The application of artificial intelligence in sports evaluation

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Abstract: With the rapid development of artificial intelligence (AI) technologies, the application of machine learning in physical education has become increasingly widespread, providing new solutions for assessment and teaching in traditional sports classrooms. This paper reviews the current status, key methodologies, and future trends of AI applications in sports evaluation. Research indicates that intelligent assessment systems based on technologies such as Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN), and Few-Shot Learning can efficiently analyze students' athletic performance, significantly enhancing the accuracy of motion recognition and skill assessment. For example, studies show that the ANN model achieves an accuracy rate of 99.6% in football teaching evaluations, while CNN combined with Few-Shot Learning reduces the average error rate in detecting incorrect movements to 0.034%. Furthermore, the integration of technologies such as motion-sensing games and Virtual Reality (VR) has further enriched the interactivity and engagement of sports education, especially in younger age groups and small-class teaching settings. However, current research faces challenges such as the complexity of data labeling and insufficient model generalization. In the future, the deep integration of AI with sports education will require further optimization of algorithmic design and exploration of multimodal technologies to promote the development of intelligent and personalized sports teaching.

keyword ： Artificial intelligence；physical education；machine learning

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Introduction

With the rapid advancement of information technology, machine learning, as one of the core technologies of artificial intelligence (AI), has gradually permeated various fields in recent years, including physical education(1). Traditional physical education often relies on teachers' subjective observations and limited quantitative indicators, which makes it difficult to comprehensively and objectively reflect students' athletic skills, learning progress, and physical development(2). In essence, traditional sports classrooms are overly simplistic and lack depth. The introduction of machine learning technology offers new possibilities for physical education(3). By using data-driven approaches, machine learning can extract valuable information from multidimensional data sources such as motion capture, physiological signals, and video analysis, enabling scientific assessment and personalized guidance of student performance(4).

As AI technology becomes more deeply integrated into physical education, an increasing number of studies and practices have demonstrated its significant role in improving teaching effectiveness, optimizing teaching processes, and promoting student development. In recent years, advancements in computer vision, sensor technology, and wearable devices have laid a solid foundation for the collection and analysis of sports education data. For instance, motion recognition algorithms can automatically assess the precision of students' movements; temporal data analysis can track the trajectory of students' skill improvement; and personalized recommendation models can create targeted training programs for individual students. The application of these technologies not only enhances the objectivity and efficiency of assessments but also opens new pathways for the intelligent and precise development of sports education. Additionally, AI technologies, such as Virtual Reality (VR) and Augmented Reality (AR), can simulate real-world sports scenarios, allowing students to train in a safe environment while improving their skills. Furthermore, AI can provide real-time feedback on students' athletic performance, helping them improve quickly. These applications not only enhance the quality and effectiveness of physical education but also spark students' interest and enthusiasm for sports.

However, the practical implementation of machine learning in physical education still faces several challenges, including the complexity of data labeling, the limitations of model generalization, and the specific requirements of sports education environments. Therefore, an important direction for current research is to explore how to effectively integrate educational theories with algorithmic models to build a scientific and reliable intelligent evaluation system.

This study aims to explore the current status, key methodologies, and future trends of machine learning applications in physical education classrooms. Through case studies and technical analysis, it provides insights for educators, researchers, and developers, contributing to the advancement of physical education towards an intelligent and personalized era. To better promote the development of AI in physical education and enhance the capabilities of physical education teachers, this paper systematically reviews and discusses existing research on the application of AI in physical education. The study provides an overview of the current research landscape to identify gaps and explore future research directions. By reviewing the application of AI in physical education classrooms in detail, this paper aims to facilitate the organic integration of AI into sports education, ultimately contributing to improving the efficiency of physical education classrooms.

1 Literature Review

Rui Yang et al(5). proposed an intelligent evaluation system for football teaching quality in universities, based on Artificial Neural Networks (ANN). The system aims to address issues such as lack of personalization and low resource utilization in traditional physical education. The research team developed an ANN model integrated with association rule mining (ARM) and an optimized particle swarm algorithm. This system can analyze players' training data (including technical movements, physical fitness metrics, and psychological states) in real-time, using the ANN model to uncover functional relationships between different data sets. Experimental results show that the model achieved an accuracy rate of 99.6% in football teaching evaluations, significantly outperforming the traditional K-Means algorithm, which only reached 92.4%. The study particularly highlighted the advantages of the Logit transformation method in handling Area Under Curve (AUC) values (e.g., 0.948), ensuring the rationality of confidence interval calculations. The study also successfully implemented a personalized training support system via an intelligent human-machine interaction system (FTT system), which included technical corrections, motivational analysis, and optimization of training plans. The results revealed that the system notably improved key technical indicators such as passing (97% improvement) and dribbling (89% improvement), while reducing hardware dependency costs, thus providing new ideas for multimedia-based teaching. Despite challenges in data labeling and small sample generalization, this work provides an important example for AI applications in sports education, with potential for expansion into innovative areas such as AR immersive training, thus contributing significantly to the promotion of the "lifelong sports" education concept.

