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The application and practice of artificial intelligence in promoting the development of physical education in colleges and universities: a review

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Abstract

With the rapid development of artificial intelligence (AI) technology, its application in college physical education has gradually shifted from marginal exploration to system integration. Based on literature review, case study and empirical data analysis, this paper systematically explores the multi-dimensional application of AI technology in college physical education, including sports performance analysis, personalized training, teaching management optimization and intelligent evaluation. The results show that AI can effectively improve teaching efficiency, scientific training and objectivity of evaluation, while promoting the precision and fairness of physical education. Through surveys and data comparisons of multiple colleges and universities, this paper verifies the significant effectiveness of AI in improving students' sports performance, reducing sports injury rates, and improving classroom organization efficiency. At the same time, the article also points out the challenges of current applications, such as infrastructure shortage, insufficient digital literacy of teachers, low algorithm transparency and data ethics concerns. Based on this, this paper proposes a path to promote the deep integration of AI into physical education from four dimensions: system construction, teacher empowerment, technology development and data governance. The study believes that AI will play the role of "intelligent engine" in future college physical education, promoting the transformation of the education paradigm from experience-driven to data-driven.

Keywords: artificial intelligence; college physical education; personalized training; teaching management; integration of educational technology

1. Introduction

With the implementation of the Healthy China 2030 and the "Strong Sports Nation" strategy, how to improve the quality of physical education in colleges and universities and enhance students' athletic ability and comprehensive quality has become an educational issue that needs to be solved urgently. The traditional sports teaching model relies more on the experience of teachers and the self-effort of students. Although it can improve students' physical fitness to a certain extent, it fails to fully consider individual differences and lacks targeted training programs [1]. With the rapid development of AI technology, its application in the field of education, especially in physical education, has gradually expanded. AI technology can provide personalized teaching, accurate feedback, intelligent evaluation and other multi-dimensional support through big data analysis, deep learning and intelligent equipment, breaking the limitations of traditional teaching models [2]. The application of artificial intelligence in physical education not only includes sports performance analysis and the design of personalized training programs, but also covers teaching management, intelligent evaluation, teaching resource allocation and other aspects. By introducing AI technology, real-time data feedback, personalized training, sports health monitoring, etc. can be realized in teaching, greatly improving the scientificity and accuracy of physical education [3]. However, despite the broad application prospects of AI technology, many colleges and universities still face problems such as insufficient hardware facilities, weak technical ability of teachers, and data security risks in actual application. Therefore, this paper aims to comprehensively explore the current status, effects, challenges and future development directions of artificial intelligence in college physical education through literature review, data analysis and case study.

2. Materials and Methods

2.1 Literature review

Artificial intelligence technology has made breakthroughs in many fields, especially in the field of education, where AI technology is gradually changing the traditional teaching model. The application of AI in sports education is relatively new, but with the maturity of technologies such as deep learning, computer vision, and natural language processing, more and more research has

begun to explore the potential of AI in sports teaching [4]. AI technology, especially deep learning and computer vision, has made significant progress in the application of sports performance analysis. Deep learning technology can accurately identify the standardization and efficiency of movements by analyzing students' sports data and provide real-time feedback. For example, some college basketball courses use AI to analyze shooting movements. The AI system captures students' movement trajectories and postures, uses computer vision technology to evaluate them, and then provides students with personalized movement optimization suggestions [5]. Studies have shown that this technology not only improves students' shooting accuracy, but also helps students quickly identify and improve common mistakes in sports. In addition, AI sports performance analysis technology has also been applied to football, gymnastics, track and field and other projects. It can analyze students' running speed, jumping height, movement angle and other indicators in real time, and dynamically adjust training intensity according to data changes during exercise [6]. The application of this technology, especially in data collection and processing, has broken through the limitations of traditional methods and greatly improved the scientific nature and personalization of training.

The combination of AI technology and smart devices has provided a new solution for personalized training. Smart wearable devices, such as smart bracelets, motion sensors, and heart rate monitors, can collect students' exercise data in real time and transmit this data to the AI system for analysis and processing. By analyzing each student's physical fitness level, exercise habits, and training results, AI can automatically generate personalized training plans and adjust the training content in real time according to the student's progress. This personalized training method not only takes into account the differences in students' physical fitness, but also dynamically adjusts the training intensity to avoid sports injuries and improve training results [7]. A university introduced AI-based smart sports equipment to help students with physical training. AI provides real-time feedback on training intensity based on students' heart rate, exercise load and other data, and makes corresponding adjustment suggestions. The study found that after the AI-guided training model, the students' physical fitness level increased by an average of 18%, and the incidence of sports injuries was significantly reduced.

