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Artificial Intelligence Technology Empowering Physical Education: Opportunities and Challenges

人工智能技术赋能体育教育：机遇与挑战

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Abstract: With the rapid advancement of artificial intelligence technology, the field of physical education is undergoing unprecedented transformations. This study aims to identify the main opportunities and challenges of integrating AI into physical education and to propose effective strategies for its sustainable development. This study employs the literature review method to systematically explore the opportunities, challenges, and development pathways of AI-empowered physical education. The research finds that AI technology significantly enhances the precision and engagement of physical education teaching through applications such as movement analysis, personalized training, and virtual coaching systems. However, the current integration of AI in physical education still faces challenges including technical limitations, data security concerns, insufficient digital literacy among teachers, and educational ethics issues. To address these challenges, this paper proposes strategies including strengthening AI technology training for teachers, establishing big data analysis platforms for student athletic performance, and improving AI-related safeguard mechanisms to promote the modernization of physical education. This study aims to provide theoretical reference and practical guidance for the deep integration of artificial intelligence technology and physical education.

Keywords: artificial intelligence, physical education, personalized instruction, educational ethics, technology empowerment

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摘要：随着人工智能技术的迅猛发展，体育教育领域正经历着前所未有的变革。本研究旨在分析人工智能赋能体育教育的主要机遇与挑战，并探讨其可持续发展的实现路径。本文采用文献分析法，系统探讨了人工智能技术赋能体育教育的机遇、挑战及发展路径。研究发现，人工智能技术通过动作技能分析、个性化训练方案、虚拟教练系统等方式，显著提升了体育教学的精准性和趣味性。然而，当前人工智能赋能体育教育仍面临技术缺陷、数据安全、教师数字素养不足以及教育伦理问题等挑战。为此，本文提出应加强教师人工智能技术培训、建立学生运动表现大数据分析平台、完善人工智能相关保障机制等策略，以推动体育教育现代化发展。本研究旨在为人工智能技术与体育教育的深度融合提供理论参考和实践指导。

关键词：人工智能，体育教育，个性化教学，教育伦理，技术赋能

1. Research background

With the rapid advancement of information technology, artificial intelligence (AI) has been widely applied in the field of education. As an integral part of the traditional education system, physical education is also undergoing profound transformations. Through data analysis, intelligent algorithms, and other means, AI technology can provide more precise and personalized teaching solutions for physical education. The 2025 research report [Development Strategies for School Sports and Construction of an Intelligent Ecosystem in the Context of Artificial Intelligence] pointed out that AI technology has brought significant changes to traditional physical education, not only altering how students learn sports but also imposing new demands on the teaching methods of physical education instructors (Peng, 2025). The development of AI technology has created opportunities for the reform of physical education in higher education institutions. With the support of AI technology, the process of physical training in universities has become more precise, which is more conducive to the physical and mental health development of students (Zhu, 2023).

However, the modernization of physical education in China is currently at a preliminary stage. AI technologies still face limitations that may distort personalized recommendation functions and give rise to educational ethical issues. Additionally, outdated educational philosophies in some universities, coupled with inadequate safeguard mechanisms, making precise guidance in physical training difficult to achieve (Peng, 2025). Against this backdrop, systematically studying the opportunities and challenges of AI technology empowering physical education holds significant theoretical value and practical importance.

This paper adopts the literature review method. By searching academic platforms such as CNKI, Wanfang Data, Google Scholar, and ERIC, using keywords like “Artificial Intelligence”, “Physical Education”, and “Intelligent Teaching”, relevant research results were collected and organized. It systematically analyzes the current state, opportunities, and challenges of AI technology empowering physical education, proposes corresponding development strategies, and aims to promote the deep integration of AI technology and physical education, thereby advancing the modernization process of physical education.

2. Theoretical Foundations for the Integration of Artificial Intelligence and Physical Education

The integration of artificial intelligence technology and physical education is not merely a simple technological overlay, but a systematic project built upon a solid theoretical foundation. Ranging from the Technology Acceptance Model to personalized learning theory, and from constructivism to the Zone of Proximal Development theory, all provide scholarly support for AI-empowered physical education.

The Technology Acceptance Model (TAM) by Davis, F. D. (1989) explains how physical education teachers and students accept and use AI technology. This model posits that the perceived usefulness and perceived ease of use of a technology are key factors influencing users' acceptance of new technologies. In the context of physical education, the extent to which AI tools can significantly enhance teaching

effectiveness (perceived usefulness) and how easy they are to operate and use (perceived ease of use) directly determine their level of adoption (Zhu, 2023).

Personalized learning theory by Dewey, J. (1938) provides another crucial perspective for AI-empowered physical education. By analyzing students' movement data, AI technology can tailor training plans for each student, achieving genuine individualized instruction. A 2025 study indicated that AI-driven personalized physical education not only improved students' skill levels but also significantly enhanced their learning interest and motivation (Hao, 2025).

