Research Article

Construction of a Six-Pronge Intelligent Physical Education Classroom Model in Colleges and Universities

Lihua Zhou and Qiang Tang

1 Department of Physical Education, Xiangtan University, Xiangtan, Hunan 411105, China
2 Physical Education Teaching and Research Group, Mingde Tianzhong Middle School, Changsha, Hunan 410029, China

Correspondence should be addressed to Lihua Zhou; zlh1818@xtu.edu.cn

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A main form of information construction in colleges and universities is smart campus, which is a new model based on the improvement and perfection of digital campus construction. The development of smart campus is inseparable from the support of technologies such as Internet of Things (IoTs), cloud computing, and big data. By perceiving the teaching environment and intelligently identifying the characteristics of teachers and students, it can be used as a basis to improve the physical education, teaching environment, and digital teaching space, that is, an intelligent and diversified teaching environment for college teachers and students. In this study, we introduce an intelligent teaching mode into physical education classroom, construct the “six-pronge” intelligent classroom model, and apply the model by setting up a control and an experimental group to study the application effects of the proposed model in physical education teaching. The control group consists of the students who do not adopt the teaching mode, while students in the experimental group use the intelligent physical education teaching model. Through a comparative analysis, students’ physical education classroom teaching atmosphere, students’ learning interest and learning attitude, the proposed intelligent physical education classroom model are tested and verified. The analysis results show that after implementation of the “six-pronged” intelligent physical education classroom model, the physical education classroom atmosphere is active, and students have strong interest in learning and correct learning attitude. We believe that the model can help students complete pre-class preparation, in class teaching and after class practice supervision, and obtain a lot of knowledge about physical training. In addition, the model can help to cultivate students’ lifelong physical education learning and exercise habits, and greatly improve the quality of physical education classroom teaching in colleges.

1. Introduction

In the world, colleges and universities are the cradle of cultivating national talents. However, due to the high pressure of schoolwork, Chinese students generally lack physical exercise. They have not formed the habit of physical exercise since childhood and do not pay attention to physical education after entering colleges and universities. They believe that physical education is not a compulsory course, which makes the physical quality of Chinese college students poor. For this problem, colleges and universities need to strengthen physical education curriculum teaching. In addition, the traditional physical education teaching mode in colleges and universities cannot keep up with the development of the times and technologies [1]. Therefore, it is essential to account for state-of-the-art technologies that should be integrated into the classrooms for better quality education and student experiences, as well as, teachers’ practices.

With the rapid development of information technology, experts all over the world began to focus on exploring the field of smart classrooms [2, 3]. Furthermore, in the era of wisdom, the rapid development of cloud computing technology, big data, Internet of Things (IoTs), and other emerging computational technologies has accelerated the reform stage of intelligent physical education classroom. In this paper, we construct a “six-pronge” intelligent physical education classroom model to change the current situation of physical education teaching and diversify the previous
single physical education classroom model. The “six-pronge” intelligent sports classroom model is centered on six stages, that is, (i) the "student-centered" three levels, (ii) three platforms, (iii) three modules, (iv) the student sports classroom teaching system, (v) the off-campus training group, and (vi) the closed-loop practice teaching quality monitoring system. Moreover, the “six-pronge” teaching quality assurance system for the construction of the teaching staff ensures that teachers are constantly focusing on the quality of classroom teaching.

Moreover, this paper constructs a "six-pronge" smart classroom system centered on students’ activities, which uses sensor-based human motion patterns to identify students’ sports actions, and teachers guide. Subsequently, we analyze the sensor-based data according to students’ sports data, which is conducive to students’ after-school training and classroom content consolidation [2]. We also build an intelligent physical education classroom model, for colleges and universities, on the intelligent terminal equipment platform. We apply the developed model to the physical education classroom in colleges and universities, analyze and apply the teaching model to college students, and randomly select students who do not use the teaching model. Through a comparative analysis, we analyze the interest of physical education classroom teaching atmosphere, students’ learning interest and learning attitude, and analyze the role of intelligent physical education classroom model. The following are the main contributions of the research presented in this paper:

(i) we introduce the intelligent teaching mode into the physical education classroom and constructs the “six-pronged” intelligent physical education classroom model in colleges and universities, and apply the model in the physical education classroom teaching in colleges and universities.

