EAI Endorsed Transactions
on Pervasive Health and Technology
Research Article EAI.EU

Wearable Sports Smart Glasses Real-time Monitoring and Feedback Mechanism in Physical Education

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Abstract

INTRODUCTION: With the continuous development of science and technology, wearable technology has been more and more widely used in various fields, including physical education. As an emerging technological tool with real-time monitoring and feedback capabilities, wearable sports smart glasses provide a new possibility for physical education teaching. This study aims to investigate the application of wearable sports smart glasses in real-time monitoring and feedback mechanisms in physical education teaching.
OBJECTIVE: This study aimed to evaluate the effectiveness of wearable sports smart glasses in real-time monitoring and feedback mechanisms in physical education teaching and to explore their potential to improve students' motor skills and teaching effectiveness. It enhances the quality of physical education teaching in China from the perspective of sports medicine equipment and solves the problems of poor quality of physical education teaching and easy injury of athletes in China.
METHODS: First, many physical education teaching scenarios were selected, and many students were invited to participate in the experiment. Then, wearable sports smart glasses are applied to the teaching process, and students' movement status, posture, and skill performance are monitored in real-time through their built-in sensors and software, and the data are fed back to teachers and students. At the end of teaching, the data were collected and analyzed to assess the impact of wearable sports smart glasses on students' sports performance and teaching effectiveness.
RESULTS: The experimental results showed that wearable sports smart glasses could accurately monitor students' motor posture and skill performance and provide timely feedback to teachers and students. Through real-time monitoring and personalized feedback, students' motor skills were effectively improved, and the teaching effect was significantly enhanced. Students also showed high acceptance and enthusiasm for this new teaching method.
CONCLUSION: Wearable sports smart glasses have the advantages of real-time monitoring and personalized feedback in physical education teaching and can effectively improve students' motor skills and teaching effectiveness. Therefore, it is of great significance to apply them in physical education teaching, which is expected to promote the development of physical education teaching in the direction of digitalization and intellectualization.

Keywords: wearable medical devices; sports smart glasses; physical education; sports medicine

Received on 12 February 2024, accepted on 21 April 2024, published on 26 April 2024

doi: 10.4108/eetpht.10.5531_____

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1. Introduction

In the rapid development of the information age, smart devices have profoundly impacted fitness methods and physical education. Traditional fitness methods are gradually being replaced by intelligence, data, and personalization[1]. The combination of smart devices such as sensors and mobile apps can continuously record and analyze changes in users' behavior, location, and physical performance and provide individuals with appropriate fitness advice, thus making the fitness process more scientific and personalized[2]. In physical education, the application of intelligent wearable sports smart glasses has injected new vigor into teaching. These devices include 3D modeling functions and can facilitate teachers' and students' learning of technical functions from a third-party perspective, providing a new concept and method for teaching[3]. Therefore, using smart devices injects new vitality into traditional physical education and brings new challenges and opportunities.

The Chinese government proposed a plan to develop innovative fitness for all in 2019, aiming to build intelligent fitness paths and innovative sports parks. Smart sensors are widely used in fitness equipment and parking lots, capable of objectively and accurately presenting workout results based on the duration and intensity of the user's activity, providing scientific guidance and direction for fitness, which is highly popular among spectators and users[4]. Traditional teaching methods and processes often make it difficult to arouse students' interest in physical education in schools. However, with the use of sensors and electronic devices, students participate in the learning process through wearable devices, which improves learning efficiency and dramatically increases their interest in physical education courses[5]. In summary, the use of smart devices has opened up entirely new possibilities for fitness styles and physical education, facilitating the industry's development while posing new challenges to be addressed[6]. Introducing technologies such as artificial intelligence and wearable sports smart glasses on campuses offers teachers and students new learning methods. Portable devices and mobile applications require Bluetooth as an information and communication tool[7]. Accurate real-time feedback can be provided by combining real-time communication capabilities and large amounts of mobile data analysis with accurate and objective feedback from wearable sports smart glasses [8]. On the other hand, it is an innovative approach to learning that not only encourages students to learn and acquire specialized skills but also combines modern online technology with physical education.

In the age of big data, combining new learning methods can provide new insights into exercise. Wearable sports smart glasses and mobile apps can collect, process, and analyze data. A mobile app is a mobile application that connects to a device connected via Bluetooth and displays information on a cell phone. At the same time, the app provides 3D simulation animations that show the students' movements and fluctuations in real-time, facilitating the learning of technical movements[9]. The combination of the device and the mobile app can produce more scientific and accurate sports data and provide teachers with a wide range of physical education methods[10]. Exercise is a long and repetitive process. Technical measures are often repeated to create muscle memory and applied rigorously to real-life situations. Students play to help them understand and master their physical skills.

