest in this course. The uncertainty of the content of the sports theory course is one of the main internal reasons why the current sports theory teaching is difficult to carry out. Therefore, in addition to the theoretical teaching of traditional sports, it is necessary to investigate students' interest in sports theory courses, increase new sports knowledge in combination with the actual situation of the school, so that students can understand more and more extensive sports content, so that students can have a deeper understanding of sports, and also help students to have an interest in sports theory courses [14]. At the same time, leisure sports knowledge can also be properly started to let students understand that sports theoretical knowledge is not boring content, but can let them have more choices for extracurricular entertainment. For different students, we can let them participate in the teaching of theoretical courses that they are interested in, and we can also teach them sports facts to adjust the pressure on students [15].

Sports and health knowledge plays an important role in students' understanding, understanding and implementing sports. Sports and health knowledge can help students understand the methods of physical exercise, help students understand the role of sports and health knowledge in promoting physical health, promote better implementation of sports activities, and lay a solid foundation for lifelong sports [16]. Strengthening the theoretical teaching of PE and health knowledge has great significance and far-reaching influence on school PE and cultivating students' lifelong PE. School PE is particularly important for a person to cultivate health awareness and improve the physical quality of the whole people. The university period is an intermediate stage of the students' school education. The PE in this stage plays a connecting role. On the one hand, it is a consolidation of the students' theoretical knowledge of PE and the results of physical exercise in the primary school period. On the other hand, it is also a key training period for students to develop good PE concepts in college and later higher stages or after entering the society [17]. From the current college PE (CHE) teaching, most of the CHE is still concentrated in some practical teaching. Some theoretical teaching has not been carried out, and some have been carried out very little, and the quality of specific development is not satisfactory. In order to carry out CHE in an all-round way and make PE truly play a good role in the cultivation of college students' future PE concepts, the theoretical teaching of CHE must be reformed, and many aspects such as class hours and teaching methods need to be reformed. When practical teaching is really carried out, theoretical teaching should be effectively combined to improve the quality of CHE fundamentally, let students have a set of systematic and scientific sports theoretical knowledge while cultivating healthy physique [18].

This paper combines BD technology to construct the teaching mode of CHE theory course system, and improve the teaching effect of CHE theory course.

2 DATA PROCESSING OF INTELLIGENT PE TEACHING

2.1 Sensor Noise and Outlier Removal

In the research of this paper, the HC-SR04, which is more common on the market, is selected as the intelligent PE hardware ultrasonic ranging sensor, as shown in Figure 1. It is made using the piezoelectric effect of piezoelectric materials, and consists of three parts: an ultrasonic transducer, a processing unit, and an output stage.

When a voltage is applied, the ultrasonic transducer can emit ultrasonic waves in the form of pulses, and the returned ultrasonic signal is received and analyzed by the ultrasonic transducer. The distance to the measurement target is calculated by the time difference between when the reflected wave is received and when it is transmitted. The ultrasonic sensor sampling data is x_i $(1 \leq i \leq n)$, and n is the length of the sample sequence. The progressive standard deviation of the current data is:

Figure 1: Ultrasonic sensor HC-SR04.

$$S^2(i)=\overline{x^2(i)}-\bar{x}(i)\Big)^2,(3\le i\le n) \tag{2. 1}$$

Among them, $\overline{x^2(i)}$ is obtained by taking the square value of the ultrasonic sensor data and then smoothing it. $(\bar{x}(i))^2$ is obtained by first smoothing the ultrasonic sensor data and then taking the square value. The calculation formula is as follows:

$$\overline{x^2(i)}=\frac{1}{n}\sum_{i=1}^{n}x^2(i) \tag{2. 2}$$

$$\bar{x}(i))^2=\left(\frac{1}{n}\sum_{i=1}^{n}x(i)\right)^2 \tag{2. 3}$$

For the newly collected data sequence x(i+1), if it can satisfy:

$$\bar{x}(i)-kS(i)\le x(i+1)\le\bar{x}(i)+kS(i) \tag{2. 4}$$

Then it can be considered that x(i+1) is acceptable, otherwise, this point is discarded and replaced by an extrapolation method, as shown in Equation 5. Among them, k is set according to experience, generally between 3 and 9.

$$\hat{x}(i+1)=2x(i)-x(i-1) \tag{2. 5}$$

The range of ultrasonic sensor is (50,500) (cm). When the obstacle distance exceeds 5 meters, the sensor outputs 5 meters. φ represents the obstacle angle, and in the case of multiple obstacles, φ takes the value that minimizes $\left|\varphi-\frac{\pi}{2}\right|$. The distance values of 10 sensors are represented by $c_i(i=0\sim7)$, and the value after simple fusion is (c,φ).Obstacle partition around PE hardware is shown in figure 2.