(ii) we build an intelligent physical education classroom model in colleges and universities on the intelligent terminal equipment platform, apply the model to the physical education classroom in colleges and universities.

(iii) by setting up a control and an experimental group to study the application effects of physical education classroom model in physical education teaching, in which the control group is the students who do not adopt the teaching mode, and the experimental group is the students who use the intelligent physical education teaching model.

The rest of the manuscript is structured as follows: In Section 2, we briefly discuss state-of-the-art research work within the domain of intelligent teaching models. Section 3 talks over the “Six-pronge” an intelligent physical education classroom system in colleges and universities. Construction of an intelligent physical education classroom model is elaborated in Section 4. Experimental results and analysis of the “six-pronge” intelligent physical education classroom are discussed in the subsequent Section 5. Finally, Section 6 summarizes this manuscript while offering several directions for more research and investigation.

2. Related Work

Smart physical education classroom is an important part of smart classrooms. With the rapid development of information technology, experts all over the world began to focus on exploring the field of smart classrooms [3]. Aversi-Ferreira et al. analyzed a similar model and observed that the current distance education is only in one-way teaching and network courseware, which is difficult to support the interaction between teachers and students in the classroom. Therefore, the authors put forward a new demonstration mode and distance teaching, which can realize the interaction between virtual scenes, teachers, and students. Focusing on the design of intelligent teachers, the authors put forward a variety of ways on how to use virtual reality technology in distance teaching [4]. Faria et al. also analyzed the current teaching situation of installing intelligent devices in Israeli national schools. Students have high-learning enthusiasm in the classroom and can give full play to teachers’ ability. In addition, the authors also studied students’ learning status in the smart classroom environment and analyzed various advantages and disadvantages of the applications of smart classrooms for students in teaching institutes [5].

From the perspectives of reflective thinking, student negotiation, function design, and ease of use, Mabassa et al. investigated and observed students’ preference for teaching classroom in intelligent classroom learning, and come to the conclusion that the developed instrument is used as a reliable tool to judge college students’ preference for intelligent classroom learning environment [6]. Similarly, other scholars also analyzed from the two aspects of classrooms: (i) wisdom, and (ii) intelligent classroom. Liu et al. analyzed from the two points of informatization and education, fundamentally changing the traditional “knowledge classroom” into “intelligent classroom,” so as to strengthen students’ intelligent ability [5]. Guo et al. pointed out that smart classroom is inseparable from the support of new technology environment. A new classroom teaching model is established for the purpose of cultivating students’ wisdom [7]. Liu et al. proposed that smart classroom is based on constructivism learning theory, which trains students to master learning wisdom according to the new generation of information technology, highlights the individual differences of different students, and strengthens the emotional communication between teachers and students [8].

Wang et al. pointed out that under the rapid development of informatization, the concept of intelligent classroom was put forward and applied, and integrated with education and teaching [9]. Zeng et al. propose to carry out geography classroom education in the smart classroom based on iPad. Compared with traditional multimedia environment teaching, it can effectively improve students’ interest in learning geography, enhance students’ attention, better understand and master knowledge, and improve students’ autonomous learning abilities [10]. Shao put forward that smart classroom is consistent with the requirements of the current new curriculum reforms in different colleges, universities, and teaching institutes [11]. They believe that the
application of smart classroom concept in physical education teaching strategy can fully show the interest, innovation, and sense of experience of physical education teaching [12].

Bai proposed several smart classroom methods and approaches which are based on e-book package. In addition, the authors have analyzed the smart learning content, evaluation methods, and basic composition on the created smart classroom system to form a complete system [13]. Based on the in-depth analysis of the technical characteristics of smart classroom, Wang and Zheng designed the latest learning model of smart classroom and applied it in practice [14]. Hu et al. launched the smart classroom teaching mode of “three stages and ten steps.” The core of this mode is to organically combine the teaching mode with information technology and test the advantages of the teaching mode through experiments [15]. Wang and Zhao divided the system’s functional requirements on the basis of big data and cloud computing platform. Their proposed model can design online classroom modules and improve the interactivity of video transmission, significantly [16].