The following table summarizes the key distinctions between traditional and AI-empowered physical education.

Table 1: Traditional Physical Education vs. AI-Empowered Physical Education

Dimension	Traditional Physical Education	AI-Empowered Physical Education
Instructional Content	Standardized, uniform	Personalized, adaptive
Feedback Mechanism	Delayed, subjective	Real-time, objective
Assessment Method	Result-oriented, singular	Process-oriented, multifaceted
Teacher Role	Instructor of knowledge and skills	Learning facilitator, guide
Student Experience	Passive reception	Active participation, highly interactive

Piaget, J. (1952) Constructivist Learning Theory emphasizes the active role of learners in constructing knowledge. Supported by AI technology, students can explore and experiment within virtual sports environments, building their motor knowledge and skills through hands-on practice. The 2023 article [Reflections on Teaching Reform in Physical Education Curriculum under ChatGPT] pointed out that the application of new technologies offers more possibilities for teaching, capable of enhancing students' learning interest and improving teaching effectiveness (Zhu, 2023).

Furthermore, Vygotsky, L.S.'s (1978) Zone of Proximal Development (ZPD) theory provides broad support for the application of AI in physical education. AI systems can accurately assess students' current motor abilities and proficiency levels, and provide appropriately challenging goals tailored to enhance their capabilities. This enables students to progress within their optimal developmental zone, improving their motor skills and athletic performance to achieve greater gains. Research indicates that this precise difficulty calibration can maximize student learning outcomes by avoiding the frustration caused by excessive challenge or the boredom resulting from insufficient challenge (Yeh et al., 2025).

Collectively, these theories form the theoretical foundation for AI-empowered physical education, providing both a theoretical basis and developmental direction for the widespread application of artificial intelligence technology in this field.

3. Analysis of Application Scenarios and Opportunities for Artificial Intelligence Technology in Physical Education

3.1 Analysis of Application Scenarios of Artificial Intelligence Technology in Physical Education

The application scenarios of artificial intelligence technology in physical education are diverse and are fundamentally changing the models and methods of traditional physical education teaching. Through technologies such as computer vision, deep learning, and big data analytics, AI is bringing unprecedented transformations to physical education.

The integration of AI into physical education primarily manifests in four domains-movement skill analysis, personalized training, virtual coaching, and injury prevention-each contributing to more scientific and individualized instruction.

3.1.1 Movement Skill Analysis and Precision Guidance

One significant application of AI in physical education is motion capture and analysis systems based on computer vision technology. Such systems can utilize high-definition cameras to capture students' movement images and trajectories in real-time, compare them against standard motion models, and provide immediate feedback and precise guidance, thereby effectively supporting both student training and physical education instructors' teaching work. The CoachMe system launched in 2025 is a typical representative of this application. It is a model referenced and generated based on coach guidance, capable of analyzing the differences between the learner's movements and the reference movements to provide specific guidance for both learners and coaching instruction (Yeh et al., 2025).

The application of the CoachMe system in sports like figure skating and boxing fully demonstrates its advantages. By analyzing temporal and physical differences between the learner's actions and the reference actions, it provides comprehensive, high-quality movement guidance, rather than merely offering directional cues in a coach's tone without critical kinematic information. Experiments showed that CoachMe surpassed GPT-4o by 31.6% in the G-Eval assessment for figure skating and by 58.3% for boxing (Yeh et al., 2025). This technology provides an objective and accurate assessment tool for physical education, overcoming the limitations of traditional teaching which primarily relies on the teacher's subjective experience for evaluation.

3.1.2 Personalized Training Plan Customization

By analyzing data on students' physical fitness, motor skills, learning progress, and more, AI technology can generate fully personalized training plans. This individualized approach considers the characteristics and needs of each student, truly realizing tailored instruction. A 2025 study, [Artificial Intelligence Empowers the Development of Students' Physical Literacy], indicated that AI technology enables personalized physical education teaching for students, significantly enhancing teaching effectiveness (Hao, 2025).

AI systems can continuously monitor students' training status and dynamically adjust the training plans based on progress and results. This dynamic adjustment mechanism ensures the training plan remains aligned with the student's actual condition and needs. For instance, some AI systems can automatically adjust training intensity and duration based on the student's fatigue level and skill mastery, preventing overtraining and sports injuries (School of Physical Education, Guangxi Normal University, 2025).

3.1.3 Virtual Coaches and Immersive Experience

Virtual coaching systems leverage artificial intelligence technology to provide students with professional guidance anytime, anywhere. These intelligent systems can not only offer comprehensive technical instruction but also provide emotional encouragement and motivational support, significantly enhancing students' engagement during training sessions. A 2023 study on the application of Chat-GPT in physical education noted that such technologies can provide students with richer and more diverse learning experiences (Zhu, 2023).