2. Relevant studies

Since the 1960s, the device has been developed and applied in various fields, and its research value and application possibilities are being gradually explored. It rapidly attracted widespread attention in science and industry and slowly gained a place in many fields, including industry, health, military, education, and entertainment. Around the 1950s, the technology field saw a revolutionary innovation in wearable sports smart glasses[11]. Based on their special sensors mounted on the user's body, these devices enabled the recording of people's daily behavior and physical condition for the first time, thus ushering in a new era of human interaction with technology. The so-called wearable sports smart glasses refer to a class of computerized devices that integrate a variety of technologies and whose function is to transmit information about the user's body or the clothes they are wearing. These devices incorporate a variety of technologies, including various detection, monitoring, data connectivity, and cloud technologies, to enable the processing and analysis of data, thus allowing users to perform a variety of functions such as infotainment, community sharing, and personal health monitoring through these devices[12]. One of their most notable features is their comfort level, enabling users to wear them for long periods without discomfort. The most popular wearable products on the market today mainly include smart glasses, smartwatches, and intelligent clothing[10]. With people's growing concern for quality of life, wearable technology is gradually becoming a hot topic for research and attention, and various innovative products are emerging. Users can enjoy a variety of conveniences with these devices, such as inertial sensors, pedometers, pressure switches, and heart rate monitors, among which inertial sensors are most widely used. In the future, intelligent wearable products will be further intelligentized, integrating various functions such as human health monitoring, data transmission, human-computer communication and interaction, and becoming a product of the profound fusion of different technological fields to meet the multifaceted needs of humans[13]. At the same time, new industrial facilities are actively exploring and applying these advanced technologies in various fields. These technologies utilize multiple sensors to store data when a person or object moves and analyze the data through databases to keep and notify users of relevant behaviors[14]. With the rapid development of technology and the overcoming of various difficulties, recent technological

advances have shifted from the "smart" direction to the "wearable" direction[15]. By connecting a Bluetooth device to a cell phone, wearable technology can bring more convenience and possibilities to people's lives through multi-functional applications that meet the different needs of users.

Depending on the purpose of use, portable devices can be divided into two categories. One category is the wearable smart sports glasses based on knowledge and entertainment, which are very miniature electronic devices that one can use with the help of computers, communication, and touch technologies[16]. In addition, jacket rollers activate the connection with the clothes and allow the user to create different sounds by touching and moving other buttons so that people can imagine or improvise music anytime, anywhere. Installing sensors on the clothing allows users to share their students' joy more efficiently [17]. In addition, use the built-in Bluetooth to connect your phone to the watch. In addition to recording training data such as speed, heart rate, and calories burned, the watch can synchronize certain phone functions with the watch, including calls, text messages, QR code payments, and more[18]. Innovative headsets connect electronic devices such as computers and cell phones to Bluetooth devices and support and connect to Bluetooth through specific software features[19]. The second category is mainly used for health testing devices.

3. Research methodology

3.1 Wearable sports smart glasses design

After reviewing a lot of literature and questionnaires related to other studies, the understanding of the study was deepened by developing a questionnaire about students' physical behavior and intelligent wearable device use. Based on Psychological Communication Satisfaction and Self-Efficacy Theory, the questionnaire was divided into four sections: basic knowledge of students, apparent motor behavior, normal motor behavior, and use of smart devices. A specific questionnaire on the physical behavior of the participants was developed, which included three indicators: duration of exercise, frequency of training, and intensity of exercise. The motor behavior survey was based on the Motor Behavior Scale, and three dimensions were selected: motor behavior, behavioral perceptions, and behavioral management awareness. The assessment criteria were based on a questionnaire about students' hidden physical behaviors on a subject-specific scale of 1-5. Individual assessment was based on a personal understanding of biological behavior. The questionnaire identified six indicators: type, use, operation, duration, frequency, and duration of intelligent wearable devices.