3. “Six-Pronge” Intelligent Physical Education Classroom System in Colleges and Universities

3.1. Building a “Six-Pronge” Smart Classroom System. This paper adopts the “six-pronge” concept and the student-centered smart classroom system to replace the traditional “teacher-centered” education model [17]. Based on students’ innovative and practical abilities, set up curriculum project cards, open implementation projects, graduation projects, and extracurricular scientific and technological works. In order to improve the practicality of students’ physical education classroom and strengthen the professionalism of training, a layered and modular system is established to cultivate students’ strong innovative thinking and practical abilities. The proposed modular system consists of three platforms: (i) in school classroom, (ii) extracurricular, and (iii) out of school classroom. In order to standardize the management and improve the quality of teaching, we establish two systems, that is, (a) the teaching-quality monitoring system, and (b) the teaching evaluation quality system. The main purpose of the system is to ensure the quality of daily physical education, and put forward the “three levels, three platforms and three modules” student physical education classroom teaching system, the training system outside the school, the closed-loop practice teaching quality monitoring system, and the “six-pronge” sports classroom teaching quality assurance system [18]. The proposed model is shown in Figure 1.

3.2. Human Motion Pattern Recognition Based on Sensor. In this study, the human movement pattern recognition method based on sensor is used to collect and recognize students’ physical education classroom actions. The proposed system is more accurate than the traditional naked eye recognition and judgment method of teachers. Moreover, it can master the data of students’ learning physical actions, intensity, training degree, and so on. The essence of this recognition mode is to use sensors to collect students’ physical education classroom data, train the recognizer that meets the requirements of the recognition system according to the collected data, and finally recognize human motion data on the successfully trained recognizer. The recognition process includes various stages such as collecting the data, preprocessing the collected data, selecting, and extracting...
features (using feature extraction from learning systems), and selecting recognizer. The specific process is shown in Figure 2.

In this study, 11 kinds of characteristic acceleration signals on X-axis, Y-axis, and Z-axis in frequency domain and time domain are extracted. The process of eigenvalue extraction algorithm is described in detail below. The $A_i$ represents the $i$ sampling value of any axis in X-axis, Y-axis, and Z-axis acceleration signals, and its relationship is represented by $A \in \{X, Y, Z\}$, where $n$ represents the window length.

3.2.1. Mean Calculation Formula.

$$\mu_A = \frac{1}{n} \sum_{i=1}^{n} A_i.$$  (1)

The DC component of acceleration signal is the main meaning of mean value, which is used to show the difference of characteristics of different motion signals.

3.2.2. Calculation Formula of Standard Deviation.

$$\sigma_A = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (A_i - \mu_A)^2}.$$  (2)

The mean value of acceleration data in the window is represented by $\mu_A$. The standard deviation is the most widely used statistical feature, which can directly reflect the dispersion degree of acceleration compared with the average value [19]. At the same time, the standard deviation is in positive proportion to the intensity of human movement.

3.2.3. Energy Calculation Formula

$$E_A = \sum_{i=1}^{n} |A_i|^2.$$  (3)

The acceleration data energy in the window is represented by $E_A$, and the energy consumption of human motion in the window time is explained through the energy characteristics. For example, compared with running at the same time, running consumes more energy, so it can be accurately distinguished by energy characteristics.

3.2.4. Calculation Formula of Crest Factor.

$$A_{CrFr} = \frac{0.5 (A_{max} - A_{min})}{\sqrt{1/n \sum_{i=1}^{n} A_i^2}}.$$  (4)

The highest and lowest values on the acceleration signal in the window are represented by $A_{max}$ and $A_{min}$, respectively. The peak factor of the acceleration signal is $A_{CrFr}$, and the peak factor is the ratio between waveform peak and effective value, which can effectively express the intensity of human movement.

3.2.5. Kurtosis Calculation Formula

$$A_K = \frac{1}{n \sigma_A^4} \sum_{i=1}^{n} (A_i - \mu_A)^4.$$  (5)

The variance and mean value of the acceleration signal in the window are determined by $\sigma_A$ and $\mu_A$, respectively. According to the value obtained from formula (5), the steepness of the acceleration signal curve waveform can be reflected.