Three ultrasonic sensors S_0,S_1,S_2 divide the right side of the PE hardware into five areas $A/B/C/D/E$. It is stipulated that the sensor is in the same direction as the PE hardware, and its angle is 90 degrees. The position angles of the three sensors in the PE hardware are 0 degrees, 30 degrees and 60 degrees respectively. Two ultrasonic sensors S_3,S_4 divide the front of the PE hardware into three areas $F/G/H$, and the sensor position angle is 90 degrees. Three ultrasonic sensors s_5,s_6,s_7 divide the left side of the PE hardware into five areas $I/J/K/L/M$, and the sensor position angles are 120 degrees, 150 degrees and 180 degrees

respectively. Two ultrasonic sensors S_8, S_9 divide the rear of the PE hardware into three areas $N/0/P$, and the sensor position angle is 270 degrees.

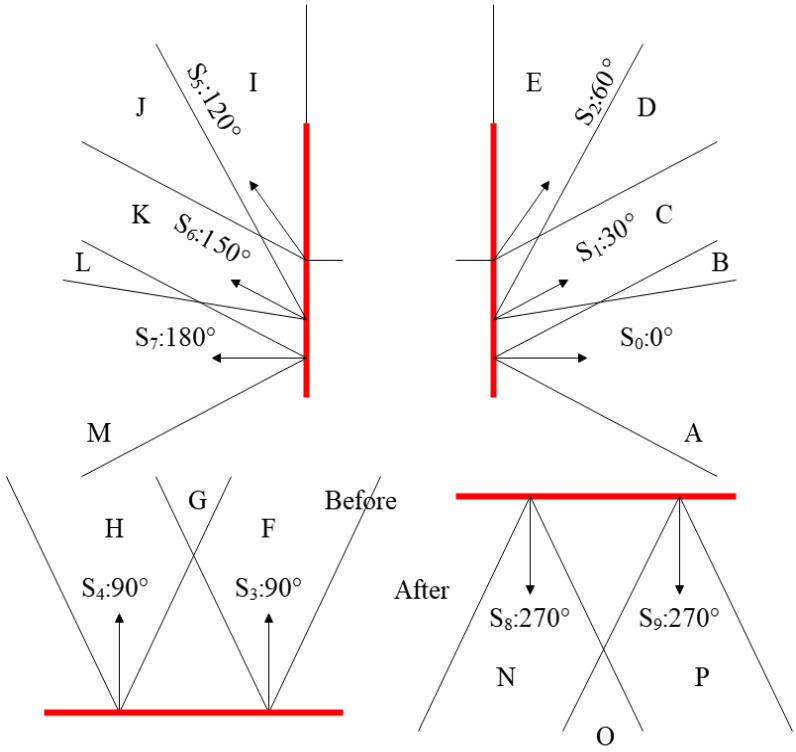

Figure 2: Obstacle partition around PE hardware.

The ranging range of the ultrasonic sensor is (50,500) (cm). First, its linear transformation is a domain of discourse [-4, 4], in which $C_z\left(c_r, c_f, c_l, c_b\right)$ is defined as the fuzzy distance variable of the ultrasonic sensor, and its fuzzy subset is defined as {very close, near, medium, far, very far}. The language variable is NN, which means that the distance is very close, N means that the distance is close, M means that the distance is medium, F means that the distance is far, and FF is very far. Its membership function expression is:

$$p=\begin{cases}1-2|u-m|/\sigma, m-\sigma/2 & <u<m+\sigma/2 \\ 0, & other\end{cases} \tag{2. 6}$$

Among them, p represents the value of the membership function, u represents the universe of ultrasonic linear transformation and $u\in[-4,4];m$ represents the central value of the membership function and $m\in\{-2,0,2\};\sigma$ represents the width of the membership function. The membership function diagram is shown in Figure 3.