Stratified sampling and random questionnaires were used to survey students from different schools in Hunan Province. The subjects were from different genders, classes, schools, orientations, and places of birth. The specific process of the survey was as follows: in August, a preliminary survey was conducted using questionnaires, and 353 general incomplete questionnaires were collected. The data was analyzed before the study, and the questionnaire was edited to remove topics that did not match the survey content before creating the official questionnaire. The official questionnaire, published in September 2021, utilized a multilevel sampling method selected from ten colleges and universities. The questionnaires were sent out randomly, totaling 958 with 97% validity. Sensors measure the user's body data and external pressures such as heart rate, blood pressure, oxygen, body temperature, air pressure, and rhythm. Intelligent wearables can also include features such as seat reminders and sleep tests. Researchers in many countries are continuously working on wearable AI products to prevent certain cardiovascular diseases rapidly. In addition, some researchers in rehabilitation education have invented a rehabilitation bra for spinal injury patients. It can reflect the curvature of the patient's spine and give appropriate instructions based on the user's movements. The institute has developed a knee-guided training support device called PT Viz, which can determine how much a patient squats during use and guide the patient through rehabilitation exercises. Objective and accurate external information from the device used can help athletes adjust their training based on this information, enabling coaches to develop more detailed training programs based on this information. Wearable sports innovative medical device testing is shown in Figure 1. Wearable sports are an innovative medical device testing process, as shown in Figure 2. The measurement site of the wearable sports smart glasses is shown in Figure 3.

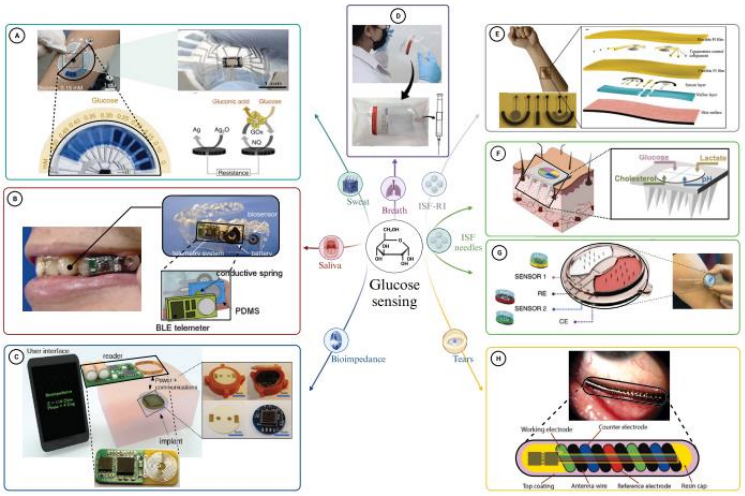

Figure 1 Wearable sports intelligent medical device testing[20]