3.2.6. Skewness Calculation Formula

$$A_{Sk} = \frac{n}{(n-1)(n-2)\sigma_A^3} \sum_{i=1}^{n} (A_i - \mu_A)^3.$$  (6)

The variance of the acceleration signal in the window is determined and represented by $\sigma_A$, the mean value is represented by $\mu_A$, and the skewness of acceleration signal in the window is represented by ask. Furthermore, according to the
skewness result, the skew direction, and asymmetry degree of the data distribution can be judged. The skewness value is either positive or negative as the discussion follows. In case, if the acceleration signal value in the window is lower than the average value, then it indicates that the skewness result of the value is negative, otherwise, the skewness result value is positive and vice versa.

3.3. Analysis of "Six-Pronge" Physical Education Classroom Teaching Resource System. Based on the field of deep learning, the most important thing in the process of teachers' physical education classroom teaching is teachers' key ability, which involves teachers' personal physical education skills, teaching attitude, and personal knowledge reserve. Therefore, in the in-depth teaching environment, teachers should have digital survival ability, scientific and technological integration ability, lifelong learning ability, and professional teaching ability. On the basis of this ability, the quality of the physical education classroom teaching can be guaranteed. The key abilities of teachers are directly related to the cultivation and realization of the "six-pronge" of physical education classroom teaching. In addition, teaching institutes such as colleges and universities can collect resources inside and outside the classroom in order to provide students with physical education teaching environment. Similarly, they can contact large-scale sports venues outside the school to establish cooperative relations, and they provide venues [20].

Schools provide teaching resources to jointly complete physical education teaching training, so that students are not limited to the teaching methods of traditional classroom books, teaching materials, and theoretical knowledge. It can let students really get in touch with all kinds of sports and avoid some students being unable to train on the spot due to less contact with sports. At the same time, when cultivating students' "six-pronge" sports teaching, by combining teachers' theoretical knowledge and students' independent display, each student can show the sports learned in sports classroom teaching. After that, the teachers will guide each student's sports activities and evaluate the nonstandard actions in the process of students' sports training. In addition, teachers focus on explaining the difficulties of physical training and let students know the essentials of movement by demonstration. Moreover, schools, colleges, and universities could adopt diversified teaching methods in the physical education classroom, hire professional teachers to teach the sports that need to be studied in the university, and strengthen the strength and professionalism of the schoolteacher team.

Carrying out physical education classroom teaching in this way (as described above) can improve the sports professionalism of students. This should be noted that physical education classroom teaching is not only a simple skill training but also combined with in class and out of class resources to cultivate students' "six-pronge" ability, so that students can apply their theoretical knowledge to practical physical training in physical education classroom. Besides the above-illustrated scenarios, students can also participate in college community activities or physical education competitions to improve their personal sports capabilities.

4. Construction of Intelligent Physical Education Classroom Model

4.1. Intelligent Terminal Equipment Platform. Intelligent terminal equipment platform refers to a variety of different types of terminal equipment tools, which is an important tool for teachers to carry out intelligent physical education classroom teaching [21]. The main function of the platform is to collect data from sensors, and use the Internet medium to transmit data to the health cloud management platform. In addition, it can intuitively feedback the cloud data analysis results. Teaching institutes including colleges and universities can build an intelligent terminal platform according to the actual situation. Through this platform, students' physique, sports capabilities, and sports performance can be tested and entered. At the same time, the platform is also an intelligent fitness equipment, which can monitor students' center jump, speed, sports ability, and other data in real time. These are some of the most important basis for judging students' physical qualities. As a result of the above model, all physical education teachers classify students according to students' physical exercise data and adopt different teaching methods for different groups of students. This will essentially help to realize accurate teaching for different types of students, improve students' enthusiasm to participate in physical education classroom, let students complete physical training under their affordable physical education classroom teaching methods, and give full play to the advantages of each student.