AI technology can not only improve the personalized effect of physical education, but also optimize teaching management. AI systems can help teachers

monitor students' sports performance and learning progress in real time, predict students' learning status through data analysis, and adjust teaching content and strategies in a timely manner. AI can also help teachers efficiently manage teaching resources, optimize classroom time allocation, and improve teaching efficiency. In a physical education course at a certain university, AI technology is used to manage student attendance, participation, and performance evaluation [8]. The AI system automatically records students' classroom performance and provides real-time feedback on students' learning progress, helping teachers to identify students' learning difficulties in a timely manner and make adjustments. The results show that the introduction of the AI system not only improves classroom management efficiency, but also improves students' participation enthusiasm and learning effects.

AI's intelligent assessment function makes the assessment of physical education more scientific and objective. Traditional sports assessment relies heavily on teachers' subjective judgment, while AI can provide a more accurate and standardized assessment system through data analysis and model prediction[9]. By using AI to analyze students' sports data, teachers can quickly understand students' sports level, skill mastery, and physical fitness development trends, thereby providing tailored feedback to each student. In some college physical education courses, the AI assessment system can not only assess students' sports performance, but also assess students' psychological state, athletic ability, and other dimensions[10]. This comprehensive assessment method helps teachers understand students' learning situation more comprehensively and provides data support for subsequent teaching improvements.

2.2 Data Analysis and Empirical Research

In order to verify the application effect of AI in physical education in colleges and universities, this paper combines empirical data from multiple colleges and universities to conduct quantitative and qualitative analysis on the application effect of AI technology in different physical education courses.This empirical study selected physical education courses from 12 different colleges and universities as the research objects, including students and teachers. In each college, sports performance analysis systems, intelligent evaluation systems, personalized training systems and other technologies based on AI technology were selected for testing, and relevant data were collected. Data sources include

students' sports performance data, physical fitness test data, classroom participation data, student satisfaction survey data, etc.

In order to evaluate the effect of AI technology in physical education, this paper adopts the before-and-after comparison method. By comparing the data changes before and after the introduction of AI technology, the impact of AI technology on students' sports performance, learning effects, classroom participation, etc. is analyzed [11]. At the same time, combined with the student satisfaction survey, the students' acceptance and cognition of the application of AI technology in physical education are evaluated. By statistically analyzing the collected data, this paper uses methods such as analysis of variance and regression analysis to analyze the impact of AI technology on the improvement of students' sports performance, changes in learning enthusiasm, and classroom management efficiency [12].

In order to further verify the actual application effect of AI technology in physical education in colleges and universities, this paper selects cases from multiple colleges and universities for detailed analysis. The case content includes the application of AI in courses such as basketball, football, gymnastics, and physical training, covering multiple aspects such as the implementation process of AI technology, adjustment of teaching strategies, student feedback, and effect evaluation. In a basketball training course at a certain college, AI technology is applied to sports performance analysis and personalized training. The AI system uses smart cameras to capture students' shooting movements in real time, analyzes the standardization of movements, shooting angles, etc., and provides personalized optimization suggestions [13]. In a gymnastics course at a certain university, AI technology monitors students' movement techniques in real time, analyzes the standardization and accuracy of movements, helps students correct mistakes quickly, and improves their execution and skill mastery [14].

3. Results

In this study, based on literature review, field research and data analysis, the application effect of artificial intelligence in college physical education was systematically evaluated. The results will be described from three dimensions: sports performance analysis, personalized training and intelligent evaluation, and teaching management optimization and intelligent decision support. Each

dimension is based on real cases and statistical data, highlighting the role and potential of AI in actual teaching environments.

3.1 AI-based sports performance analysis: significant improvement in multi-dimensional indicators

Sports performance analysis is one of the most widely used areas of AI in physical education in colleges and universities. Through computer vision and deep learning algorithms, AI can collect and process students' motion data in real time during physical education courses, and evaluate indicators such as posture accuracy, movement amplitude, speed, and stability. Taking a Chinese university as an example, after introducing an AI posture analysis system in basketball teaching, a multi-model architecture combining OpenPose and YOLOv5 was used to track and evaluate students. The system automatically marked key movement nodes, generated vector diagrams, and compared them with standard models to evaluate differences [15]. The results showed that the average shooting accuracy of students increased by 17.3%; the average action completion time was shortened by 12.8%; and the action standardization score increased by 25%. In addition, after introducing the AI action recognition system in volleyball teaching, the hand shape accuracy of students' passing actions increased from 73% to 87%, effectively reducing the passing deviation caused by non-standard posture.

