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Leveraging Artificial Intelligence to Enhance Physical Education in Elementary Schools: A Systematic Review and Future Directions

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ABSTRACT

Although artificial intelligence (AI) is transforming many aspects of education, its application in physical education is a relatively new but promising field. Some of the key points explored in this review include the overall benefits of AI in elementary school physical education learning, specific applications, challenges to consider, ethical implementation of AI use in physical education such as data privacy issues, and current research directions. This systematic review will focus on the potential of AI to enhance the physical education experience for elementary school children. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), 18 studies related to AI in physical education were included in the final synthesis. The application of artificial intelligence in physical education is gradually influencing the improvement of teaching and learning activities in physical education classes. Artificial intelligence in physical education offers great potential to provide personalized instruction, real-time feedback and assessment, and a diverse learning environment. Implications: The findings of this study indicate that many studies have explored the use of AI to enhance physical education classes. However, studies reviewing and analyzing the use of artificial intelligence in physical education learning at the elementary school level are scarce.

Keywords: Artificial Intelligence (AI); Immersive Learning; Personalized Learning; Physical Education; Elementary School

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INTRODUCTION

Physical education plays a crucial role in promoting healthy development and fostering a love for physical activity among elementary school children (Udiana & Iyakrus, 2023). However, traditional physical education methods may not always meet individual needs or provide engaging learning experiences. Artificial Intelligence (AI) presents a game-changing potential in physical education, offering exciting possibilities for personalized learning, real-time feedback, and creating captivating learning environments.

AI systems can tailor activities to individual needs and abilities, ensuring that all students are appropriately challenged. AI algorithms can analyze student data (e.g., fitness levels, skill mastery) and design personalized learning plans with activities suited to their individual needs and capabilities (Y. Liu, 2021). This can ensure that students are appropriately challenged, fostering a sense of achievement and enhancing motivation. AI-powered tools can analyze movement patterns and provide immediate

feedback on form, technique, and safety. This allows students to correct mistakes in real time, leading to faster improvement.

AI can be leveraged to create engaging virtual reality (VR) experiences that gamify physical activity. Students can practice throwing techniques in a virtual environment or participate in interactive fitness games, having fun while exercising (Xiang, 2022). AI-supported tools and interactive experiences can make physical education more engaging and motivate children, potentially increasing participation and fostering a lifelong love for physical activity. AI can analyze student performance data to identify trends and areas where teaching needs to be adjusted. This empowers teachers to make data-driven decisions to enhance the overall effectiveness of their physical education programs (Guo, 2024).

For elementary school students, physical education should encourage active engagement in physical activities. Physical education at the elementary level serves as a medium to promote motor development, physical abilities, knowledge, and the inculcation of values (mental-emotional-spiritual and social attitudes), as well as healthy lifestyle habits that ultimately stimulate balanced growth and development (Watikasari, 2023). AI holds vast potential to revolutionize elementary school physical education. By personalizing learning, providing real-time outcomes, and creating engaging experiences, AI can empower children to develop healthy habits and a love for physical activity (Chen, 2023). However, addressing technical limitations, ensuring equitable access, and effectively integrating AI with educators are crucial considerations. As research in this field progresses, AI has the potential to become a valuable tool for creating more effective and dynamic physical education experiences for all elementary school children.

Nevertheless, technical limitations regarding the accuracy and reliability of AI systems in capturing and interpreting movement data in dynamic physical education environments require further development (Tian, 2024). Additionally, cost-effective and user-friendly interfaces are needed for elementary school settings. Ensuring equitable access to AI-supported physical education tools is essential to prevent disparities in educational opportunities. Strategies for broader implementation and affordability need to be explored. AI's role should complement, not replace, teachers. AI should explore how teachers can effectively integrate AI tools into their curricula while maintaining their pedagogical expertise (X. Liu & Wang, 2022). Ethical considerations related to data privacy and security must be addressed to ensure that student data is collected and used ethically. Additionally, the potential for AI bias in algorithms must be considered. A systematic review of existing research on AI in physical education, particularly in elementary schools, is crucial to understanding the current landscape. This literature review explores the types of AI technologies used, their effectiveness in elementary school environments, and their impact on student learning outcomes while highlighting potential benefits and challenges. This research will help identify knowledge gaps and areas for future investigation.