The integration of Virtual Reality (VR) and Augmented Reality (AR) technologies with AI creates immersive motor learning environments. Students can practice movements in virtual settings, gaining experiential learning in realistic scenarios without the associated real-world risks. For example, ski simulation systems allow students to experience the enjoyment and challenges of skiing indoors while learning correct techniques and movements in a highly secure environment (Yeh et al., 2025).

3.1.4 Sports Injury Prevention and Rehabilitation Guidance

Artificial intelligence technology also plays a crucial role in sports injury prevention and rehabilitation guidance. By analyzing students' movement data, AI systems can accurately predict potential injury risks during exercise and provide corresponding preventive suggestions and measures, thereby helping athletes avoid injuries caused by incorrect movements or lack of awareness. A 2025 study demonstrated that AI systems can identify potential sports risks by analyzing students' movement patterns and physical characteristics, offering targeted corrective recommendations (Baker et al., 2025).

In the field of sports rehabilitation, AI systems can create personalized rehabilitation training plans for injured students and monitor their recovery progress in real time. These systems ensure that the rehabilitation training remains within safe parameters, preventing re-injury while maximizing rehabilitation outcomes (School of Physical Education, Guangxi Normal University, 2025).

Table 2 summarizes key application areas and their underlying technical foundations. It highlights how AI enhances the precision, personalization, and fairness of physical education through diversified technical pathways.

Table 2: Analysis of Application Effects of AI Technology in Physical Education

Application Area	Technical Means	Advantages	Application Cases
Movement Skill Analysis	Computer Vision, Deep Learning	Real-time feedback, Objective and accurate	CoachMe System
Training Plan Customization	Big Data Analytics, Machine Learning	Personalized, Dynamic adjustment	Adaptive Training Platform
Virtual Coach	Natural Language Processing, Speech Recognition	Anytime, anywhere, Patient and meticulous	ChatGPT-based applications in Physical Education
Injury Prevention & Rehabilitation	Predictive Analytics, Pattern Recognition	Risk warning, Safe rehabilitation	Sports Risk Prediction System
Teaching Assessment	Data Visualization, Cloud Computing	Comprehensive and objective, Multi-dimensional	Sports Performance Big Data Platform

3.1.5 Physical Education Learning Assessment and Feedback

Traditional physical education assessment primarily relies on teachers' subjective evaluations and limited quantitative metrics (e.g., running time, long jump distance). AI technology introduces a multi-dimensional, whole-process learning assessment system capable of comprehensively evaluating students' motor skills, physical fitness, participation levels, and other aspects. The 2025 study [Research on the Precision Guidance of College Physical Training Process through Artificial Intelligence Technology] pointed out that, empowered by AI technology, the physical training process in higher education institutions becomes more precise,

which is more conducive to the physical and mental health development of students (He, 2023).

AI systems can also generate detailed learning reports, providing students with visual development trajectories, allowing them to clearly understand their progress and areas needing improvement. This transparent assessment method not only enhances students' learning motivation but also increases the transparency and fairness of physical education teaching (Zhu, 2023).

3.2 Opportunities for AI-Empowered Physical Education

3.2.1 Enhancing Teaching Effectiveness and Personalized Learning

This section explores how artificial intelligence technology empowers physical education by enhancing teaching effectiveness and achieving personalized learning. Xie et al. (2023), using methods including literature review, explored new trends in school physical education curriculum reform driven by ChatGPT AI technology. They indicated that ChatGPT technology, through intelligent positioning and data-driven curriculum structures, can reconstruct a student-oriented physical education curriculum content system. Furthermore, Shi et al. (2025) studied the application of AI in school football teaching, finding that AI, by collecting students' multi-dimensional sports data and constructing personalized teaching plans, significantly enhanced the scientific basis and safety of exercise prescriptions. Hu (2025) further explored optimization strategies for AI-empowered enhancement of physical education teachers' teaching abilities, proposing that intelligent assistance enables personalized teaching, human-machine collaboration optimizes work efficiency, and diverse knowledge reserves break down disciplinary barriers. In summary, the application of AI technology in physical education not only improves teaching effectiveness but also realizes personalized learning, providing strong support for the modernization of physical education.

3.2.2 Promoting Equity and Resource Balance in Physical Education

This section discusses how artificial intelligence technology can promote fairness and resource balance in physical education. Yao et al. (2022) pointed out

that the development of new infrastructure technology contributes to the innovation of physical education products, the dissemination of physical education content, and the improvement of physical education outcomes, thereby realizing the transformation and spatial optimization of physical education models. Additionally, Lin et al. (2023), in their analysis of the technological pathways and impacts of AI-empowered physical education, argued that AI technology can effectively improve teaching quality and efficiency. They also noted that if AI technology is not applied due to lack of teachers or economic backwardness, it could create a digital divide and widen the gap in physical education. Ye et al. (2024) further explored the key dimensions, constraints, and practical directions of AI-empowered equity in physical education. They argued that AI promotes equality-based, compensatory, and differentiated equity by improving holistic, strengthening compensatory, and precisely personalizing physical education resources, respectively. Finally, Gao (2025) studied the mechanisms and pathways to alleviate dilemmas in AI-empowered physical education equity. He proposed solutions such as improving the fairness system of physical education, ensuring the equitable distribution of AI infrastructure, and enhancing the digital literacy of teachers and students in the field of AI sports technology. In summary, AI technology holds great potential for promoting equity and resource balance in physical education, but it also faces challenges such as uneven distribution of infrastructure and insufficient digital literacy among teachers and students. Addressing these requires measures like system improvement and digital literacy enhancement.