Yu Zhang(6) introduced a tactical performance evaluation system for tennis, based on a multi-layer feedforward neural network. The fundamental working principle of the multi-layer feedforward neural network involves data flowing from the input layer to the hidden layers, and finally to the output layer during forward propagation. When the output layer does not produce the desired result, the weights are adjusted through backpropagation of errors. These two processes alternate, achieving gradient descent, which minimizes the error function in the weight vector space. Through dynamic iteration, the system searches for a set of weight vectors that minimize the network's error function. Using official data, the evaluation system effectively identifies the strengths, weaknesses, and problems in players' use of tactics during matches. This diagnostic index system can provide real-time analysis of tactics used during and after men's tennis hard-court singles matches, offering a detailed understanding of athletes' tactical use and performance. It provides a foundation for formulating tactical strategies and training schedules for athletes during and after matches, facilitating specific training and match guidance.

Xiaowei Jiang et al.(7) proposed a hybrid model, based on Genetic Algorithm (GA)-Backpropagation (BP)-Random Forest (RF), for evaluating the quality of information-based physical education classes in universities. The research integrated the global optimization capability of GA, the nonlinear learning ability of BP neural networks (BPNN), and the ensemble classification advantages of RF. The study optimized the traditional RF algorithm’s node splitting approach to address the accuracy limitations of single splitting models. Experimental results showed that the improved GA-BP-RF algorithm led to faster error convergence during training, with a significant increase in classification accuracy (over 95%) and a processing time of only 5.4 milliseconds. In practical applications for sports education evaluation, the model improved students' average score from 0.68 to 0.91, and reduced evaluation time from 50 minutes to 35 minutes. The study also compared different optimization algorithms (SGD, RMSProp, Adam) and ultimately selected the Adam algorithm due to its faster convergence speed. Despite limitations in computational complexity and small sample generalization, the model shows significant potential in data mining and educational assessment, with future opportunities for combining it with reinforcement learning or multimodal technologies to enhance robustness and expand applicability.

Mengnan Zhao et al. (8)conducted a meta-analysis on the effectiveness of exergames (motion-sensing games) in physical education, offering valuable insights for the reform of physical education in the AI era. The research found that exergames had a moderate positive impact on students' physical learning (SMD=0.45), with significant improvements observed in both cognitive abilities (e.g., sports skills, physical fitness) and non-cognitive abilities (e.g., learning motivation, interest). The results validated that exergames, through their entertainment, interactivity, and real-time feedback mechanisms, can effectively stimulate students' intrinsic motivation for learning while providing an immersive sports experience. This addresses the lack of engagement often present in traditional physical education methods. Notably, the study revealed moderating variables for the effectiveness of exergames: they showed the best results in smaller class sizes (e.g., kindergarten classes with SMD=0.44 and small-scale classes with SMD=0.51), and 1-2 month interventions (SMD=0.62) were significantly more effective than longer interventions (≥3 months). This suggests that the application of exergames should follow the "moderation principle"—excessive use may diminish the novelty effect, and larger class sizes may weaken the advantages of personalized interaction. These findings offer practical guidance for physical education teachers: exergames should be prioritized in younger age groups and small class settings, with regular updates to maintain student engagement. Future research could explore the integration of exergames with other intelligent technologies (e.g., VR/AR) and how data-driven optimization of game design can improve teaching adaptability while fostering a lifelong sports mindset.

Minkai Dong et al.(9) proposed a sports skill assessment model based on Convolutional Neural Networks (CNN) and Few-Shot Learning, providing an innovative technical solution for sports education. By combining deep learning techniques, the model can efficiently identify and correct errors in sports training under small sample conditions, significantly improving the accuracy and efficiency of assessments. Experimental results showed that the method achieved an average error rate of only 0.034% in detecting incorrect movements, far outperforming traditional 2D wavelet packet (0.103%) and spatial clustering (0.168%) methods, proving its superior performance. The practical significance of this research lies in its provision of an objective and scientific tool for skill assessment in sports education, helping teachers identify and correct students' mistakes promptly, thus improving teaching quality. Furthermore, the introduction of Few-Shot Learning addresses the problem of data scarcity in sports education, allowing the model to perform well even with limited samples, making it highly practical and scalable.

2 Discussion and Conclusion

The deep integration of artificial intelligence (AI) technology into physical education is reshaping traditional teaching models, bringing about systematic changes in sports education evaluation, training guidance, and classroom management. This study, through a systematic review of the existing literature, provides a comprehensive analysis of the current state, technological pathways, and development trends of AI applications in physical education. It reveals the multifaceted role of AI in promoting the modernization of sports education.

From the perspective of technological application, AI has permeated every aspect of physical education. In the area of motor skill assessment, computer vision-based motion capture and recognition technologies have enabled precise quantification of movement postures. The combination of Convolutional Neural Networks (CNN) and Few-Shot Learning methods has shown outstanding performance in motion recognition, with studies indicating an error detection rate as low as 0.034%, far surpassing traditional evaluation methods. In personalized teaching, Artificial Neural Networks (ANN) analyze multidimensional data such as students' technical movements, physical fitness metrics, and psychological states to generate tailored training suggestions, significantly improving teaching efficiency. For instance, a football teaching evaluation system achieved an accuracy rate of 99.6%, with students' passing and dribbling skills improving by 97% and 89%, respectively.