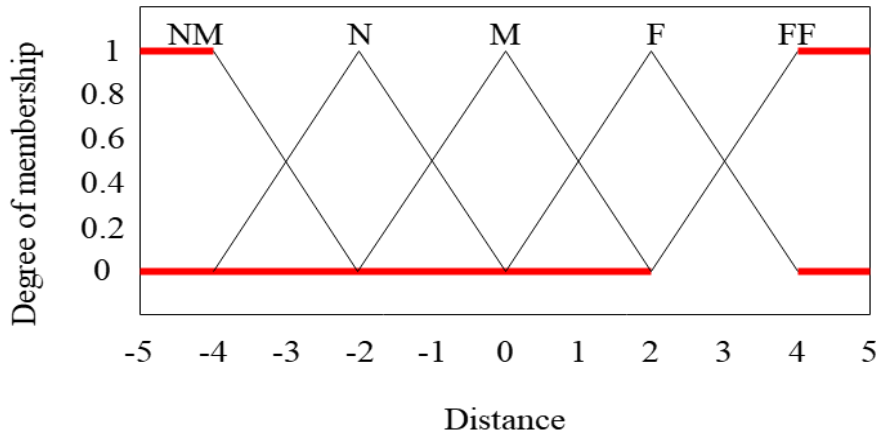

Figure 3: Membership function of C_z .

2.2 Information Fusion based on NN

In this paper, the NN is used to learn the preprocessed ultrasonic sensor data, that is, the sample composed of the vector C_z , so as to realize the fusion of sensor information, so that it can classify the obstacle environment. Then, a fuzzy controller is designed to complete the intelligent PE teaching hardware control based on sitting posture and multi-sensor fusion based on the input of the environment category and the user's sitting posture information. Its overall structure is shown in Figure 4.

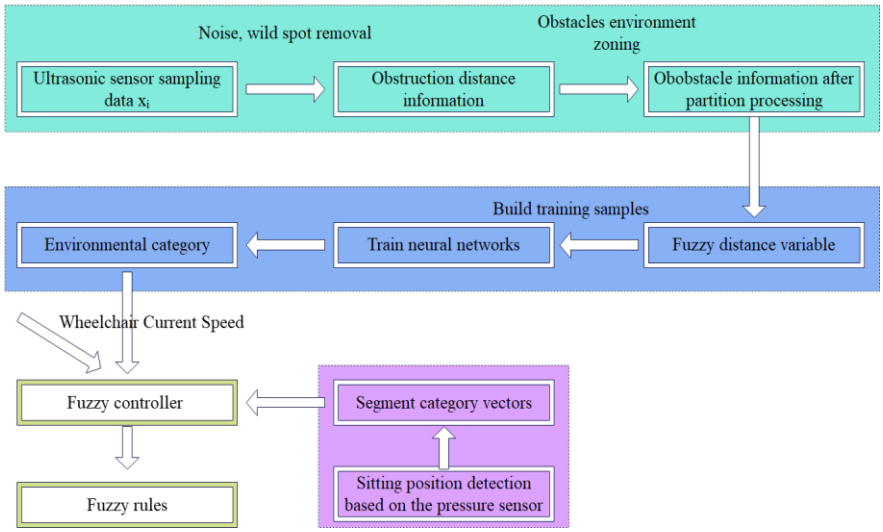

Figure 4: Information fusion structure.

Taking the sensor information as the input and the environment category as the output, establishing the sample training NN to make it have the ability of pattern recognition, which is a typical supervised learning. In this process, the NN continuously compares the expected output. BP

network can learn and store the characteristics of relatively complex nonlinear process without obtaining the exact mathematical description of the process. It uses the gradient descent method as the standard error correction method, and gradually adjusts the connection weights by means of error back propagation, and finally minimizes the sum of squares of errors in the network structure.

The layers of BPNN are interconnected, and the nodes in the same layer are not connected. The number of input nodes is the dimension of the input vector, the input vector of this paper is $C_z\left(c_r,c_f,c_l,c_b\right)$, and the number of output nodes is the dimension of the output vector. Since the output vector is the category of the obstacle environment, there are 8 categories in total by binary encoding for the right, front, left and rear directions. Therefore, the output node is 8. Therefore, this paper chooses a single hidden layer BP network for information fusion. Its topological structure is shown in Figure 5.