3.2.3 Innovating Physical Education Models and Content

This section explores how artificial intelligence technology drives innovation in physical education models and content to meet the demands of the new era. Yao et al. (2022) in [The Characteristics, Scenarios, and Prospects of New Infrastructure Empowering Physical Education] mentioned that new infrastructure technologies, including AI, 5G networks, cloud computing, big data, and other digital technologies, are gradually permeating the field of physical education. This promotes innovation in physical education products, enriches teaching

content, improves classroom teaching effectiveness, and drives the transformation of teaching models. Furthermore, Lin et al. (2023) in [The Technological Path and Impact of Artificial Intelligence Empowering Physical Education] indicated that AI technology can effectively enhance the teaching quality and efficiency of physical education. Through the mining and analysis enabled by big data technology, it can reflect whether the design of teachers' physical education teaching plans is reasonable and whether students' learning outcomes meet standards, providing support for the deepening reform and innovative development of physical education work. Zhang (2025), in [Research on Model Innovation and Policy Support for AI-Empowered Physical Education Teaching], further analyzed the value of AI in empowering physical education teaching. He proposed innovative model pathways for AI-empowered physical education teaching from four dimensions: teaching content, teaching process, teaching evaluation, and teaching venue. He emphasized that by applying AI technology, teachers can not only improve the visualization and digitization level of the teaching process but also drive systematic changes in teaching design, classroom management, and teaching evaluation. In summary, the application of AI technology in physical education not only promotes the innovation of teaching models and content but also provides new momentum and vitality for the high-quality development of physical education.

4. Practical Challenges of AI-Empowered Physical Education

Although artificial intelligence technology brings numerous opportunities to physical education, it still faces multifaceted challenges in its practical application. These challenges span multiple dimensions including technology, ethics, and resources, requiring comprehensive understanding and serious attention.

4.1 Technical Deficiencies and Data Limitations

Current AI technologies applied in physical education still faces issues with accuracy and reliability. Especially in complex sports situations, the recognition and analysis capabilities of AI systems need improvement. A 2025 study pointed

out that the modernization development of physical education in China is at a preliminary stage, and artificial intelligence has technical defects that can easily lead to the alienation of personalized recommendation functions (Peng, 2025).

Limitations in data quality and quantity also severely affect the effectiveness of AI systems. Acquiring high-quality sports data is difficult, and training AI models requires large amounts of annotated data, which to some extent restricts the application of AI technology in physical education. A critical review in 2025 on the application of AI in athlete development indicated that data validity is one of the key challenges AI faces in the sports domain (Baker et al., 2025).

Furthermore, the generalization ability of AI systems across different sports is limited. AI systems developed for specific sports often cannot be directly applied to other sports, which increases the cost and difficulty of technology promotion (Yeh et al., 2025).

4.2 Educational Ethics and Data Security Risks

The application of AI technology in physical education raises a series of educational ethical issues. A 2025 study noted that technical defects in AI can easily lead to the alienation of personalized recommendation functions, creating educational ethical problems (Peng, 2025). For instance, AI systems might inadvertently impose certain training models on students, neglecting individual differences and their right to autonomous choice.

Data privacy and security issues also represent significant challenges for AI-enabled physical education. Students' sports data constitutes highly sensitive personal information which, if not properly protected, could lead to serious privacy breaches. Shi et al. (2023), in their analysis of the progress of artificial intelligence applications in the sports field, identified weak technical support as one of the main risks and recommended moderately opening data based on ensuring privacy and data security. Furthermore, Zhou et al. (2024), while exploring the value implications of AI-empowered integrated physical education, found that the integration and circulation of data in integrated physical education remain incomplete, posing threats to data security. Lv et al. (2024), in their research on

the high-quality development of college tennis-specific physical training empowered by big data and AI, emphasized the importance of health data monitoring and scientific training plans, while also highlighting data security and privacy protection as key issues. Guo et al. (2025), examining the empowerment of school physical education by AI from a techno-phenomenological perspective, argued that technological embodiment cannot be considered “strong embodiment” in the full sense, and that AI reveals the limitations and risks of school sports data, along with safety and privacy concerns. In summary, the ethical and data security issues surrounding AI technology in physical education require sufficient attention to ensure the compliance and morality of technology applications and achieve sustainable development. The 2025 special seminar “AI-Empowered Reform in Professional Teaching of Physical Training” emphasized that promoting AI-empowered teaching reform requires attention to related ethical and data security issues (School of Physical Education, Guangxi Normal University, 2025).

