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TECHNOLOGY INTEGRATION IN PHYSICAL EDUCATION LEARNING IN SCHOOLS: SYSTEMATIC LITERATURE REVIEW

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Abstract
The swift progression of digital technology is fundamentally reshaping educational methodologies, including those in physical education (PE), by presenting distinct advantages and formidable obstacles for institutions. This systematic literature review (SLR) was specifically designed to evaluate the existing scientific literature on integrating technology into school based PE instruction. The review followed rigorous, established procedures: formulating clear research questions, searching major academic databases, screening and selecting relevant articles, appraising the quality of the selected studies, and finally, synthesizing the gathered data. We focused on high-quality studies published between 2020 and 2025 that explored technology integration in PE. After applying strict inclusion and exclusion criteria, ten studies were chosen and assessed for quality using the Mixed Methods Appraisal Tool (MMAT). The resulting data underwent both annotated bibliographic and qualitative content analysis. The core findings affirm that the strategic integration of various technologies including learning management systems, digital resources, video modeling, augmented and virtual reality (AR/VR), gamification, and wearable devices yields positive effects on PE outcomes. These tools notably boost student motivation, engagement, the development of motor skills, and subject knowledge acquisition. Furthermore, they facilitate individualized instruction and the provision of immediate, real-time feedback. However, the review also pinpointed significant challenges. These include disparities in technological access, insufficient school infrastructure, a lack of teacher preparedness and digital literacy, misalignment between technology and pedagogical goals, high maintenance expenses, and issues concerning data privacy. Nevertheless, successful implementation can be achieved through key facilitating factors: robust administrative leadership, ongoing professional development for teachers, reliable technological infrastructure, and instructional design that is closely aligned with pedagogical principles. Ultimately, this review confirms that integrating technology in PE holds substantial promise for elevating learning effectiveness and student performance, provided it is executed thoughtfully and supported by adequate resources. Future scholarship should concentrate on creating PE technology models that are inclusive, sustainable, and tailored to specific educational.

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INTRODUCTION

In modern era technology is developing rapidly. Technology is not only used by adults; it is also used by all groups, including children and teenagers. According to a 2024 report from the Central Statistics Agency (BPS), 39.71% of Indonesian children use mobile phones, while 35.57% have internet access, even in remote areas. This indicates that access to digital technology, especially mobile phones and the internet, has expanded and is evenly distributed across all age groups. However, technology is associated with both opportunities and risks. The benefits of using technology include: easier communication, connectivity, and faster access to information and knowledge. However, there are also disadvantages, such as a decrease in the quality of social interactions, the spread of fake news, a lack of physical activity, or addiction to technology, especially mobile phones.

Because this is almost unavoidable, it must be addressed pedagogically. One way to do this is by adequately preparing students in schools to utilize technology for life in today's society and the future. The benefits of using technology in the learning process include making learning more effective, improving student learning outcomes, and creating a quality generation capable of facing future challenges (Suyuti et al., 2023).

Physical education is a subject that is an integral part of the school curriculum, aiming to develop knowledge, skills, and attitudes through physical activity (Harding et al., 2021; Mustafa & Masgumelar, 2022; Rahayu, 2013). However, in today's digital era, conventional learning methods that rely on direct instruction are starting to face various obstacles. The use of technology has become a trend in education, including in physical education, to increase student participation, provide more effective feedback, and support distance and online learning models hybrid (Chen, 2022).

Integrating technology into physical education learning is a solution that can be used to improve the quality and effectiveness of the learning process. Innovations such as video motion analysis, physical activity monitoring applications, and technology...virtual reality (VR) has been applied in various educational situations (Akinola et al., 2020; Asrori, 2022; Chen, 2022; Hartwig et

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al., 2019; Widyaningsih et al., 2021). This innovation is used as an interactive medium, increasing student engagement in learning, enabling students to gain feedback in a way real time.