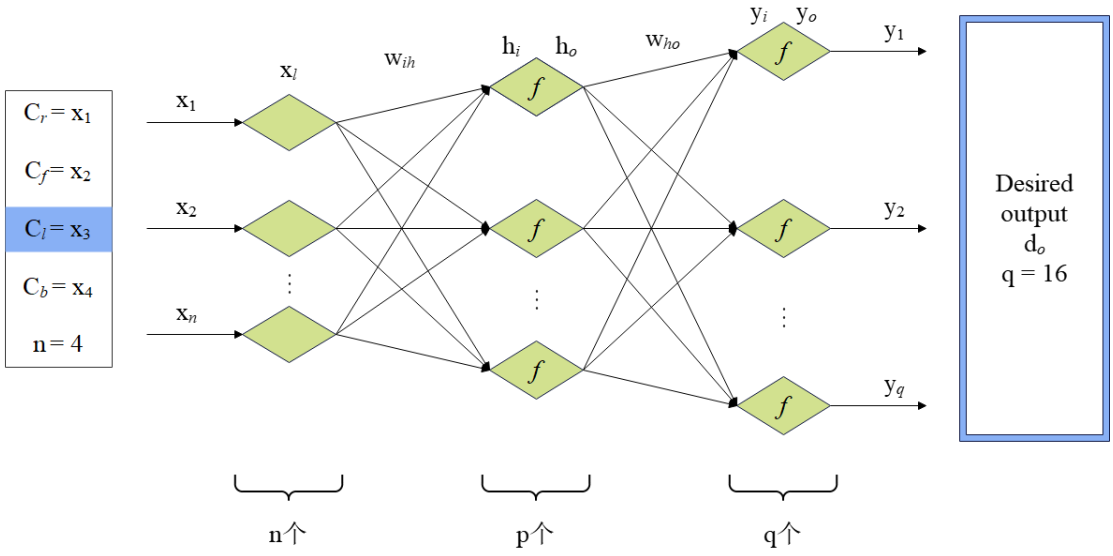

Figure 5: Topological structure of BPNN.

The BPNN algorithm often has multiple local extreme points, and the initial value of the network determines which local extreme point or global extreme point the network converges to. In general, the selection of initial weights and thresholds is randomly generated by uniform distribution, and its range is between -1 and 1. Appropriate weights can avoid falling into a local optimum. If the initial weight range is not properly selected, false saturation may occur during the learning process, and even the network cannot converge. The initial weights are determined by generating random numbers within (-1, 1) and performing multiple experiments to determine the appropriate weights.

It adjusts the weights according to the derivative of the error to the weight or threshold, so that the error decreases rapidly and finally reach its minimum value. The learning rate should be less than a certain value for the algorithm to converge. Generally, $0<\mu<1$ is taken, and the convergence speed of the algorithm will become slower and slower as the gradient change tends to zero. The learning rate has a great influence on the network performance. Its value should not be too small to avoid the slow convergence of the Kan network and fall into the local optimum. A

larger μ should be chosen to improve the convergence speed, but it should not be too large to avoid oscillation near the stable point or even non-convergence.

An inappropriate hidden layer will cause the model to overfit. There is still no universal method to determine hidden layer nodes. In order to ensure that the network has good generalization ability and high performance, the selection of hidden layer nodes follows the following principles. First, the accuracy needs to be guaranteed. Under this premise, it is necessary to take a compact structure and a small number of hidden layer nodes and satisfy:

1) If N is the number of training samples, the number of hidden layer nodes must be less than N-1, so as to avoid the error of the model from tending to zero because it has nothing to do with the sample and the poor generalization ability of the model. At the same time, the number of nodes in the input layer is also less than N-1.

2) The number of connection weights of the NN needs to be less than the number of samples, and the sample data is divided into multiple parts during training and trained in turn.