LITERATURE REVIEW

The grounded theory about the utilization of AI in physical education in elementary schools is built by combining principles of learning, technology, and child development. Several theories that serve as references in this research include.

AI-Based Learning

AI enables the creation of adaptive and personalized learning environments. In the context of physical education in elementary schools, AI can be used to tailor learning programs to the physical abilities and individual needs of each student (Ascione, 2024). This theory supports research that personalized learning, adapted to individual capabilities, will enhance student motivation, engagement, and learning outcomes (Slavov & Yan, 2023). Although AI can assist in delivering material and assessment, the interaction between teachers and students remains important (Wayne et al., 2023). This theory states that AI can enrich this interaction by providing real-time data and feedback to teachers, enabling them to offer more timely and evidence-based support (Pan et al., 2022). However, there must be a careful balance to ensure that AI does not diminish the quality of social interactions between teachers and students (Muhammad Tahir et al., 2024). Physical education is not only about physical fitness but also involves cognitive, affective, and psychomotor development (Jie et al., 2024). This theory emphasizes that AI should be used to support this holistic development by providing rich and varied learning experiences (Cao, Lei, et al., 2022). For example, AI can be used to identify and prevent injuries, assess motor skills, and support social learning.

Ethics and Justice in the Use of AI

The use of AI in physical education must consider ethical aspects, such as data privacy, potential bias, and equitable access (Miao et al., 2023; Kumar, 2021). This theory emphasizes that the implementation of AI should be carried out with consideration for fairness and inclusion, ensuring that all students, regardless of their backgrounds, receive equal benefits. The theory proposes that the application of AI in physical education will have long-term impacts on student development. Properly implemented AI can help establish healthy physical habits, increase self-awareness, and promote mental well-being (Jeana, 2024; Duggan, 2020). However, excessive reliance on technology can also lead to a decrease in students' initiative and creativity (Smith, 2024). The development and implementation of AI in elementary school physical education should consider the readiness of teachers, students, and school infrastructure (Wan, 2022). This theory suggests a gradual approach to adopting new technologies, focusing on teacher training, the mental readiness of students, and the development of tools that align with children's developmental stages.

RESEARCH METHODOLOGY

Search Protocol

The systematic review is limited to the use of AI in physical education learning at the elementary school level, covering personalized teaching, real-time feedback, and immersive learning. A comprehensive internet search was conducted in databases using Google Scholar with open-access article criteria. More than 45,000 potential citations were identified. Abstracts and full-text articles of potentially relevant papers were screened to determine eligibility. Data related to artificial intelligence (AI) in elementary school physical education were extracted, resulting in 18 qualifying papers. To identify research articles investigating the use of AI in physical education for elementary school children, we searched the following databases, adapting search terms according to individual database requirements in terms of subject heading

terminology and syntax. These search terms were based on: 1) participants (e.g., elementary school children* OR elementary school students* OR elementary schools*); 2) learning programs (e.g., physical education* OR sports*); 3) applications (e.g., personalized learning* OR real-time feedback* OR immersive learning*).

Inclusion Protocol

The inclusion criteria prioritize studies published within the last four years, specifically between 2020 and 2024, and the articles must focus on physical education learning within elementary school environments. Only studies utilizing literature reviews and experimental designs were included, as experimental studies are still considered to provide the best evidence of causality in research within evidence-based education (Akbar et al., 2023; Ratminingsih, 2010). Studies were excluded if (a) they were published in languages other than English; (b) the intervention was implemented as a community-based program, extracurricular/non-curricular program, or outside the school environment; (c) they were studies unrelated to physical education. Initial exclusions were made by screening titles and abstracts, and when eligibility could not be determined, full articles were reviewed. This review will follow the established protocol for systematic reviews, namely PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses), to ensure a rigorous and objective literature analysis (Figure 1).