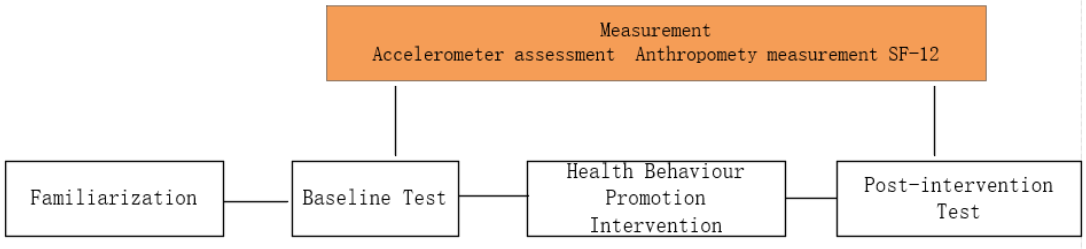

Figure 2 Wearable sports innovative medical device testing

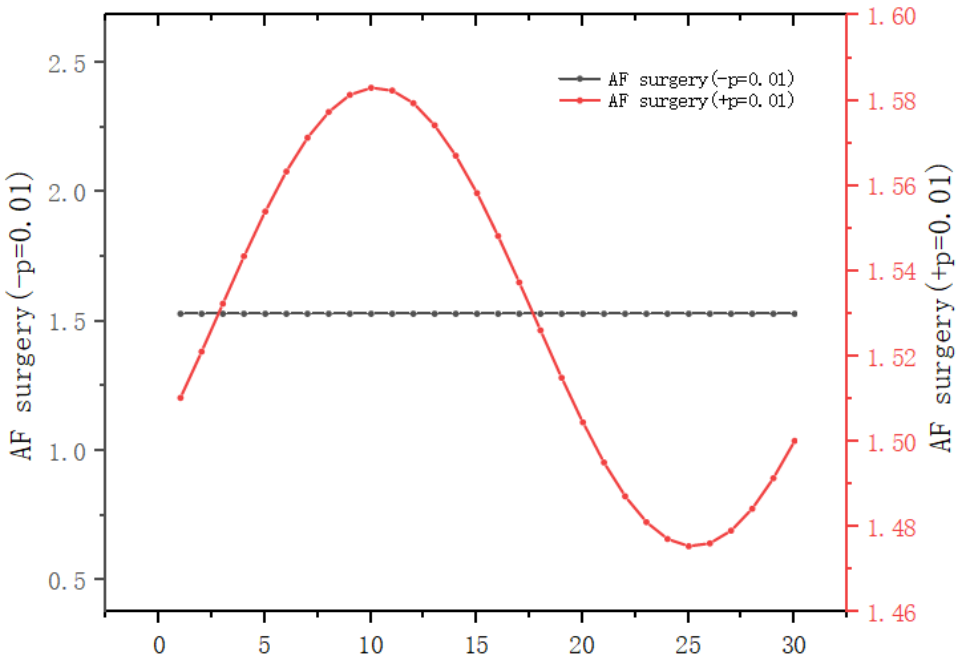

Figure 3 Measurement site of wearable sports smart glasses

3.2 Wearable Sports Smart Glasses Network Connection and Data Transmission

After collecting the questionnaires, the relevant data were categorized, saved, and analyzed using SPSS 25.0. The data were analyzed using descriptive statistics, independent t-control samples, crosstabulation (Nain test), one-way ANOVA, and correlation analysis to create graphs that directly reflect the essential characteristics of the data. The study analyzed the current status and demographic differences in the physical behaviors of students using smart wearable devices. Crosstabulation methods were used to analyze behavioral differences (time, frequency, and intensity) among students who used intelligent wearable devices for learning. Univariate analyses examined differences in hidden physical behaviors (attitudes, perceptions, and material behavior management) among smart wearable device students. Appropriate analytical methods were used to analyze the relationship between students' physical behaviors and intelligent wearable device use. There were significant differences in exploring the differences between the two, but no significant differences. The correlation analysis showed a high correlation between the two when the r-value was more critical than 0.8. When the r value is between 0.3 and 0.8, there is a weak correlation and average correlation between the two; if r is less than 0.3, there is a weak correlation. Their relationship is statistically significant, while the relationship between them is not.

Traditional sport is an educational process that includes teacher and student training, especially in technical sports. Teachers begin by explaining the function of the technique and use simulation exercises and student- and teacher-led demonstration models. Although this learning method can help students master technical movements, the learning process is too long and monotonous, especially for beginners. It is not easy to maintain and is not conducive to students' acquisition of motor skills. Mobile apps are an innovative and attractive way of engaging students by displaying them in real time on a mobile screen through mobile apps and using 3D animations to simulate student activities. Secondly, students can understand the changing attitudes towards technical activities by teaching new technical activities. Multiple perspectives and directed animations enabled students to learn more about the data. The instructor's guidance helps students to learn and reinforce the technical activities and to continuously improve the consistency, coordination, and standardization of the technical activities; at the end of the course, students are free to practice and challenge themselves with the advanced modules of the mobile application, which are enriched with self-study and improve their self-study skills—the design principle of the wearable sports smart bracelet, as shown in Figure 4.