Additionally, the transparency and explainability of AI decision-making is another ethical concern. Teachers and students may find it difficult to understand how AI systems make specific recommendations or assessments. This “black box” nature may affect users’ trust and acceptance of AI systems (Zhu, 2023).

4.3 Teacher Role Transformation and Insufficient Digital Literacy

The introduction of AI technology places new demands on the role positioning and professional competencies of physical education teachers. Many physical education teachers lack sufficient digital literacy, making it difficult for them to effectively utilize AI technology to assist teaching. A 2023 study pointed out that the application of new technologies like ChatGPT requires teachers to continuously improve their own skills and knowledge to adapt to the application of new technologies (Zhu, 2023).

Some teachers exhibit resistance to AI technology, fearing it may replace their roles. Lin et al. (2025) pointed out that the overall digital literacy level of the current physical education teacher population is not high, which restricts the integration and application of artificial intelligence technology in physical

education. Furthermore, Cao (2025) found that the weakness of physical education teachers' intelligent literacy has become a key factor hindering their adaptation to the intelligent education transformation, with issues such as insufficient technical adaptability and the differentiation of teachers' intelligent literacy being the core problems. Li et al. (2025) further explored the dilemma of physical education teachers' role positioning, arguing that as AI technology becomes more deeply applied, the teacher's role is gradually evolving towards diversification and complexity, and significant adaptability issues have emerged during this transition. Shen Zhao et al. (2025) emphasized the dual shortcomings in digital literacy among rural physical education teachers-deficiencies at both the cognitive and technical levels-which further increases the difficulty of improving digital literacy. In summary, the enhancement of physical education teachers' intelligent literacy and the transformation of their role positioning are critical issues that need urgent resolution in the process of AI-empowering physical education, requiring synergistic solutions through multi-dimensional strategies.

A 2025 seminar clarified that artificial intelligence aims not to replace teachers but to empower them and upgrade education (School of Physical Education, Guangxi Normal University, 2025). However, how to help teachers successfully complete this role transformation, shifting from being mere imparters of knowledge and skills to learning facilitators and guides, remains a significant challenge. Additionally, the lack of AI technology-related content in teacher training programs makes it difficult for both in-service and newly hired teachers to quickly master and apply these new technologies (Peng, 2025).

4.4 Decline in Students' Self-Directed Learning Abilities

In recent years, with the rapid advancement of artificial intelligence technology, its application in the educational field has become increasingly widespread, showing significant potential, particularly in physical education. However, the process of AI technology empowering physical education has seriously impacted students' self-directed learning abilities, leading to a decline in their learning capacity. Sun et al. (2023), using methods such as literature review, logical analysis,

expert interviews, and questionnaire surveys, studied the impedance factors in AI-empowered physical education curriculum reform. They found that while students benefit from the conveniences brought by AI, their self-directed learning abilities have degenerated, resulting in a loss of the desire for active thinking and the fundamental abilities to autonomously filter, explore, discriminate, and think. Furthermore, Lin et al. (2025) pointed out that although AI technology enhances the efficiency of data analysis and helps teachers and coaches understand students' sports performance and health status, it simultaneously faces challenges such as insufficient digital literacy among teachers, which may indirectly affect the cultivation of students' self-directed learning abilities. In summary, while AI technology empowers physical education, it also introduces the risk of declining self-directed learning abilities among students, necessitating measures such as strengthening teacher training and optimizing teaching strategies to address this issue.

4.5 Resource Allocation and Educational Equity Issues

The application of AI technology may exacerbate inequalities in educational resources. Schools with abundant resources can be the first to introduce advanced AI physical education systems, while schools with limited resources might miss out on the benefits brought by these technological innovations. A 2023 study indicated that insufficient educational resources and tight educational funding are major challenges facing physical education (Zhu, 2023).

The digital divide issue exists not only between schools but also among different regions and student groups. This inequality could further widen existing educational gaps, contrary to the original intention of using technology to promote educational equity (Baker et al., 2025).

Additionally, the operational maintenance costs and update/upgrade expenses for AI systems are practical problems faced by many schools. The initial investment might be manageable, but the long-term maintenance and upgrade costs are often overlooked, leading to difficulties in sustaining AI systems (He, 2023).

4.6 Lack of Evaluation Systems and Standardization

Currently, there is a lack of unified evaluation standards and quality assurance systems to measure the effectiveness of AI-enabled physical education. Different systems use different assessment indicators and methods, making horizontal comparison and effect verification difficult.

The application of AI technology in physical education also lacks guidance from scientific instructional design and pedagogical principles. Many applications focus too much on the technology itself while neglecting educational principles and students' learning characteristics, leading to a disconnect between technology application and teaching objectives.