AI technology has also innovated the forms of sports education. The application of motion-sensing games and virtual reality (VR) has created immersive training environments that effectively address the lack of engagement often seen in traditional physical education. Meta-analysis studies show that exergames have a moderate positive effect on students' physical learning (SMD=0.45), with more significant improvements observed in younger age groups and small-class settings. This gamified learning approach not only enhances students' motor skills but also fosters a lifelong sports mindset.

In terms of classroom management, AI-driven smart evaluation systems have greatly improved assessment efficiency. For example, the GA-BP-RF hybrid model reduced evaluation time from 50 minutes to 35 minutes, and increased accuracy from 0.68 to 0.91. These technological advancements free teachers from the burden of complex assessments, allowing them to focus more on instructional design and individualized guidance.

However, the application of AI in physical education still faces several challenges. Difficulties in data collection and labeling limit the training effectiveness of models, especially in non-standardized sports. The generalization ability of models needs improvement, as current systems are often developed for specific sports, making it difficult to meet the diverse needs of teaching. Additionally, the high cost of technology poses a barrier to its widespread adoption in grassroots schools. From a pedagogical perspective, issues such as balancing technological evaluation with teachers' expertise, protecting student privacy, and avoiding over-reliance on technology need further exploration.

Future directions should focus on several key areas: in terms of technological innovation, more efficient few-shot learning algorithms need to be developed to reduce data dependency; methods for multimodal data fusion should be explored to integrate video, sensor, and physiological data from multiple sources; and improvements in model real-time performance and robustness should be prioritized to accommodate complex teaching scenarios. In terms of application, lightweight solutions should be developed to lower the technical barrier to entry; teacher training should be strengthened to enhance their ability to use AI technologies effectively; and standardized evaluation systems should be established to ensure the application of AI technologies is both normative and scientific.

From an educational perspective, the application of AI should serve the student-centered teaching philosophy. Technology should not replace teachers but rather provide them with more powerful teaching tools. The ideal intelligent physical education system should be collaborative, leveraging the objective accuracy of technology while preserving the humanistic care and educational wisdom of teachers. Through the deep integration of technological and educational innovations, the ultimate goal should be to enhance teaching quality, promote educational equity, and cultivate lifelong physical activity habits.

In conclusion, AI provides significant momentum for the innovative development of physical education, but its application must adhere to educational principles and the service-oriented role of technology. In the future, educators, technology developers, and policymakers must work together to foster the deep integration of AI and physical education, creating a more scientific, efficient, and human-centered intelligent sports education ecosystem. This will not only have profound implications for improving the quality of sports education but also provide valuable insights for the broader development of educational informatization.

References

[1]Li Y, Li X. The Artificial Intelligence System for the Generation of Sports Education Guidance Model and Physical Fitness Evaluation Under Deep Learning. Front Public Health 2022;10:917053. DOI:10.3389/fpubh.2022.917053

[2]Emmert-Streib F, Yli-Harja O, Dehmer M. Artificial Intelligence: A Clarification of Misconceptions, Myths and Desired Status. Front Artif Intell 2020;3:524339. DOI:10.3389/frai.2020.524339

[3]Wang JH, Wu MC, Chang HH. Urban-rural disparity in physical fitness of elementary schoolchildren in Taiwan region. Pediatr Int 2013;55:346-354. DOI:10.1111/ped.12044

[4]Abel EL. Football increases the risk for Lou Gehrig's disease, amyotrophic lateral sclerosis. Percept Mot Skills 2007;104:1251-1254. DOI:10.2466/pms.104.4.1251-1254

[5]Yang R, Lin H. Evaluation of the Quality of Football Teaching in Colleges and Universities Based on Artificial Neural Networks. Comput Intell Neurosci 2022;2022:8001252. DOI:10.1155/2022/8001252
[6]Zhang Y. The optimization of college tennis training and teaching under deep learning. Heliyon 2024;10:e25954. DOI:10.1016/j.heliyon.2024.e25954
[7]Jiang X, Du Y, Zheng Y. Evaluation of physical education teaching effect using Random Forest model under artificial intelligence. Heliyon 2024;10:e23576. DOI:10.1016/j.heliyon.2023.e23576
[8]Zhao M, Lu X, Zhang Q, Zhao R, Wu B, Huang S, Li S. Effects of exergames on student physical education learning in the context of the artificial intelligence era: a meta-analysis. Sci Rep 2024;14:7115. DOI:10.1038/s41598-024-57357-8
[9]Chen Q, Dong M. Design of Assessment Judging Model for Physical Education Professional Skills Course Based on Convolutional Neural Network and Few-Shot Learning. Comput Intell Neurosci 2022;2022:7548256. DOI:10.1155/2022/7548256