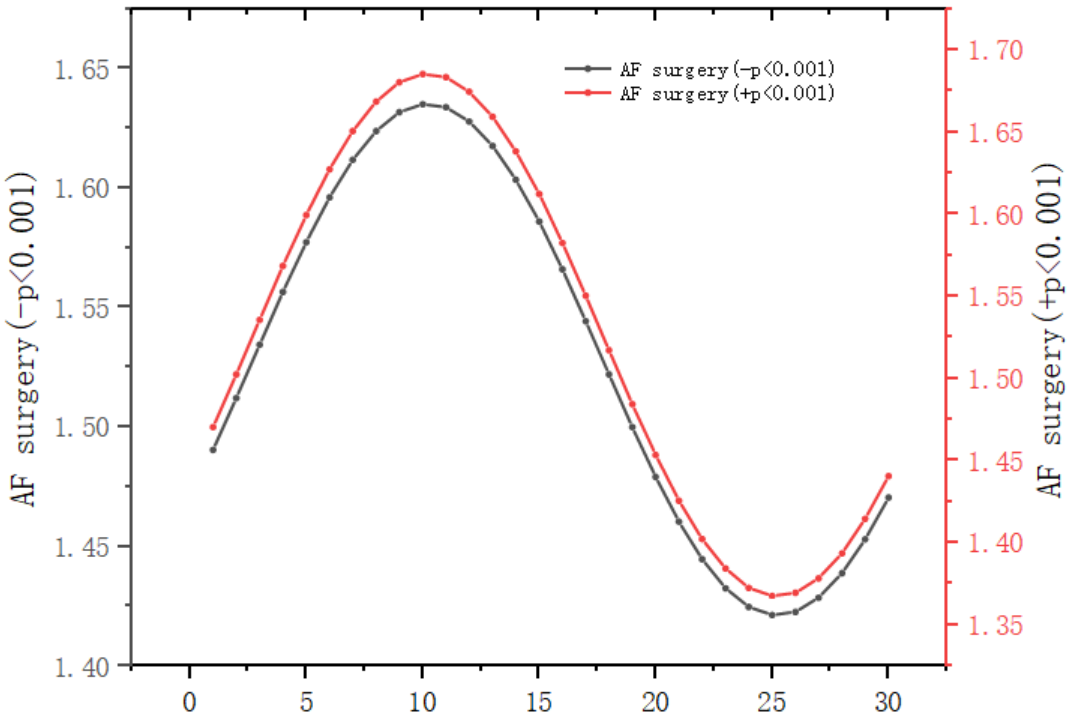

Figure 4 Wearable sports innovative bracelet design principle

The real-time monitoring and feedback mechanism system for physical education is modeled as follows:

$$x_j' = x_i + \phi_i(x_i - x_p) \quad (1)$$

Equation (1) $\phi_i(x_i - x_p)$ expresses the statistics of the random coefficients on the difference.

$$C = \frac{\sum_1^n C_i}{n} \quad (2)$$

$$F_i = e^{-\frac{C_i}{c}} \quad (3)$$

$$p_i = \frac{F_i}{\sum_1^n F_i} \quad (4)$$

Equation (2) is a weighted average calculation of *C*, which yields the mean value of *C*. In Equation (3), *F* is a surrogate value for the limit of the exponential function of e. In Equation (4), *P* is a calculation of the shock value for the limit of the *F* function.

$$d_i = \arg\min_j d\left(N_j, N_i\right), i = 1,2,3...n, i \neq j \quad (5)$$

In Equation (5), di is the calculation of the residual term of the least squares of the algorithm.

4. Experimental results and discussion

4.1 Other designs for wearable sports smart glasses

These devices play a substantial role in daily use and gradually expand into the field of health monitoring, providing people with more comprehensive health management solutions. In the initial stage, these smart devices were mainly used to collect data on users' daily activities, such as smartwatches to record step counts and smartphones to track exercise, providing users in-depth knowledge of their lifestyles. However, with the gradual maturation of the technology, the scope of application of these devices is rapidly expanding to medical devices. Modern medical devices can monitor vital signs and conduct more complex health assessments, providing more objective data for doctors to diagnose and formulate treatment plans more accurately. On the other hand, with the help of foreign technologies, modern monitoring and rehabilitation were introduced into sports and physical activity. The application of this technology not only enables researchers to access athletes' training data but also to develop more accurate training programs. In sports rehabilitation, these smart devices provide objective data to assist athletes in making timely adjustments during the rehabilitation process to minimize the risk of injury during training. However, studies on students' physical test results showed that neither traditional teaching methods nor portable devices could significantly improve the physical abilities of the test and control groups in a short time. Although some progress was made in the long jump, one-minute rope skipping, and 50-meter dash, overall, there was no significant improvement in the student's physical condition. This finding suggests that physical education may have a limited impact on student's physical condition in the short term.

However, in terms of student movement tests, the experimental and control groups significantly improved advanced ball skills. In particular, the experimental group performed much higher than the control group on the extended ball skill test, suggesting that traditional and handheld device instruction positively improved long ball skills. This provides valuable insights for future physical education, i.e., different teaching methods may positively affect students differently, which needs to be further studied and explored in depth. The equipment used is essential in promoting high and long ballooning techniques. High and long balloons are the most critical technical exercises for athletes. The stability and coordination of the flywheel movement play a supporting role in the study of technical movements such as cutting, gripping, and impacting. Teachers demonstrate the skills of their students before and after class while the students imitate and learn from them. Students practicing the swing must rely on their senses and cannot analyze it accurately. In physical education, testing groups show students 3D simulation animations and motion vectors based on motion models. Students can understand and adjust their technical movements from different directions and perspectives, facilitating the learning and repairing of various swing techniques, helping students develop proper driving and swing visualizations, and promoting state-of-the-art learning. The higher the force, the faster the speed, and the more significant the impact (within limits). Due to the limitations of their abilities, it is difficult for students to achieve an impact effect by pressing and rotating their elbows to improve their swing. In short, portable devices are more effective than traditional learning methods when high school students learn mid-length ball skills.

The experiment results showed that the experimental and control groups showed significant improvement after the experiment. The experimental group's results were significantly higher than those of the control group, which was taught using the traditional teacher-model teaching method and student simulation. Some students were not clear about the point and time of impact of cutting and hanging, which led to slow progress. People can only roughly control the movement of the lever but cannot accurately understand the wrist's movement. During training, students in the experimental group could use data collected in the app and real-time 3D simulation animations presented in the mobile app to track students' movements and swings, independently determine technical movements, and understand shooting techniques. Create technical

breakthrough actions to facilitate learning and management of technical actions.