The potential of technology in physical education learning has not been fully realized due to various obstacles in schools, such as inadequate infrastructure, lack of teacher competency, and low digital literacy (Damayanti & Nuzuli, 2023; Francom, 2016). This situation is exacerbated by the lack of systematic research examining its impacts, challenges, and opportunities. Therefore, it is crucial to conduct structured studies to ensure more effective use of technology. Based on these conditions, it is important to conduct research that aims to explore and summarize scientific findings regarding the application of technology in physical education learning in the school environment.

METHOD

This research uses a Systematic Literature Review (SLR), specifically an analysis of technology integration in physical education. SLR research is a series of studies that focus on data collection techniques or exploration of a particular topic through a systematic review of various library sources, including scientific publications, reference books, magazines, documentary materials, and others. According to Baker (2016), the use of SLR involves several stages, including: 1) Formulate research questions. 2) Determine clear search terms, databases, and inclusion and exclusion criteria. 3) Conduct a literature search. 4) Filter and identify relevant articles. 5) Assess the suitability and quality of the literature. 6) Conduct an in-depth review of the literature. 7) Analyze and synthesize qualitative data.

Study Participants

The data collection method for this research was secondary data exploration, sourced from primary scientific reports, specifically published academic research findings. The author searched several trusted databases, including Science Direct, using the keyword combination "Integration of Technology and Physical Education Learning." In addition to direct searches, the author also conducted reference searches from previously obtained articles to enrich the findings.

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Criteria for Inclusion and Exclusion

To decide whether the literature found is suitable for use in this Systematic Literature Review (SLR), a number of inclusion and exclusion criteria were established.The following conditions must be met for a study to be included, or for a study to be selected: 1) Only keyword related data is used. 2) The article "Data" is original. 3) Only articles indexed using established standards are included. 4) Information used between 2020 and 2025

However, here are the exception criteria: 1) Information unrelated to the integration of technology and physical education learning. 2) Review articles and data are not relevant. 3) The article is not indexed according to established standards. 4) The data is not from the 2020-2025 timeframe

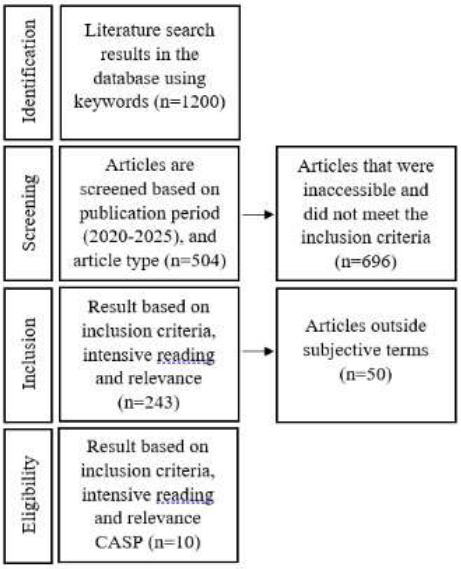

Figure 1. PRISMA scheme in the literature selection process

Study Instruments

This study uses an annotated bibliographic analysis, which is a list of sources accompanied by a brief synopsis (annotation) of their contents. Annotation analysis is conducted by evaluating the following factors: 1) Source identity: name of the source referred to. 2) Author's purpose: background and purpose of the author. 3) Summary of the material: a brief summary of the research. 4) Relevance value: the importance of the source in answering the research question

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RESULT AND DISCUSSION

Table 1. Evolution of the number of publication at year

Year of Publication	Number of Articles
2025	279
2024	284
2023	159
2022	155
2021	170
2020	153

Table 2. Source from type

Types	Number of Articles
Book Chapter	155
Book Part	1
DataSet	1
Journal Article	782
Monograph	1
Peer Review	11
Posted Content	46
Proceedings Article	189
Reference Entry	7
Report	2
Other	5

Ten studies were selected for further analysis because they met the inclusion criteria, were relevant, and had been thoroughly read. The quality of the studies was then evaluated using the Mixed Methods Assessment Tool (MMAT), modified from Hong (2018). Based on the MMAT results, the ten qualitative studies (Table 4) were shown to have used random sampling that included a control or comparison group.