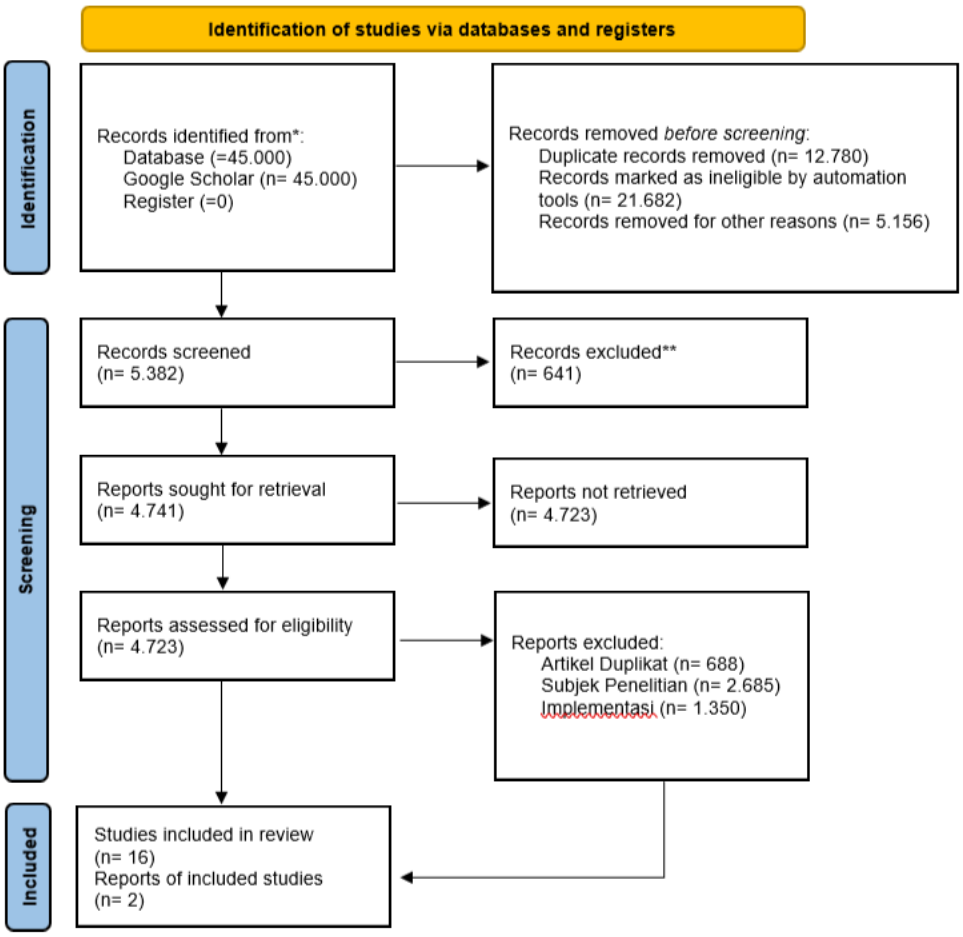

Figure 1. Preferred Reporting Items for Systematic Review and Meta-Analyses

RESULTS AND DISCUSSION

Identification and Selection of Literature

The literature search in the Google Scholar database resulted in 5,382 potentially relevant publications. After screening the titles and abstracts, 4,741 references were confirmed as potentially relevant and were retrieved in full text. Based on the examination of preferred reporting items, 4,723 were excluded from our review for the following reasons: a) 688 were duplicate articles; b) 2,685 studies were conducted at the university level and did not meet the school criteria; c) 1,350 studies applied AI in extracurricular activities or sports training outside of school, used as tools for referees, early athlete detection, or performance enhancement for professional athletes.

A total of 18 final studies were synthesized, providing information on the impact of AI in physical education learning, the use of applications in learning (5 studies), personalized teaching (2 studies), real-time feedback (10 studies), and immersive learning (1 study). Table 1 presents the previous research findings that are closely related to the focus of this study.