4.2 Test results

The results of the physical therapist's experiment showed significant improvement in the ability of the choice test and control groups after the test. Students in the experimental group had much higher choice test results than those in the control group, suggesting that traditional and portable learning methods can improve students' choice skills but that mobile devices significantly impact students' choice skills. For an upward-sloping trajectory, students needed to assess the correct position of the free-fall hitting maneuver to perform the technical manipulation of the ball and were taught more effectively than the control group. In short, portable devices were better than traditional learning methods.

From the results of the experiment, it can be concluded that at the end of the experiment, the results of the experimental and control groups were significantly higher than those of the control group. Traditional and wearable learning methods can improve internet technology in physical education, but wearable sports smart glasses play an essential role in technology. In ball sports, the upper arm and forearm lift the ball backward, while the net in front of the net is based on the weight of the action itself and bounces back to the bat's surface through which the ball passes. Students in the control group could not comprehend the forces on their wrists and fingers, which meant that the ball did not meet the pre-test requirements. Students can strengthen the darting action to improve their starting position and punch delivery continually. When collecting the actual data, due to the accuracy and roundness of the sensor and the poor technical performance of the front grill mounting, it was not possible to accurately measure the strength of the front grill layout, which utilizes the elasticity of the bat surface to feed the ball into the net. If the value is more significant than "1", it can be reflected horizontally to improve the network's technical performance and help students understand and learn the network technology. In short, portable devices are better than traditional learning methods. The sports medicine design mechanisms 1, 2, 3, and 4 for wearable sports smart glasses are shown in Figures 5, 6, 7, and 8.