Table 3. Mixed Method Appraisal Tool (MMAT) 2018

Author, Year	Screening Questions		Quantitative randomized controlled trial				
	Is question research clear?	Is collection data collection can answer questions research question?	2.1. Was randominazation carried out appropriately?	2.2. Are the groups comparable from the beginning?	2.3. Is there is result data complete?	2.4. What is the intervention given confidentially (blind) to the result assessor?	2.5. Is participant obey intervention which given?

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(Putri, S. Z., & Bhakti, 2025)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Alkasasbeh, W., & Amawi, 2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Tohănean, D. I., Vulpe, A.-M., Mijaică, R., & Alexe, 2025)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Mulato, N., Hidayatullo h, F. S., Purnama, S. K., & Syaifullah, 2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Carvalho, U. C. D. A., & Leal, 2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Indarto, P., Nasuka, N., Hidayatulla h, M. F., Sulaiman, S., Setyawati, H., Raharjo, H. P., & Suryadi, n.d.)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Ha, T., Moon, J., Yu, H., Fan, X., & Paulson, n.d.)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Arif, Y. M., Nugroho, F., Aini, Q., Fauzan, Abd. C., & Garcia, 2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Marttinen, R., Rodrigues, A. I. C., Centeio, E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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E., & Mercier, 2025)							
(Zhao, J., Sitthiworachart, J., & Ratanaolarn, 2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4. Review of research result

Title	Method	Finding
(Putri, S. Z., & Bhakti, 2025)	Systematic Literature Review	Technology has been proven effective in increasing student motivation, learning outcomes, and engagement in physical education classes in elementary schools, although its effectiveness depends on the type of material. Therefore, appropriate technology integration strategies are needed to align with physical education objectives.
(Alkasasbeh, W., & Amawi, 2024)	Systematic Secondary Literature Review	The integration of EdTech into physical education learning faces obstacles such as human resources, disparities in teacher effectiveness, facilities, and changing priorities. Therefore, readiness, flexibility, technological support, and strengthening of the PETE program are necessary.
(Tohănean, D. I., Vulpe, A.-M., Mijaică, R., & Alexe, 2025)	Systematic Literature Review	AI and ICT have a positive impact on physical education, such as: more personalized learning, instant feedback, increased motivation, inclusive support, and improved motor skills assessment accuracy. However, there are also obstacles, such as: differences in infrastructure access, inadequate teacher training, and sensitive issues regarding ethics and personal data.
(Mulato, N., Hidayatulloh, F. S., Purnama, S. K., & Syaifullah, 2024)	Systematic Literature Review	Achieving goals depends on a broad strategy combining educational management practices, cooperative and blended learning models, and fresh curriculum innovation. This is presented alongside a necessary recognition of the challenges and downsides accompanying the digitalization process, ensuring a comprehensive view
(Carvalho, U. C. D. A., & Leal, 2024)	Mixed Methods	Unequal access to technology (digital inequality) poses problems for student participation in online physical education. This results in substantial differences in the number of students who are able to participate in and access the activities instructed by teachers during online learning.
(Indarto, P., Nasuka, N., Hidayatullah, M. F., Sulaiman, S., Setyawati, H., Raharjo, H. P., & Suryadi, n.d.)	Systematic Literature Review	The integration of technology in physical education learning can increase student motivation, participation, and understanding. However, challenges such as infrastructure, readiness, and a decline in physical activity have