4.2. Subject Structure of Intelligent Physical Education Classroom in Colleges and Universities. The construction of an intelligent physical education classroom in colleges and universities belongs to system engineering, which should be realized with the support of big data, cloud computing, Internet of Things (IoTs), Internet medium, and other emerging technologies. Based on the intelligent service platform of "cloud, museum, and end," the theoretical knowledge of the physical education classroom is pushed, and the information management mode is adopted to evaluate the process of intelligent physical education classroom teaching [22]. Starting from the overall structure characteristics of smart physical education classroom, this paper constructs smart physical education classroom in a bottom-up way. The proposed intelligent smart physical education in the context of smart classrooms is as shown in Figure 3. The platform consists of four different layers: (i) foundation layer, (ii) data processing layer, (iii) end-user service layer, and (iv) teaching realization layer. Discussion around these layers can be found in subsequent sections.

4.3. Constructing Intelligent Physical Education Classroom Model in Colleges and Universities. Compared with the traditional physical education classroom-teaching mode, the intelligent physical education classroom teaching proposed in this study is significantly different [23]. The main purpose of the traditional physical education classroom is to tell the theoretical knowledge in the classroom, and then carry out
teaching and intelligent physical education classroom. By using information technology to enrich the classroom content and applying big data technology to intelligently reform the physical education classroom, evaluate the students’ preview before class, determine teaching by learning, real-time monitor the training during and after class, and give full play to the students' subjectivity and initiative [24]. Moreover, pay attention to the individual differences of each student, teach students according to their aptitude, and evaluate the students’ physical education classroom learning process. Combined with the characteristics of smart physical education classroom, the smart physical education classroom teaching model is established and divided into three stages, namely, (i) pre-class preparation, (ii) in class teaching, and (iii) after-class training. Figure 4 shows the smart physical education classroom teaching structure model.

This study establishes an intelligent college physical education classroom on the information platform, in the context of smart classrooms. Moreover, it extends physical education classroom education to before and after the class, promotes the mutual communication between students and teachers and realizes the sharing of all kinds of resources. Before teaching, teachers can design the teaching mode according to the data processing cloud information. Students can obtain the teacher’s class content from the terminal and preview it in advance. After preview, students’ initiative in the physical education classroom can be improved, and they can also follow the teacher’s teaching ideas. In the course, teachers use intelligent devices to understand students’ learning status in real time, conduct differential teaching for different types of students based on real-time information, and monitor students’ exercise intensity. Middle-school students in physical education classroom can also learn physical education knowledge independently and communicate training essentials with other students. After the physical education classroom teaching, teachers use the intelligent platform to reasonably arrange the after-school training tasks, and take online counseling for the places where students are not clear. In addition, students can exercise independently after class so as to master the classroom teaching content, strengthen the physical education classroom teaching results, and cultivate students to develop good physical exercise habits.

5. Analysis of the “Six-Pronge” Intelligent Physical Education Classroom

According to the “six-pronge” intelligent physical education classroom model established above, the practical application effect is analyzed by means of questionnaire [25]. Taking the students of aerobics course as the research object, the “six-pronge” intelligent physical education classroom model is implemented in a university for one semester, and the practical application effect of the model is tested at the end of
the semester. Approximately, 40 students were randomly selected for the questionnaire survey. The 40 students were in the experimental group, and a total of 40 questionnaires were distributed. Then, 40 students who did not carry out the “six-pronge” intelligent physical education classroom teaching in colleges and universities were randomly selected as the control group. Thus, 40 questionnaires were distributed, and all questionnaire reports were recovered. The degree coefficient of the questionnaire exceeded 0.8, indicating that the data has high reliability and can be used in later analysis. Tables 1 and 2 illustrate the reliability test results of the questionnaire in the experimental group and the control group, respectively.

5.1. Analysis of Classroom Teaching Atmosphere Feeling.
The students in the experimental group use smart phones to answer the questions raised by the students in the physical education classroom. The students record videos for each other. The classroom atmosphere is active and interesting. They correct each other’s physical training movement problems so that the students can grow together in the physical

![Diagram](image-url)
education classroom. The control group still adopts the traditional teaching mode in the physical education classroom. The teachers tell the theoretical knowledge and the students practice in groups. In the process of group practice, some students do not practice seriously and appear lazy. Only a few students train according to the requirements of the teachers. The whole classroom atmosphere is rigid, and there is less communication between students. This study investigates and analyzes the evaluation and analysis results of the students in the experimental group and the control group on the sports classroom atmosphere, and draws the following Figure 5 to show the analysis results of the sports classroom atmosphere. The vast majority of the experimental group has a good experience of this new teaching mode, and the teaching atmosphere is ideal, which can stimulate students’ interest in learning. More than 50% of the students in the control group said that the physical education classroom atmosphere is not active and cannot raise their interest in learning.