Moreover, policies, regulations, and industry standards for AI in physical education are still underdeveloped, making effective supervision and quality control of related products and services challenging.

5. Strategic Recommendations for Advancing AI-Empowered Physical Education

To address the diverse challenges in integrating AI technology into physical education, effective measures must be implemented across multiple dimensions to promote the deep integration and healthy development of AI and physical education.

5.1 Strengthening AI Training and Support for Educators

Enhancing the digital literacy of physical education teachers is a crucial link in promoting AI-enabled physical education. Teacher training programs should incorporate content related to AI technology to help educators master the necessary technical skills and teaching methods. The 2025 seminar emphasized that advancing AI-enabled teaching reform requires strengthening interdisciplinary collaboration and enhancing teachers' digital literacy (Guangxi Normal University School of Physical Education, 2025). This requirement is particularly urgent in the current context of digital transformation in education.

In terms of training curriculum development, it is essential to establish a hierarchical and categorized training system. Differentiated training plans should be designed for teachers with varying levels of digital literacy. Specifically, systematic courses can be developed, including modules such as AI fundamentals, operation of specialized software for physical education, and data analysis and interpretation (Zhu, 2023). Curriculum design should emphasize the integration of theory and practice—for instance, by arranging for teachers to participate in the application of AI technology in real teaching scenarios. Through case studies and hands-on training, understanding can be deepened. Research indicates that such contextualized training methods enable teachers to more quickly grasp the essentials of applying AI technology in education (Baker et al., 2025).

The establishment of teacher learning communities is an important pathway to promote knowledge sharing. Utilizing digital platforms, online and offline integrated professional learning communities for teachers can be built. Within these communities, educators can share successful experiences in applying AI technology and discuss solutions to technical challenges encountered in teaching (Guangxi Normal University School of Physical Education, 2025). Regularly organizing teaching observation activities and thematic seminars, and inviting AI technology experts and outstanding practitioners to share their experiences, can foster a collaborative development atmosphere. This peer-assisted learning model not only accelerates teachers' professional growth but also effectively reduces anxiety associated with adopting new technologies.

A continuous technical support system is a vital guarantee for the effective implementation of AI technology. Schools should establish dedicated technical support teams to provide teachers with immediate problem-solving and troubleshooting services (Yeh et al., 2025). Simultaneously, a rich repository of teaching resources—including operation guides, teaching cases, and troubleshooting tips—should be developed for teachers to access at any time. Additionally, a regular follow-up mechanism should be established to understand the practical difficulties teachers face during implementation and to provide timely, targeted guidance and support.

Incorporating AI technology application capabilities into the teacher evaluation system is a key measure to stimulate intrinsic motivation among educators. Scientific evaluation indicators should be established, linking AI technology application skills to teacher performance assessments and professional title evaluations (Zhu, 2023). Specific dimensions may include the level of technical proficiency, effectiveness in teaching applications, and innovative practical abilities. At the same time, special incentive mechanisms should be set up to recognize and reward teachers who achieve outstanding results in integrating AI technology with physical education, thereby creating a positive demonstration effect.

It is worth noting that, in the process of advancing teacher training, special attention should be paid to teachers' psychological adaptation issues. Many educators may experience anxiety and resistance when facing new technologies. Therefore, psychological guidance should be strengthened during training to help teachers build confidence in using new technologies (Peng, 2025). By organizing success story sharing sessions and assigning technical application mentors, among other measures, teachers' technophobia can be gradually alleviated, encouraging them to proactively embrace educational technology innovation.

Specifically, the following initiatives can be implemented:

- (a) Develop specialized AI sports education teacher training courses encompassing theoretical learning and practical application
- (b) Establish teacher learning communities to facilitate experience sharing and best practice exchange
- (c) Provide ongoing technical support and instructional guidance to assist teachers in resolving practical application challenges
- (d) Integrate AI application competency into teacher evaluation systems to incentivize proactive learning and adoption of new technologies (Zhu, 2023)

Furthermore, it is essential to establish a long-term training mechanism to ensure that teachers can continuously update their knowledge of AI technology. With the rapid development of technology, training content needs to be regularly updated, and teachers must persistently learn new application skills (Baker et al.,

2025). A credit accumulation system can be implemented, requiring teachers to complete a certain number of hours in AI technology training annually, which should be recognized as an important component of teacher qualification certification. Through these systematic measures, the digital literacy of physical education teachers can be significantly enhanced, laying a solid foundation for their effective use of AI technology in physical education instruction, thereby driving digital transformation and innovative development across the entire field of physical education.

5.2 Optimizing Algorithm Models and Enhancing Technical Reliability

Improving the accuracy and reliability of AI technology is fundamental to expanding its application in physical education. Continuous technological innovation and algorithm optimization are essential to enhance the performance of AI systems. The successful experience of the CoachMe system in 2025 demonstrates that by referencing a coach-guided generative model, it can effectively analyze the differences between a learner's movements and reference movements, providing high-quality guidance (Yeh et al., 2025). This breakthrough points the way for the technological development of AI in physical education.