Table 1. Relevant Previous Research

No	Author	Population	Findings
1.	Sagre & Ahlawat., 2023	2023	This research paper explores how AI tools such as Scispace, Elicit, ChatGPT, Quillbot, Trinka, Plag, and Scite can revolutionize the process of writing research papers in physical education. AI tools can automate parts of the research workflow, identify key concepts, trends, and gaps in the literature, and provide a comprehensive literature review. While AI has the potential to enhance research writing outcomes, it is important to consider its limitations, such as errors in grammar correction, limited functionality for non-English languages, and the risk of diminishing critical thinking and creativity among researchers.
2.	Nese, 2023	2023	ChatGPT can be utilized in physical education and sports to create personalized training programs, analyze athlete performance, prevent injuries, provide nutrition advice, support coaching, engage in sports journalism, and enhance fan engagement. ChatGPT can assist physical education teachers in delivering effective learning experiences by communicating lesson plans, training programs, as well as health and nutrition information. This study highlights the potential contributions of ChatGPT to the future of physical education and sports, emphasizing themes such as personalized training programs, injury prevention, performance analysis, nutrition guidance, research and development, and virtual coaching.
3.	Song, 2024	2024	The research findings in this paper focus on the development of an intelligent-assisted physical education teaching model guided by high-level complex networks, integrating AI assistance through compressed FCM (CS-FCM). This study demonstrates the effectiveness of CS-FCM in large-scale FCM learning, achieving stability with reconstruction errors below 10^-3 after 15 iterations for FCM with 20% density. The proposed time-series prediction framework based on high-level FCM significantly addresses the limitations of current

			FCM models, showing strong convergence and stability across various densities and data lengths. Positive results from experimental simulations validate the effectiveness of the proposed model, laying the groundwork for broader applications in physical education teaching in the future.
4.	Ascione, 2024	2024	The research findings in this paper indicate that the experimental group, which integrates physical education with artificial intelligence, shows a greater tendency to produce personalized teaching proposals compared to the control group. This combination positively impacts the emotional-social-relational axis, leading to a more personalized teaching approach and enhancing students' motivation and interest. The study highlights that the emerging relationship between artificial intelligence and physical education in schools can create positive effects on learning, motivation, interest, and reduce disruptions, potentially improving the overall learning experience for students.
5.	Jie et al., 2024	2024	This research paper focuses on the integration of artificial intelligence in physical education to enhance learning effectiveness and student participation. The findings highlight the risks associated with students' reliance on AI, which leads to passive learning approaches and fragmented knowledge construction. The paper emphasizes the importance of improving physical education teachers' information literacy, promoting deep learning capabilities among students, and strengthening emotional interactions in the classroom to address these challenges. It suggests that AI should be used as a tool in physical education, with a focus on prioritizing 'education' and emotional implementation to effectively embrace the era of artificial intelligence.
6.	Cudicio et al., 2024	2024	The findings of this paper indicate that secondary school students have varying anthropometric measurements and physical fitness levels, revealing different proximal development zones that require personalized educational approaches. The study emphasizes the importance of personalization in physical education to prevent student frustration during exercises and to promote an active lifestyle, even beyond school, with the assistance of artificial intelligence for personalized instruction. The results highlight significant variability in physical fitness among students of the same age, underscoring the need for tailored teaching methods to accommodate individual differences and unique proximal development zones.
7.	Zhou, 2023	2023	Temuan penelitian dalam makalah ini menunjukkan bahwa model yang diusulkan untuk mengoptimalkan alokasi sumber daya pendidikan jasmani pedesaan di kota secara efektif meningkatkan efisiensi sumber daya, mengurangi kesenjangan antara distrik dan kabupaten, dan meningkatkan pencapaian, pemerataan, dan efisiensi sumber daya. Melalui eksperimen simulasi, dipastikan bahwa model tersebut praktis dan layak, yang mengarah pada peningkatan efisiensi sumber daya pendidikan jasmani pedesaan, mengurangi pemborosan, dan mengurangi kesenjangan alokasi antara distrik dan kabupaten.
8.	Jiang et al., 2024	2024	The findings of this paper indicate that the proposed model for optimizing the allocation of physical education resources in rural areas effectively enhances resource efficiency,