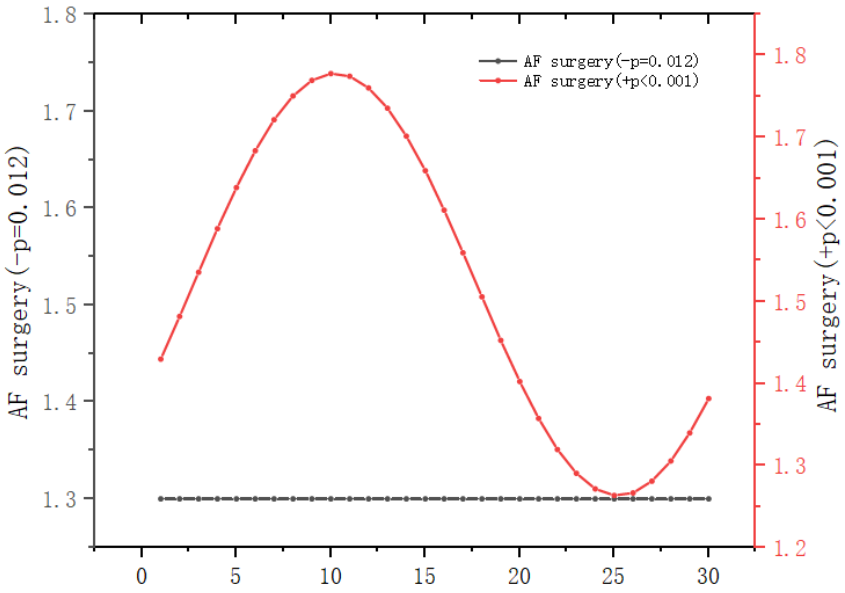

Figure 5 Sports medicine design mechanism for wearable sports smart glasses1

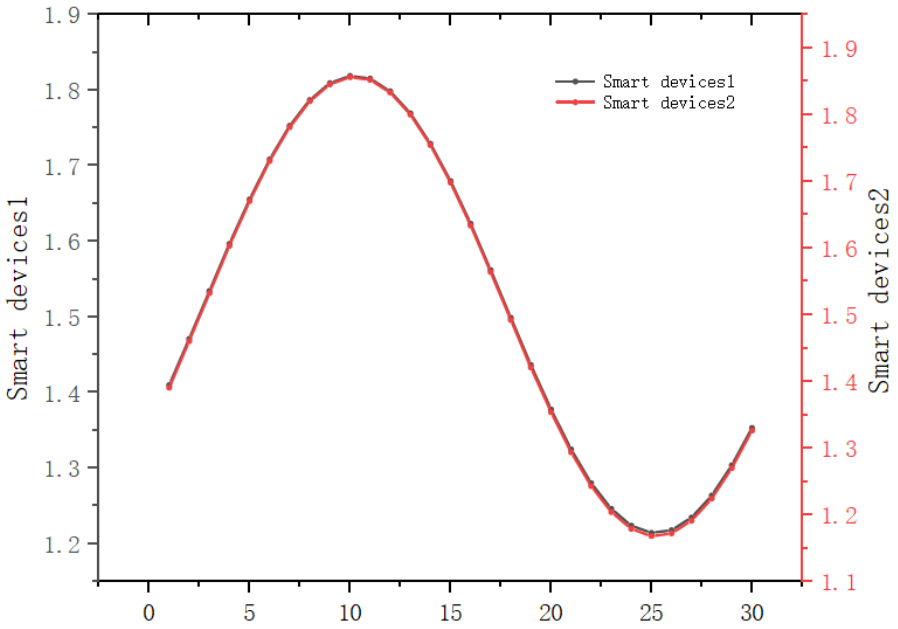

Figure 6 Sports medicine design mechanism for wearable sports smart glasses2

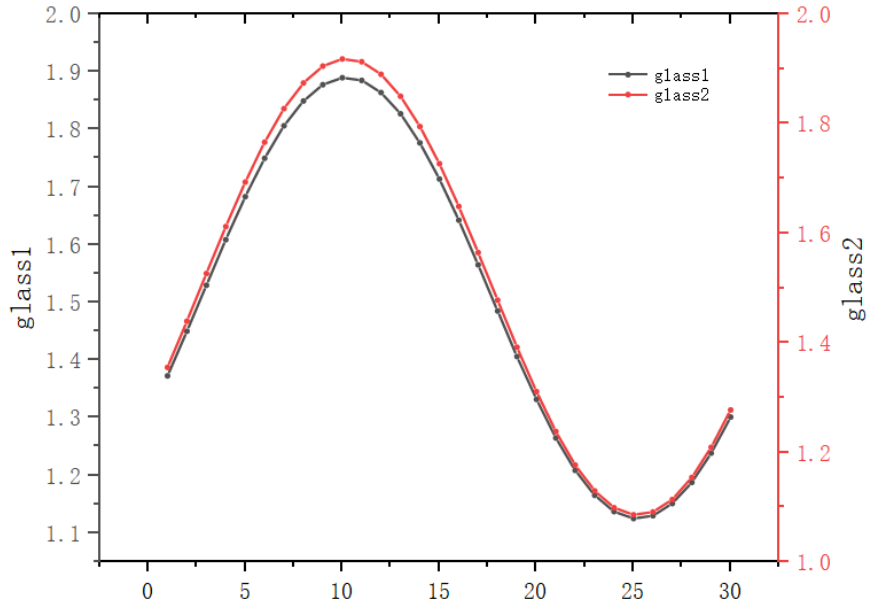

Figure 7 Sports medicine design mechanism for wearable sports smart glasses3

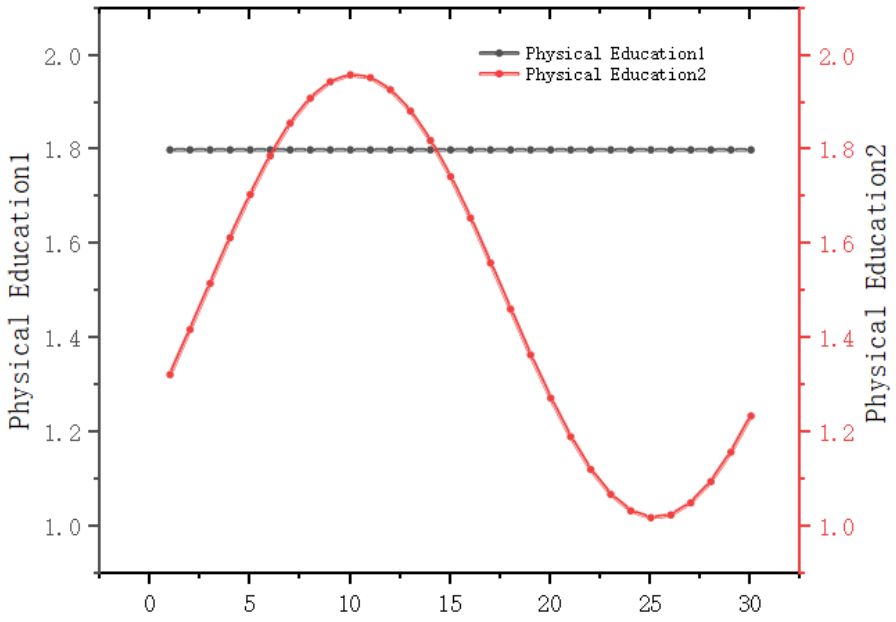

Figure 8 Sports medicine design mechanism for wearable sports smart glasses4

Portable devices are widely used in many areas, but few have attempted to teach high school students to exercise. Currently, most physical education teachers use a classroom model that mimics student learning and rarely use textbooks to teach physical education. In this compelling exercise test, the students in the test group succeeded in realizing the students' expectations through the sophisticated use of wearable sports smart glasses and declared the training performed to be significantly innovative. Negative learning attitudes are often rooted in multiple factors, including ambiguity of learning goals, limited learning time, lack of physical and mental energy, and inadequate curriculum. While learning traditional exercise methods, some students become frustrated due to poor coordination and poor athletic conditioning, leading to numerous technical movement errors. However, in addition to training in technical movements, physical education learning for students needs to stimulate a strong interest in the subject and develop a suitable learning method to promote the development of their sports thinking. In the course of the study, it was observed that students in the experimental group showed higher levels of concentration compared to the control group, which could be attributed to the teacher's ability to interact with the students through visual communication, continuous monitoring of the mobile application, and emphasizing measures to enhance students' technical skills. Therefore, learning is about improving students' creative qualities and scientific learning methods, which are essential to strengthening students' independent learning abilities. During the training process, students in the experimental group began to learn specific technical movements and independently mastered the core points of technical movements, including theoretical knowledge and skill assessment, through the mobile application. This series of innovative methods enriched students' learning experiences and laid a solid foundation for their future learning and development.

To summarize, by introducing innovative teaching methods and technical means in physical education learning, the author can effectively promote students' learning effect and independent learning ability and lay a solid foundation for their future development. Based on lectures, students could quickly understand and mimic the teacher's technical movements and actively participate in home vibration training using tools outside the curriculum. Students also practiced transition swings through the mobile system for independent training, actively learning and promoting the creation of independent swing movements.