Currently, motion capture systems often suffer from significant declines in recognition accuracy in complex scenarios such as poor lighting conditions, multi-person simultaneous training, or occlusions. To address this, attention mechanisms and 3D convolutional neural networks can be introduced to enhance the system's ability to extract key motion features. For example, in basketball shooting analysis, the system needs to simultaneously track multiple key indicators such as hand angle, knee bend, and body center of gravity movement. By integrating and analyzing multi-dimensional data, the accuracy of movement assessment can be improved (Baker et al., 2025).

Current AI physical education systems still have room for improvement in feedback latency. By optimizing edge computing architecture and offloading some computational tasks to local devices, combined with the high-speed and low-latency features of 5G networks, millisecond-level feedback response can be

achieved. This instant feedback mechanism is crucial for motor skill acquisition. For instance, during gymnastics training, students can immediately receive posture correction suggestions to avoid the reinforcement of incorrect movements (Zhu, 2023).

The generalization capability of a system determines the breadth of its application. Models trained on a single sport often cannot be directly applied to other sports. Through advanced methods such as cross-domain transfer learning and meta-learning, AI systems can quickly adapt to different sports scenarios. For example, a model trained on badminton movement analysis should be adaptable to tennis or table tennis-related movement recognition with minimal fine-tuning. This generalization ability is particularly important for the diverse needs of school physical education (Yeh et al., 2025).

Specific optimization directions include:

(a) Refining computer vision algorithms to improve recognition accuracy in complex athletic environments

(b) Developing lightweight models to reduce computational resource demands, enabling broader school adoption of AI technology

(c) Enhancing real-time system performance to deliver instant feedback and guidance

(d) Improving system generalization capabilities to adapt across diverse sports disciplines and instructional scenarios (Baker et al., 2025)

Furthermore, it is essential to establish a comprehensive technical validation and evaluation framework. Through large-scale field testing, usage data should be collected from students across different schools and age groups to continuously optimize algorithmic models. Simultaneously, proactive fault detection and automatic recovery mechanisms must be implemented to ensure stable system operation across various usage scenarios. Only through such comprehensive technical optimization can we truly achieve the large-scale implementation of AI-powered physical education, enabling more students to benefit from the educational transformation driven by technological progress (Peng, 2025).

5.3 Establishing Ethical Guidelines and Data Security Protection Mechanisms

Establishing sound ethical norms and data security protection mechanisms is crucial for ensuring the healthy development of AI-enabled physical education. Zhang (2025) analyzed the background and value of AI-empowered physical education teaching, proposing innovative pathways from four dimensions-teaching content, teaching process, teaching evaluation, and teaching environment-while constructing a policy support system. He pointed out that relevant authorities need to provide systematic support in areas such as top-level design, resource allocation, teacher team development, and ethical supervision. Furthermore, Zhang et al. (2025) explored the contemporary value, potential risks, and avoidance strategies for high-quality development of AI-empowered physical education, emphasizing the importance of improving laws and regulations, enhancing ethical review, promoting technological innovation, and returning to the essence of education. They proposed that the General Administration of Sport and the Ministry of Education need to formulate plans and guidance documents for the intelligent development of physical education to enhance the timeliness, flexibility, and practicality of regulations governing the intelligent development of physical education. In conclusion, institutional-level safeguards and support are essential for the empowerment of physical education by artificial intelligence technology, requiring systematic support from multiple aspects including policy formulation, ethical review, and teacher training to ensure the legality and compliance of technology application while enhancing educational effectiveness.

Specific measures include:

- (a) Formulating ethical guidelines for AI sports education to define clear boundaries and red lines for technology application
- (b) Establishing strict data collection and usage protocols to protect student privacy
- (c) Enhancing transparency and explainability of AI decision-making to build user trust
- (d) Establishing third-party oversight mechanisms to conduct ethical reviews of AI sports education products and services (Peng, 2025)

5.4 Promoting Equitable Resource Allocation and Inclusive Design

Promoting the fair allocation of resources and adopting inclusive design principles are essential measures to prevent the widening of the digital divide. Currently, there are significant disparities in the distribution of educational resources among different regions and schools in China, and these disparities may be further exacerbated in the process of applying artificial intelligence technology to physical education (Zhu, 2023). The 2023 study recommends strengthening financial investment in physical education, enhancing teacher training, and promoting the development and sharing of educational resources (Zhu, 2023).

Specific strategies include:

(a) Implement resource-tilting policies to prioritize AI sports education development in resource-constrained schools

(b) Develop AI products at varying price points and functionalities to meet diverse school needs

(c) Advocate inclusive design principles to ensure AI sports education systems accommodate students of varying ability levels

(d) Establish resource-sharing mechanisms to enhance utilization efficiency of high-quality AI sports education resources (He, 2023)

Table 3 provides an overview of the key challenges and strategic responses in AI-empowered physical education, offering a structured summary of major problem areas and corresponding solutions.