3.2 Personalized training and intelligent assessment system: precise intervention to improve training efficiency

Another core application of AI is the personalized training recommendation system. By modeling students' historical exercise data, real-time heart rate, basic physical fitness data, etc., AI can design personalized training plans for each student and adjust the training content and intensity in real time according to the data during the training process[16]. In the physical training course of a university in southwest China surveyed in this paper, an AI-driven smart wearable system was deployed for monitoring. The study found that students who were intervened by the personalized training system had an average improvement of 15.6% in the 800-meter running test; the improvement of students' sit-ups and pull-ups training was 21.4% and 22.2% respectively. The system incorporates biometric recognition and dynamic feedback mechanisms, and teachers can receive training suggestions and risk warning information in real time. The system is of great significance to the improvement of teaching precision and training safety.

Table 1. Results of AI precise intervention to improve training efficiency

Item	Average score before AI intervention	Average score after AI intervention	Improvement
800-meter run	3.12	3.61	+15.6%
Sit-ups	28 pieces/min	34 pieces/min	+21.4%
Pull-ups	18 pieces/min	22 pieces/min	+22.2%

3.3 Teaching management and intelligent decision support: optimizing classroom organization efficiency and feedback accuracy

In the teaching management link, AI helps teachers organize classes more scientifically and intervene in students' learning problems in a timely manner through technologies such as teaching behavior analysis, attendance tracking, and classroom performance scoring[17]. In a comprehensive university in South China that was surveyed, after the introduction of the AI physical education classroom management platform, teachers can grasp students' attendance, scoring curves, and training fluctuations in real time. Data from the AI platform showed that the student lateness/absenteeism rate decreased by 28.3%; the time teachers spent on post-class recording decreased by 41.7%; and the "classroom management efficiency" score in the teaching satisfaction survey increased from 3.7 points to 4.4 points (out of 5 points). More importantly, the platform integrates natural language processing technology, which can analyze students' classroom feedback texts and extract key information for optimizing teaching content. AI can also make suggestions for class division and learning path recommendations based on students' stage performance, providing an intelligent basis for stratified teaching[18].

4. Discussion

4.1 The core advantages of AI in empowering physical education in colleges and universities

The multi-dimensional application of artificial intelligence technology in physical education in colleges and universities has shown a significant empowering effect, which is specifically manifested in the four major characteristics of "precision, real-time, personalization, and data-driven". First,

AI has achieved "precise analysis" of sports skills. With the help of deep neural networks and posture recognition models (OpenPose, HRNet, etc.), the system can annotate and vector model multiple nodes of the human body, greatly improving the accuracy and coverage of action recognition [19]. This high-precision evaluation provides scientific support for error correction training in physical education teaching, allowing teachers to shift from traditional "experience judgment" to "model-assisted decision-making". Secondly, AI breaks the limitations of time and space and realizes "real-time response" of training feedback. Compared with the lag of teachers' after-class video review or manual scoring in the traditional mode, AI can capture, evaluate and generate feedback suggestions at the moment students complete the action, improving teaching interactivity and training efficiency [20]. Students can "practice and adjust" at the training site, significantly shortening the action improvement cycle. Third, AI supports "personalized adaptation" to achieve teaching in accordance with students' aptitude. The system models the training load through variables such as students' historical exercise data, physiological characteristics, and fatigue status, and formulates dynamic adjustment strategies to truly achieve "one plan for each student, one optimization for each exercise", which is a goal that is difficult to achieve in traditional physical education classes in large-class teaching situations [21]. Finally, AI has promoted the "data-driven transformation" of physical education. By building a learning situation database, the system can record students' training trajectories, performance fluctuations, skill development trends, etc. over a long period of time, provide teachers with a panoramic portrait, support process evaluation and target guidance, and provide decision-making basis for education administrative departments to allocate curriculum resources and evaluate quality.

4.2 Current challenges

Although the application of AI technology in physical education has achieved initial results, it still faces challenges at multiple levels in the process of promotion and deepening: First, the infrastructure is insufficient. Among the 12 universities surveyed in the sample, only 3 have a complete AI teaching software and hardware environment, and most of the others only have local equipment or rely on external platforms for experimental teaching. This shows that there is still a "regional gap" in the construction of AI platforms in colleges and universities, especially the allocation of AI teaching resources in local colleges and

professional colleges is relatively lagging. Second, teachers' acceptance of technology varies. AI systems require teachers to have certain data literacy and information technology operation capabilities. However, the survey questionnaire shows that 43% of physical education teachers said that "it is difficult to use AI-assisted systems proficiently", of which 12% of teachers have a rejection of AI technology, worrying that it will replace the dominant position of teachers or increase the teaching burden. At present, most AI products still require manual intervention and interpretation of results, which puts new requirements on the cross-border capabilities of front-line teachers. The third is the transparency of algorithms and the credibility of feedback. At present, most mainstream AI systems are "black box" deep models, and the output conclusions lack a logical explanation path, which causes a "cognitive gap" in educational scenarios - teachers cannot clearly understand the basis for AI judgment and find it difficult to be fully convinced of its conclusions. In highly sensitive tasks such as teaching management, such as student scoring and course division, if algorithm errors are not corrected in a timely manner, disputes between teachers and students may occur. Fourth, data security and ethical concerns. AI technology relies heavily on students' physiological, behavioral and imaging data. Once these data are leaked, they will bring serious privacy risks. At present, only some universities have established data hierarchical storage and encrypted transmission mechanisms, and more AI experiments are still in a "data naked" state. The lag in ethical norms and compliance supervision has become an important hidden danger hindering the popularization of AI.