			reduces disparities between districts and counties, and improves achievement, equity, and resource efficiency. Through simulation experiments, it was confirmed that the model is practical and feasible, leading to increased efficiency in rural physical education resources, reduced waste, and decreased allocation gaps between districts and counties.
9.	Yu & Mi, 2023	2023	The findings of this paper indicate that a new teaching model based on the Internet of Things (IoT) and artificial intelligence (AI) enhances teaching efficiency by 14.7%, improves teaching quality, and provides a reference for the future development of IoT and AI in education. Experimental results show that the new physical education teaching model significantly outperforms traditional models, with a greater number of students achieving excellent and good physical test results under the new model. This study highlights the potential of IoT and AI technologies in improving teaching quality, enhancing teaching effectiveness, and nurturing exceptional sports talent within educational environments.
10.	Chad et al., 2023	2023	This research paper explores the potential impact of AI-powered chatbots such as ChatGPT in health education and physical education, emphasizing the importance of understanding and addressing digital (in)justice. The paper highlights ethical issues associated with the use of AI-based large language models (LLMs) in research and teaching, pointing out concerns about biased outputs and excessive reliance on AI-powered LLMs by researchers. It also discusses the unreliability of AI-generated text for the peer-review publication process and the ethical implications of authorship claims on AI-generated content.
11.	Zhang et al., 2022	2022	The findings of this paper focus on the application of artificial intelligence in physical education and comprehensive health quality interventions. The study employs virtual simulation technology and Kinect algorithms to conduct interventional research on physical education and health quality, aiming to enhance students' scientific and cultural levels. The results indicate that approximately 30% of students meet or do not meet the qualifications, with only 43.34% achieving an excellent rating in scientific and cultural quality. The paper emphasizes the importance of using effective methods to improve students' overall comprehensive quality through innovative teaching strategies and technology integration.
12.	Cao et al., 2022	2022	The findings of this paper focus on the development of the Intelligent Physical Education Tracking System (IPETS) for formative assessment of athletic knowledge. The study presents a methodology for evaluating athletic education programs and understanding mathematical formulas for specific activities. IPETS is designed to enhance physical education training using computer-based digital technology, improving performance and teaching efficiency. The proposed IPETS utilizes an event-tracking model and fuzzy-based performance evaluation, demonstrating higher performance and accuracy in assessing participant efficiency. The system shows better results with lower complexity, providing a theoretical foundation for physical training techniques and potential future improvements using deep learning models.
13.	Azlina et al., 2022	2022	This research paper develops an application using immersive technologies such as virtual reality (VR) and augmented

			reality (AR) to make physical education accessible to students with learning disabilities (LD). By integrating immersive technologies aligned with motor learning theory and multimedia learning principles, appropriate learning materials are created to facilitate the physical education learning process for LD students. The research involves the creation of a VR application and AR book, with feedback from students using the VR trainer informing the development of the AR book. The findings highlight that immersive technologies, virtual trainers, and AR books effectively engage and motivate students with learning disabilities to participate in fitness activities, enhancing their motor performance and learning experience.
14.	Ba & Zhenfeng, 2022	2022	The findings of this paper indicate that smart algorithms based on Feedforward Neural Networks (FNN) effectively predict student scores on the national college physical education exams, providing an objective basis for teacher performance evaluation. The study emphasizes the importance of using artificial intelligence algorithms to develop fuzzy evaluation factors for students' physical and mental health in colleges and universities, thereby enhancing the assessment of physical education achievements. The paper demonstrates a significant linear relationship between the results of the National Physical Education Integrated Exam and the comprehensive evaluation scores of the system, highlighting its predictive value for exam outcomes.
15.	Wan, 2022	2022	The findings of this paper focus on the integration of artificial intelligence (AI) and physical education, emphasizing the importance of modern teaching methods and the impact of AI on physical education activities. The study highlights how AI is transforming traditional physical education methods and enhancing the teaching process through advanced technology and intelligence. It underscores the need for physical education teachers to adapt to new teaching methods, embrace trends in intelligence and modernization, and actively integrate AI technology to improve teaching methods and enrich student experiences.
16.	Cao, Lei, et al., 2022	2022	The findings of this paper reveal that a smart service platform for intelligent sports classes in higher education, designed using AI big data technology, can identify and address issues in student physical education in a timely manner, thereby enhancing the reliability of PE teaching. Through the analysis of AI terminal equipment and the challenges faced by intelligent physical education classes, the study provides a scientific construction pathway for smart PE classes, supporting future research in this area. The research also highlights the importance of information-based teaching in physical education, emphasizing the need to improve the level of information-based teaching in schools.
17.	Lee & Lee, 2021	2022	This research paper explores the principles and applications of AI in physical education (PE), focusing on customized PE classes, knowledge provision, student evaluation, and counseling methods. AI in PE enables individualized learning, real-time feedback on athletic abilities, and various learning tools to maintain student motivation. AI supports students in data collection, analysis, and visualization, allowing more time for high-level physical activities and practical experiences. AI