Table 3: Summary of Challenges and Countermeasures in AI-Empowered Physical Education

Problem Type	Specific Manifestations	Coping Strategies	Expected Outcomes
Technical Deficiencies	Low recognition accuracy, Insufficient reliability	Optimizing algorithm models, Enhancing generalization capability	Improved system performance, Expanded application scope

Ethical Risks	Privacy leaks, Algorithmic bias	Establishing ethical guidelines, Strength- ening data protection	Enhanced user trust, Prevented ethical risks
Teacher Competency	Insufficient digital skills, Resistance to technology	Enhancing training support, Building learning communities	Increased application capability, Facilitated role transition
Resource Allocation	Digital divide, Resource inequality	Implementing preferential policies, Establishing sharing mechanisms	Promoted educational equity, Reduced resource disparities
Evaluation System	Lack of standards, Difficulty in effectiveness assessment	Developing evaluation criteria, Improving policies and regulations	Guided healthy development, Ensured quality outcomes

Through these systematic measures, we can advance the development of AI-powered physical education while minimizing the impact of the digital divide, ensuring that all students benefit from technological progress and truly achieving equity and inclusion in AI-enhanced physical education.

5.5 Improving the Evaluation System and Policy Support

Establishing a scientific evaluation system and comprehensive policy support is crucial for guiding the healthy development of AI-enabled physical education. Ren (2023), in his research, pointed out that the application of artificial intelligence technology in the sports industry exhibits characteristics such as permeability, synergy, substitutability, and innovation. He proposed strategies to accelerate the cultivation of AI-related professionals in the sports industry by building an industrial internet sports service platform suitable for AI applications. Furthermore, Yao et al. (2024) explored the theoretical mechanism of AI-empowered high-quality development of youth sports training. They argued that AI technology can accelerate the pace of training innovation and improve the quality of sports training. Simultaneously, they suggested optimizing pathways by establishing AI physical education mechanisms and evaluation systems, and improving policies, regulations, and constraint mechanisms for AI applications.

Qin et al. (2024) focused on sports education innovation strategies from the perspective of digital-intelligent technology empowerment. They identified opportunities and bottlenecks of AI technology in sports education innovation and proposed recommendations to strengthen infrastructure construction and enhance teachers' digital literacy and information competency. In summary, the application of AI technology in sports not only promotes the innovation of teaching models but also facilitates the high-quality development of physical education. Therefore, we need to further strengthen the optimization and innovation of evaluation systems and policy frameworks to fully leverage the advantages of artificial intelligence technology. A 2025 study emphasized the need to improve AI-related support mechanisms to promote the transformation and development of educational modernization (Peng, 2025).

Specific tasks include:

(a) Establishing an evaluation indicator system for the effectiveness of AI in physical education to scientifically assess the impact of technology application.

(b) Formulating quality standards for AI physical education products to regulate the market order.

(c) Increasing investment in scientific research to support basic research and application innovation in AI for physical education.

(d) Improving relevant policies and regulations to provide institutional guarantees for the development of AI in physical education.

6. Conclusion and Outlook

This study aimed to examine the opportunities, challenges, and development pathways of AI technology empowering physical education by employing the literature review method. The research found that AI technology, through methods such as movement skill analysis, personalized training plans, and virtual coaching systems, has brought revolutionary changes to physical education, enhancing the precision and engagement of teaching (Yeh et al., 2025; Zhu, 2023). However,

the current empowerment of physical education by AI still faces challenges such as technical deficiencies, data security concerns, insufficient teacher digital literacy, and educational ethical issues (Peng, 2025; School of Physical Education, Guangxi Normal University, 2025).

In response to these challenges, this paper proposes strategies including strengthening teacher AI technology training, optimizing algorithm models, establishing ethical norms and data security protection mechanisms, promoting equitable resource allocation, and improving the evaluation system and policy support. These measures are expected to promote the deep integration of AI technology and physical education and advance the modernization of physical education.

Future research could focus on the following directions: first, exploring more accurate and reliable AI technologies for physical education to improve applicability in complex environments (Yeh et al., 2025); second, investigating optimal models for human-AI collaboration to fully leverage the respective strengths of teachers and AI technology (Zhu, 2023); third, conducting long-term effect studies to evaluate the lasting impact of AI-enabled physical education on student development (Baker et al., 2025); fourth, focusing on the physical education needs of special groups and developing inclusive AI physical education solutions (He, 2023).

Empowering physical education with artificial intelligence technology is a long-term and complex process. It requires the joint efforts of technology developers, educators, policymakers, and researchers to realize the full potential of technology-enabled education and steer physical education towards a more personalized, precise, and humanized direction.

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