In general, the number of hidden layer nodes should not be too small, otherwise the network may fail to train or perform poorly. Too many hidden layer nodes will make the training time too long, or make the network fall into a local optimum, resulting in overfitting. The following are several commonly used formulas for calculating hidden layer nodes:

$$m=\sqrt{n+l}+\alpha \tag{2. 7}$$

$$m=log_2^n \tag{2. 8}$$

$$m=\sqrt{n\cdot l} \tag{2. 9}$$

$$m=\sqrt{0.43n\cdot l+0.12l^2+2.54n+0.77l+0.35+0.51} \tag{2. 10}$$

Among them, m is the number of hidden layer nodes, n is the input layer node, and I is the output layer node a, which is an integer between 1 and 10.

Although BPNNs are very effective in many practical application scenarios, conventional gradient descent learning algorithms often make the training process inefficient. When the learning sample is large, the global optimal solution cannot even be obtained. Therefore, in recent years, many researchers have proposed a variety of improved methods.

Through experiments and comprehensive comparison of various training algorithms, it is found that the L-M algorithm has higher iteration efficiency and better robustness. Therefore, the L-M algorithm is used to train the NN. The calculation steps of using the LM algorithm to adjust the weight vector are as follows:

1) The algorithm gives the training error allowable value ε, constants μ_0 and $\beta(0<\beta<1)$, initializes the weights and threshold vectors, and sets $k=0,\mu=\mu_0$;

2) The algorithm calculates the network output and the error index function $E\left(w^k\right)$;

3) The algorithm calculates the Jacobian matrix J(w);

4) The algorithm calculates Δw;

5) Taking $w^{k+1}=w^k+\Delta w$ as the weight and threshold vector, the algorithm calculates the error index function $E\left(w^{k+1}\right)$. If $E\left(w^{k+1}\right)<E\left(w^k\right)$, then $k=k+1,\mu=\mu\beta$, and the algorithm restarts step 2), otherwise $\mu=\mu/\beta$, and the algorithm restarts step 4).

6) If $E\left(w^k\right)<\varepsilon$, the algorithm ends.

As an important step in the process of sensor information fusion, NN is mainly used to automatically identify the information of obstacles in the environment faced by intelligent PE hardware. Taking the value of the obstacle information vector $C_z\left(c_r,c_f,c_l,c_b\right)$ as the input of the BPNN, and the corresponding environmental category as the output of the network, the recognition and classification of the environmental category can be realized after the training. First, according to the value of the vector $C_z\left(c_r,c_f,c_l,c_b\right)$, the category of the surrounding environment of the intelligent PE hardware is defined by binary coding. If there is an obstacle in each direction, the value of the direction is 1, otherwise it is 1. The four-bit binary code can fully represent the environmental categories, and there are 2^4.

3 RESEARCH ON THE TEACHING MODE SYSTEM OF CHE THEORY COURSE FROM THE PERSPECTIVE OF BD

Based on the elements of online evaluation, this paper adopts a variety of evaluation methods, the MOOC teaching quality inspection and evaluation system consists of four basic modules: interactive evaluation, online learning behavior, evaluation analysis, and online and offline teaching, as shown in Figure 6.