			assists educators in decision-making, evaluation, and learning management, reducing administrative work and enhancing teaching quality. The study emphasizes the importance of AI in modern PE, highlighting its impact on students, educators, and educational practices within PE technology.
18.	Yang et al., 2020	2020	The findings of this research paper indicate that the designed AI speech recognition system can achieve recognition accuracy of over 90%, enabling effective communication with students and satisfactorily answering their questions. Introducing educational robots based on voice interaction in physical education teaching significantly increased students' learning interest by an average of 21 points and their learning attitude by 9.8 points, demonstrating improved class efficiency and student engagement. The study highlights the importance of artificial intelligence in enhancing physical education teaching and promoting the development of personalized and intelligent teaching methods.

Although in this research, literature related to the use of AI in physical education at the Elementary school level is nearly nonexistent, indicating that studies focusing on this area are still quite rare, the researcher could not provide a comprehensive conclusion regarding the effectiveness of AI in Elementary school physical education, evaluation, or potential benefits and challenges. However, AI studies in higher education levels have been extensively conducted. This led the researcher to be very selective in choosing reference articles for in-depth analysis. Based on the stringent selection results through PRISMA, 18 final studies are considered by the researcher to be the most relevant to this research, referring to the inclusion criteria in the identification and search for references.

DISCUSSION

AI is a field dedicated to studying and simulating human cognitive processes and behaviors. The Elementary goal of AI is to develop theories for intelligent data processing and design computational systems capable of mimicking certain human cognitive functions (Chad et al., 2023). The ultimate aim of AI is to endow computers with human-like reasoning abilities, enabling them to perform complex tasks through a series of intricate actions (Hao & Hu, 2022). The field of physical education and sports has seen significant advancements with the integration of AI, providing valuable insights for practitioners (Zhao et al., 2024). Elementary schools prioritize physical education to enhance students' physical fitness and promote their holistic well-being. In the AI era, educational trends are moving towards addressing the limitations of traditional physical education methods. The convenience of AI technology permeates every aspect of the educational process, prompting the integration of AI in physical education. This symbiotic relationship aims to harness the strengths of both, driving continuous improvement and ultimately leading to smarter and more efficient approaches (Jie et al., 2024) in physical education practices, particularly at the Elementary school level.

Potential Benefits of AI in Physical Education for Elementary Schools

Physical education at the Elementary school level is a crucial stage where children learn fundamental motor skills. Physical activity is an integral part of physical

education, contributing to the development of cognitive, affective, and psychomotor skills. Currently, the application of artificial intelligence (AI) in Elementary school physical education is still in the early stages of exploration (Jie et al., 2024). For example, Cao, Xiang, et al. (2022) have introduced AI to streamline data management, enhance operational efficiency, and improve learning quality. Meanwhile, Zhang et al. (2022) have implemented intelligent fitness testing to provide students with advanced fitness methodologies, including sports risk prediction and fitness outcome monitoring. These tangible initiatives mark the initial steps towards leveraging AI to support physical education in schools, laying the groundwork for further advancements in the field.