5.2. A Comparative Analysis of Students’ Learning Interest and Learning Attitude. After one semester of the “six-pronge” smart physical education classroom teaching, the students in the experimental group analyzed their interest in physical education courses. The data results are shown in Figure 6. A total of 21 people in the experimental group showed significant improvement in learning interest, while only 8 people in the control group. Because each student’s learning ability, physical fitness, and personal experience are different; therefore, individual differences are observed. After comparison, the improvement of students’ learning interest in the experimental group is much higher than that in the control group.

This study analyzes the changes of students’ physical education learning attitude after colleges and universities use the proposed “six-pronge” intelligent physical education classroom model. This includes taking the initiative to communicate with other students and teachers whether to preview physical education courses in advance, whether to practice after the class, and whether to take physical training as a way of personal exercise. The statistics of students’ learning attitude in the experimental group are listed in Table 3 and the survey results of the students in the control group are shown in Table 4. The results show that compared with the control group, the experimental group has more communication times, more active classroom atmosphere, and more mutual communication with teachers [26]. The experimental group submits physical training assignments through the intelligent physical education classroom platform, and the teachers will score according to the students’ completion. After physical education teaching, the students in the experimental group and the control group were asked again whether they would like to continue reading and exercise in the later stage or not. Most of the students in the experimental group expressed interest in the physical education and would take the initiative to learn and exercise later, while the students in the control group were observed less interested.

5.3. Analysis on the Role of Intelligent Physical Education Classroom Model. Based on the “six-pronge” intelligent physical education classroom model constructed above, this
study analyzes its role in college physical education classroom. According to the survey results of the students who participated in the survey, the obvious effects are to simplify the pre-class preparation process, facilitate after-class evaluation, simplify after-class review, and facilitate teachers’ classroom teaching. The corresponding proportions of each role are 81, 77.6, 66, and 58%, respectively. Moreover, the proportion of the intelligent physical education classroom that can effectively urge learning is 48.5, and 41% help find more learning resources. The details of the outcomes are shown in Figure 7

### 6. Conclusions and Future Work

Nowadays, in the era of wisdom, rapid development of cloud computing, big data, Internet, and other technologies has accelerated the reform stage of intelligent physical education classroom in colleges and universities. Under the enlightenment of smart classroom and smart education, colleges and universities gradually open the reform mode, and introduce the smart education mode into physical education classroom teaching. In this study, we designed a “six-pronge” smart physical education classroom system in colleges and universities, and clarified the “six-pronge” teaching content. Moreover, we used the human body movement pattern based on sensors to identify the training of students in physical education classroom, and obtained the accurate movement of students. Teachers can guide students’ training according to the data. Teaching institutes like colleges and universities should build intelligent terminal equipment platforms according to their own situations, establish the main structure of the college smart sports classroom, and establish a smart sports classroom-teaching model on this basis [27].
To verify the effectiveness of the proposed model, this paper investigated and analyzed the students who use smart sports classroom in colleges and universities, and sets up a control group. Approximately, 40 students were randomly selected to analyze their feelings of classroom-teaching atmosphere, students’ learning interest, and learning attitude, and the role of smart sports classroom model. The results showed that the students in the experimental group are higher than those in the control group in all aspects, which fully reflects the practical application effect of smart sports classroom in colleges and universities. We believe that our intelligent model can provide an important practical basis for the construction of smart sports classroom in colleges and universities. In the future, we will use more advanced learning algorithms so that the model can be integrated for accurate results. Similarly, the experimental and control groups have few students that could be increased for generalization of the obtained outcomes. Additional evaluation metrics should be used to strengthen the research findings. As a future work, we will work on the real implementation of the proposed intelligent model in teaching institutes [28]. However, before that, the model training times, as well as, prediction durations should be investigated. This could be related to the number of students in each group and the amount of data collected from the sensors.

Data Availability

Data are available on request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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