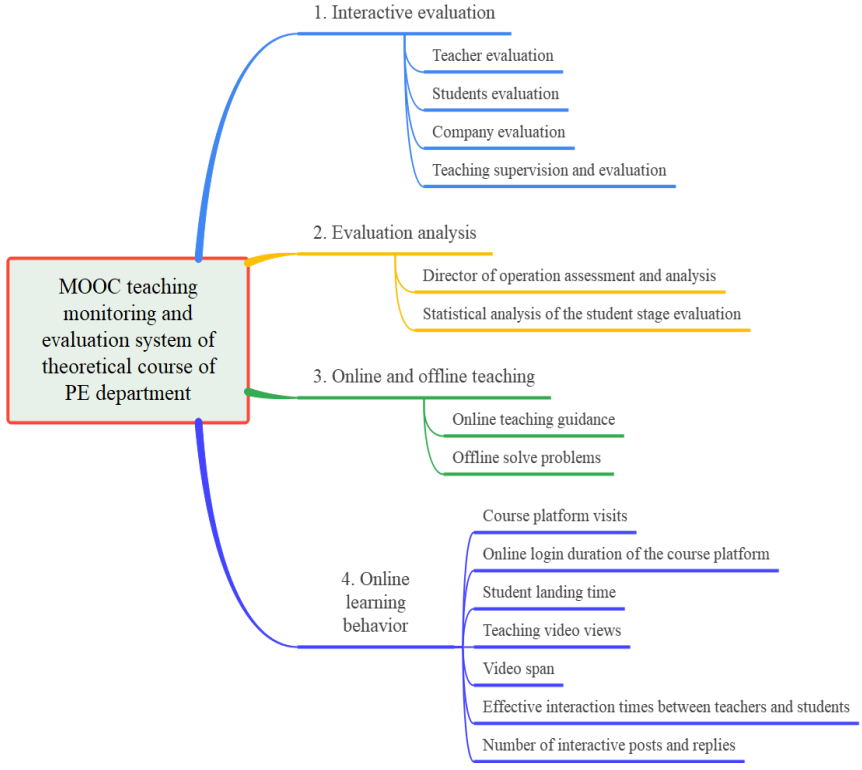

Figure 6: The existing MOOC teaching monitoring and evaluation system for theoretical courses in PE departments.

According to the actual situation, combined with the analysis of the needs of students, teachers and administrators, it is obvious that the construction of the MOOC monitoring system for theoretical courses in PE departments needs to have two main goals. The first is that students can enter the MOOC platform to study the selected courses by themselves. The second is that teachers should play a certain role in monitoring students' learning behavior. Students learn on the MOOC platform, and teachers should be able to grasp the students' learning status at all times. According to the student's learning status and the student's learning effect, the course progress and the course depth can be adjusted appropriately according to the student's specific learning situation and the student's ability to accept the course. According to the two goals of platform construction, the theoretical basis and construction principles of the MOOC monitoring system, the structural framework of the MOOC monitoring system as shown in Figure 7 is designed.

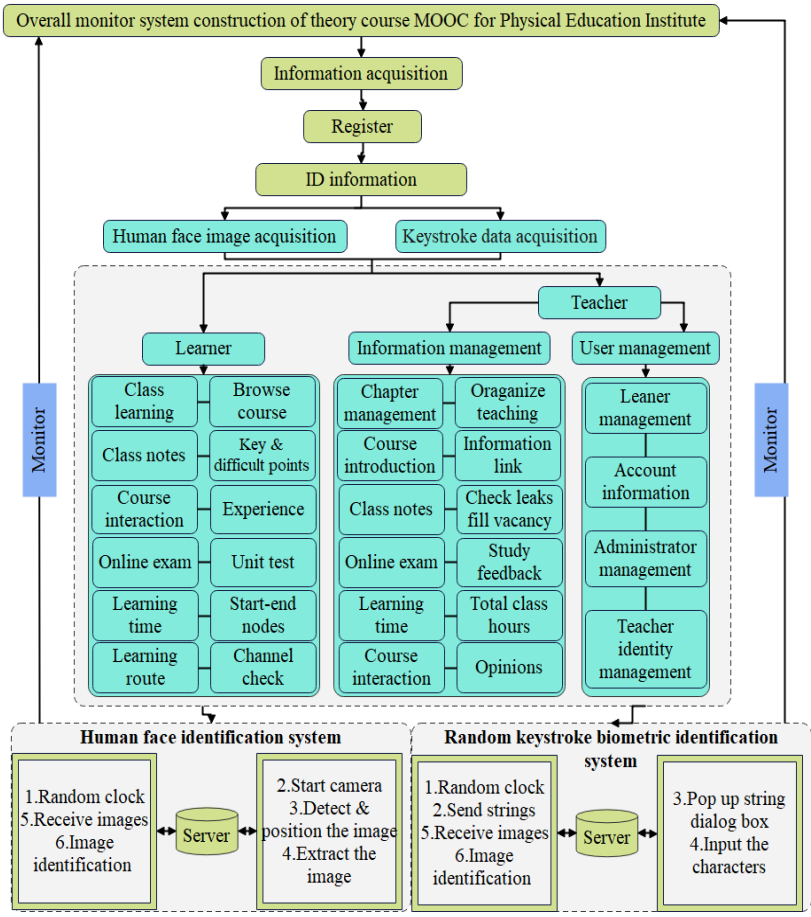

Figure 7: Design frame diagram of MOOC monitoring system for theoretical courses of PE departments.