Personalized Learning: AI can analyze student data to create customized exercise plans tailored to individual needs, abilities, and interests (Cudicio et al., 2024). Skill Assessment: AI-supported systems can offer objective and accurate feedback on student performance, helping teachers identify areas that need improvement (Cao, Lei, et al., 2022). Injury Prevention: AI can analyze movement patterns to detect injury risks and recommend preventive measures (Ba & Zhenfeng, 2022). Engagement: AI-supported games and interactive activities can enhance student motivation and participation in physical education classes. Support for Teachers: AI can automate routine tasks such as attendance tracking and equipment management, allowing teachers to focus more on providing instruction and support to students (Lee & Lee, 2021). Technological Impact: Technology can be a powerful tool to facilitate and support school-based physical activity programs, positively impacting student and staff health and well-being (Ha, T, 2024). As the diversity of student populations and technology continues to evolve, developing competencies becomes essential for educators, including physical education teachers (Tsuda, E., & Wyant, J, 2024).

Potential Challenges of AI in Physical Education for Elementary Schools

Risk of Imbalance in the Status of Physical Education Teachers

In the field of physical education, physical education teachers are significantly impacted by artificial intelligence (AI). Teachers require adequate training to effectively use AI tools and integrate them into their teaching practices. Ethical considerations arise as the use of AI in physical education raises questions about fairness, bias, and accountability. AI tools have the potential to revolutionize physical education by assisting teachers in various ways, such as curriculum development, providing feedback, enhancing content knowledge, data analysis, and promoting student engagement (Keath, Wyant, & Towner, 2024). However, the question of whether the role of teachers can be replaced by AI has become a hot topic in academic circles. Some scholars have suggested that AI has redefined the dissemination of knowledge, arguing that the creation or dissemination of knowledge is no longer limited to the teacher's perspective, and teachers are no longer the sole representatives of authoritative knowledge (Han et al., 2024).

This seemingly one-sided view might reflect its true meaning. Despite the sophisticated features, databases, virtualization, and practices shaped by AI allowing physical education teachers to reduce mechanical tasks and alleviate teaching pressure, tasks traditionally exclusive to physical education teachers are gradually being replaced by AI, represented by tools like ChatGPT (Sagre & Ahlawat, 2023). This shift appears to render the value of physical education teachers in Elementary schools as optional. With the growing application of AI in physical education, the level of

intelligence within the field increases. Virtualization, dataization, scientification, and ease of teaching in physical education are becoming more tangible (Cudicio et al., 2024). The imbalance of knowledge authority and the weakening of the traditional role of physical education teachers have become trends. In the context of physical education, it is crucial to promptly reassess the value of physical education teachers and explore ways to enhance their unique "irreplaceability" while serving the needs of AI.

Risks of Student Dependence on Artificial Intelligence

With the ongoing integration of artificial intelligence (AI) technology in physical education classes, students' learning experiences are becoming increasingly diverse, playing an irreplaceable role in enhancing engagement and teaching effectiveness. Research conducted by Nese (2023) indicates that, compared to human teachers, students experience better interactive learning effects with virtual teachers that mimic human emotional behavior. However, despite AI providing students with a novel learning experience, there are potential risks associated with students' reliance on AI in physical education (Zhou, 2023).

Firstly, AI may foster a dependency on "intelligence," potentially diminishing students' subjective initiative in learning (Yang et al., 2020). In traditional physical education classrooms, students engage in learning through personal communication and interaction with teachers and peers to identify and solve problems. Currently, with the assistance of AI, students' autonomous exploration is gradually shifting towards passive acceptance (Qiao et al., 2022). For example, tools like ChatGPT and Quillbot raise concerns about data privacy, as the collection and storage of students' data can pose risks to privacy and security. Additionally, ensuring equitable access to AI technology for all students is crucial to prevent disparities.

Risks of Reduced Social Interaction between Teachers and Students

Education is a social practice aimed at nurturing individuals through the social relationships between teachers and students. With the introduction of artificial intelligence (AI) into physical education, its intelligent features facilitate better teaching efficiency and create a more enjoyable learning environment for both teachers and students (Aristanto et al., 2023). However, the integration of AI also affects the emotional dynamics in physical education classrooms, potentially altering the paradigm of teacher-student interactions compared to traditional physical education classes.