Happy sports training means students can express their emotions, individuality, and creativity, increase confidence, and develop healthy personalities. Wearable sports smart glasses in experimental group teaching can effectively mobilize students to combat drowsiness. Different learning methods allow students to feel happy during the learning period and actively cooperate in completing the course. Students were active in physical activity before, during, and after school, which makes physical activity more critical than traditional teaching methods. The six dimensions of the physical education context are interconnected and interactive but ultimately inseparable from the student. Research has shown that intelligent wearable sports smart glasses can facilitate learning physical education techniques and positively impact the classroom environment. Experimental results show that wearable sports smart glasses can accurately monitor students' motor posture and skill performance and provide timely feedback to teachers and students. Through real-time monitoring and personalized feedback, students' motor skills were effectively improved, and the teaching effect was

significantly enhanced. Students also showed high acceptance and enthusiasm for this new teaching method.

5. Conclusion

This study explores the application of wearable sports smart glasses in real-time monitoring and feedback mechanisms in physical education teaching. First, the real-time monitoring effect of wearable sports smart glasses in physical education teaching shows remarkable accuracy and timeliness. With built-in advanced sensors, these glasses can capture students' movement status, posture, and skill performance and deliver the data to teachers and students in real-time. This gives teachers a more comprehensive view of their students' movement processes, contributing to more targeted instructional guidance. Second, through real-time monitoring, wearable sports smart glasses provide a personalized feedback mechanism for teachers and students. Teachers can provide timely advice and guidance based on student's performance, while students can get instant self-evaluation during the exercise process. This kind of personalized feedback improves teaching effectiveness, stimulates the students' learning motivation, and promotes their better understanding and mastery of motor skills.

Further analysis of the experimental results shows that the sports teaching method of real-time monitoring and feedback through wearable sports smart glasses effectively improves the students' motor skill level and significantly improves the overall teaching effect. Students show higher learning motivation and subject interest in this intelligent teaching environment, while teachers can carry out personalized counseling in a more targeted manner, making teaching closer to students' needs. Overall, the real-time monitoring and feedback mechanism of wearable sports smart glasses in physical education has introduced a new digital and intelligent teaching means. However, when applying this technology, one still needs to pay attention to data privacy protection, equipment cost, etc. Further research and practice will help more comprehensively assess its applicability in different educational contexts and promote physical education teaching in the direction of more intelligent and personalized learning. In the future, it is expected that this technology will play a more significant role in physical education and provide students with a better and more customized teaching experience.

Acknowledgements.

This work was supported by University-level research projects of Yili Normal University in 2022：“*An experimental study of exercise intervention based on students' fitness test results*”（NO:2022YSYB029）

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