The PE theory examination system can be divided into two parts, one is the examination system and the other is the scoring system. It adopts a design mode that separates examinations and judging. One of the advantages of this design is to avoid students obtaining answers through some illegal means. Second, for subjective questions, teachers must review and judge papers one by

one in order to achieve real humanization and avoid the drawbacks brought about by computer judging. Figure 8 shows the overall frame structure and functions of each part of the PE theory course examination system.

This paper combines the BD technology to verify the effect of the TM system of the above sports theory courses. Moreover, the effects of teaching monitoring, teaching evaluation, and teaching assessment of the system in this paper are tested, and the results shown in Figure 9 are obtained.

Through the experimental research shown in Figure 9, it can be seen that the TM system of the PE theory course proposed in this paper can effectively improve the teaching effect of the PE theory course.

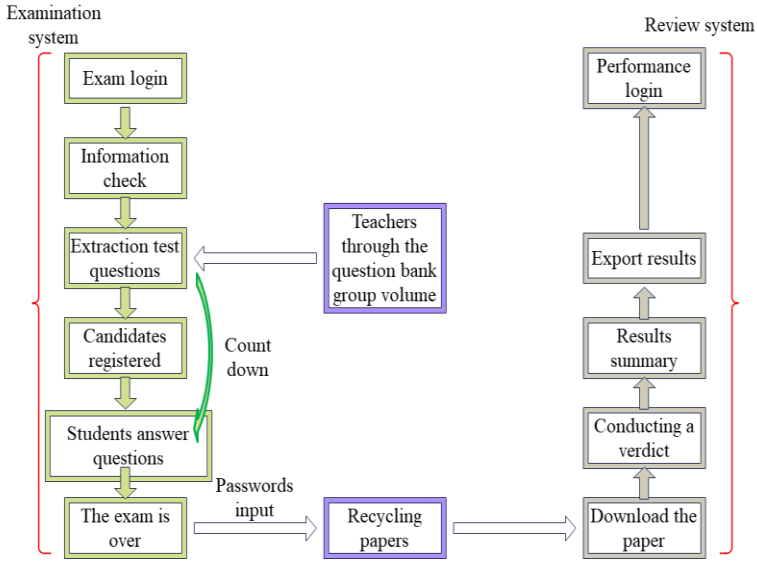

Figure 8: Flow chart of the examination system for PE theory course.

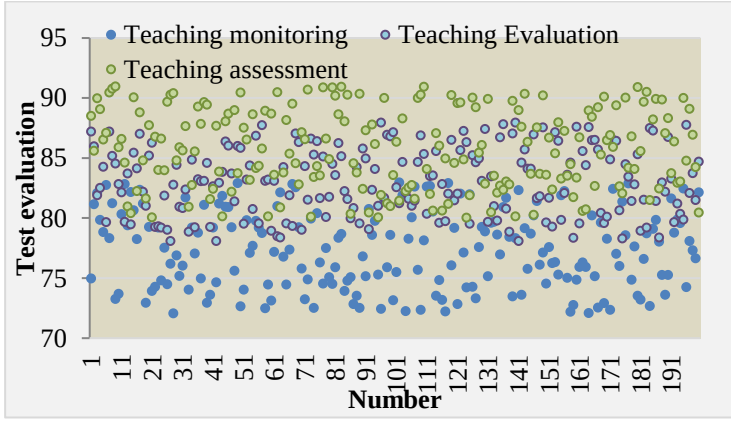

Figure 9: The effect verification of the teaching mode system of the PE theory course.

4 CONCLUSIONS

In the PE teaching in CAU, the teaching of theoretical courses plays a very important role. The basic knowledge of sports, the relevant special theoretical basis of major sports, the common sense of sports health care, and the explanation of techniques and tactics and refereeing methods should be completed through the teaching of sports theory courses. Only in this way can students know how to prevent and deal with common sports injuries, and how to organize and guide others to exercise and benefit themselves. Ultimately, it achieves the establishment of students' good sports habits and a concept of lifelong sports, thereby cultivating talents who have both practical ability of physical exercise and rich theoretical knowledge. This paper combines BD technology to construct the teaching mode system of CHE theory course, and improve the teaching effect of CHE theory course. The experimental research shows that the TM system of PE theory course proposed in this paper can effectively improve the teaching effect of PE theory course.

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