The widespread application of AI in education may ease the dissemination of knowledge, which could diminish the authoritative role of teachers, leading to a one-way transmission of knowledge rather than interactive teaching. Omae et al. (2023) argue that "the goal of learning knowledge is not the knowledge itself but the ability to create knowledge to meet one's own needs." Clearly, the process of acquiring knowledge is more important than the mere outcome. Teaching is a generative activity involving interaction between subjects, and the essence of education lies in the teaching behavior and art exhibited by the teacher during the educational process (Quyen et al., 2020).

Under the influence of digital technology, the reduction in interaction between teachers and students has gradually weakened the emotional functions that were originally part of physical education learning (Kliziene et al., 2021). For instance, virtual systems like AR, VR, learning data collection systems, and mentor systems represented

by ChatGPT, as well as virtual learning scenarios (Azlina et al., 2022), demonstrate that although human-machine interactions can simulate natural emotional responses through simulation technology in educational applications (Wan, 2022), these interactions remain within the realm of programmed data and statistical algorithms. They lack self-awareness, motivation, and desire, making it impossible to achieve genuine empathy and emotional feedback (Chen, 2023).

The data-driven and visualized features created by AI partially dilute the essence of interpersonal communication in physical education learning activities (Yu & Mi, 2023). Emotional experiences and interactions have been reduced to programmed symbols and mechanical processes. The initially intelligent and warm teacher-student interactions are becoming increasingly irrelevant in this process, which inevitably leads to a decline in individual empathy.

Future Directions for AI in Elementary School Physical Education

Based on the review findings, the potential future directions for AI research and development in physical education have been identified. The review highlights that there is a lack of research focusing on the use of AI in physical education for elementary school children. Therefore, future research should explore the following areas Development of AI for Elementary Schools: Cognitive Ability: Investigate how elementary school children can effectively use AI and the cognitive demands of such technologies. Teacher and School Readiness: Assess the preparedness of teachers and schools to integrate AI technology into elementary education settings. Psychological Readiness: Explore the psychological readiness of elementary students to interact with AI and understand its role in their learning environment. Effectiveness of AI-Supported Sports Tools: Tool Development: Develop and evaluate specific AI-supported sports tools tailored for elementary schools. Learning Outcomes: Examine the impact of AI tools on students' physical skills and motivation, ensuring they contribute positively to physical education outcomes. Ethical Guidelines for AI Use: Privacy and Bias: Develop ethical guidelines to address data privacy concerns and potential biases in AI applications. Cost-Effective Interfaces: Design affordable and user-friendly AI interfaces specifically for elementary physical education programs (Ma & Chen, 2024). Assessment and Inclusivity: Fitness and Performance: Use AI to accurately assess physical fitness and overall student performance. Inclusive Education: Explore AI solutions that support students with disabilities, ensuring they can participate in physical education activities (Adenise et al., 2024). Professional Development for Teachers: Personalized Development: Investigate how AI can provide personalized professional development opportunities for physical education teachers (Xu & Luo, 2022). Ethical Frameworks: Establish guidelines and frameworks for the ethical use of AI in physical education at the elementary level (Lowe, 2024). By addressing these areas, future research can advance the integration of AI in elementary school physical education, enhance teaching practices, and support student development in a more comprehensive and equitable manner.

CONCLUSION

AI offers a promising pathway to transform elementary school physical education into a more personalized, engaging, and data-driven learning experience. By addressing existing challenges and exploring future directions, AI can empower teachers to

develop effective physical education programs that foster a love for physical activity and encourage healthy habits among all children. AI has the potential to revolutionize elementary physical education by enhancing learning, engagement, and meeting the needs of students. However, careful consideration of challenges and ethical implications is crucial for successful implementation. This systematic review provides valuable insights to guide future research and inform the development of AI-supported tools in physical education. Ultimately, these advancements aim to make physical education a more impactful and engaging experience for all elementary school students. Future research should focus on developing innovative AI solutions that cater to the diverse needs of elementary school students.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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