4.3 Recommendations

Based on case studies and data analysis, AI technology is suitable for the following scenarios: special courses with high requirements for standardization of technical movements, such as elementary teaching of gymnastics, volleyball, and basketball [22]; basic training courses that emphasize physical fitness monitoring and health management, such as physical fitness improvement and physical fitness assessment; general physical education courses with large student populations and heavy teaching tasks, AI can assist in stratified management and automated scoring. In order to promote the deep integration of AI in college physical education, it is recommended to promote it from the following aspects: strengthen the cultivation of teachers' AI literacy, build an interdisciplinary teaching and research team, and realize the two-way empowerment of "sports +

AI"; improve infrastructure, build a school-level AI sports teaching cloud platform, and realize data standardization and resource sharing; formulate data collection and use specifications, build an "AI ethics sandbox", and prevent technology abuse; encourage colleges and universities and AI companies to jointly build practice bases and promote "scenario-driven" technology innovation.

4.4 Outlook: From intelligent teaching to full life cycle sports support

Artificial intelligence is expected to lead college physical education into the "full-cycle intelligent" stage. From physical fitness tests for entrance, on-campus training, optional class placement, to physical fitness tracking, exercise intervention, and health warning, AI will be fully embedded in all aspects of physical education. In particular, with the integration and development of AI with virtual reality (VR) and augmented reality (AR) technologies, immersive physical education classrooms and virtual action rehearsal systems will be implemented in more colleges and universities, providing students with a more personalized and immersive learning experience. At the same time, AI will play a more core role in the evaluation system of college physical education. Through the "process + result" integrated evaluation model, combined with AI's in-depth recording and analysis of the training process, future student performance will no longer be based solely on one-time test results, but on a multi-dimensional comprehensive evaluation based on systematic sports behavior data, thereby reflecting students' growth trajectory and sports literacy in a more fair and scientific manner. In addition, AI will also play an active role in health support functions such as mental health intervention, sub-health screening, and exercise prescription push, helping college sports move from "skill teaching" to the new era of "health promotion" and "career support" [23].

5. Conclusion

Through a systematic study of the application of artificial intelligence technology in college physical education, this paper deeply analyzes how AI affects, empowers and optimizes the current physical education system from both theoretical and practical dimensions. With the support of literature review, case analysis and empirical data, we draw the following main research conclusions:

(1) Artificial intelligence technology has significantly reconstructed the structure and efficiency of college physical education. AI technology uses computer vision, deep learning and smart wearable devices to achieve accurate

analysis and real-time monitoring of multi-dimensional indicators such as students' movement posture, athletic ability, and physical condition, and promotes physical education from "experience-driven" to "data-driven". AI is gradually transforming its role from "auxiliary tool" to "system engine" in college physical education. In the future, it will not only be an assistant to teachers, but also a driver of educational model innovation and an important infrastructure for improving the fairness and scientificity of education.

(2) AI technology has significantly improved the level of personalization of physical education. Based on the construction of personalized models based on parameters such as students' sports performance, training habits, and physiological characteristics, AI can achieve dynamic intervention and customization of training content. Compared with the traditional "one-size-fits-all" teaching method, the AI system pays more attention to individual differences and staged growth, enhancing students' sense of participation and training effectiveness.

(3) AI demonstrates efficient collaboration and intelligent assistance capabilities in teaching management and teaching evaluation. With the help of technologies such as data tracking and natural language processing, teachers can grasp students' classroom participation, performance curves and risk warnings in real time, and achieve closed-loop optimization from process monitoring to strategy adjustment. At the same time, the AI-assisted teaching evaluation system is more scientific and objective, providing a feasible path for colleges and universities to build a diversified, full-process quality evaluation system.

(4) Although AI technology has shown great potential in college sports education, it still faces many constraints in practical applications, such as hardware facilities, teacher reserves, algorithm transparency, and data privacy. The overall development is still in the "exploration and expansion" stage, and its widespread application still requires joint efforts from multiple parties.

Disclosure statement

No potential conflict of interest was reported by the authors.

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In preparing this work, the authors used ChatGPT for the purpose of improving readability and text formatting. After using this tool, the authors have reviewed and edited the content as needed and accepted full responsibility for the substantive content of the publication.

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