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		been identified, necessitating a balanced approach.
(Ha, T., Moon, J., Yu, H., Fan, X., & Paulson, n.d.)	Systematic Literature Review and Meta Analyses (PRISMA)	The use of technologies such as accelerometers, web-based platforms, applications, and exergaming in physical education has a positive impact on results and physical activity levels, although its effectiveness varies depending on the type of technology.
(Arif, Y. M., Nugroho, F., Aini, Q., Fauzan, Abd. C., & Garcia, 2024)	Qualitative review with combining a Systematic Literature Review and case studies	Games supported by AI, exergaming, and immersive technologies such as AR, VR, and MR have been proven effective in increasing student motivation, participation, and learning outcomes in physical education subjects. However, solutions are needed in terms of cost and training for teachers.
(Marttinen, R., Rodrigues, A. I. C., Centeio, E. E., & Mercier, 2025)	Narrative Literature Review	After the COVID-19 pandemic, teachers experienced an increase in the use of technology, and many were encouraged to develop and improve digital teaching skills that shape practices in physical education learning.
(Zhao, J., Sitthiworachart, J., & Ratanaolarn, 2024)	Systematic Literature Review	The integration of AI demonstrates progressive and effective improvements in physical skills, cognitive outcomes, learning habits, and interest in sports, despite challenges in technology selection and implementation.

DISCUSSION

The use of technology in the physical education learning process in schools essentially has the goal of not only keeping up with the development of science and technology, but also improving the learning process to be more effective and efficient, increasing student involvement to be more active and interactive, and increasing student learning motivation (ChanLin, 2008; Getenet & Tualaulelei, 2023; Ghavifekr & Rosdy, 2015; Hennessy et al., 2007; Siddiqui et al., 2020; Tumaloto et al., 2024). (ChanLin, 2008; Getenet & Tualaulelei, 2023; Ghavifekr & Rosdy, 2015; Hennessy et al., 2007; Siddiqui et al., 2020; Tumaloto et al., 2024). The integration of technology in physical education learning includes: online learning platforms (LMS) and digital content (Liu et al., 2022; Nopembri et al., 2022; Wang et al., 2023; Yao et al., 2021); video modelling with the application of media Video Assignment Based on Motion Analysis (VABMA) (Gao et al., 2025; Heryl, 2020; Mereuta & Mereuta, 2013; Ningthoujam, 2016; Nuraini & Mas'odi, 2024; Septiana et al., 2022; Zulkifli & Danis, 2022); Augmented Reality (AR) (Arena et al., 2022; Mokmin & Rassy, 2024; Wu et al., 2013); Virtual Reality (VR)

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(Bae, 2023; Kuleva, 2024; Pasco, 2013; Pérez-Muñoz et al., 2024); Gamification (Fernandez-Rio et al., 2020; Ferriz-Valero et al., 2020); Wearable Devices (Almusawi et al., 2021; Baker et al., 2017; Marttinen et al., 2020).

The integration of technology in physical education has proven highly effective in improving student learning outcomes across various aspects, particularly motivation, motor skills, and knowledge acquisition. Technology integration in the learning process has been shown to produce moderate to significant increases in student motivation (g=0.6–0.7) (Furkan Kurnaz & Koçtürk, 2025).

The integration of technologies such as motion trackers, fitness apps, virtual training systems, and video analysis software allows students to observe movements, identify problems, and make appropriate adjustments to provide feedback. This process improvescoordination, balance, and overall motor skill development (Bossavit & Arnedillo-Sánchez, 2023; Russo et al., 2024; Suo et al., 2024).

Learning Management Systems (LMS) facilitate individualized learning paths and self-paced learning, allowing students to review material as needed and collaborate through discussion forums. This flexibility encourages deeper understanding, critical thinking, and long-term knowledge retention. Data show mixed but promising results: blended learning tends to produce small to moderate positive improvements compared to entirely face to face learning (Means et al., 2013).

The application of technology in physical education learning presents complex challenges and strong supporting factors. Research shows that while technology has the potential to transform physical education, its implementation is often limited by a combination of barriers such as: facilities; human resources (Saiz-González et al., 2025); unequal access (Suardi, 2023); poor instructional design; maintenance issues, and data/privacy concerns(Saiz-González et al., 2025). Success also depends on leadership (Boeske, 2023);continuing professional development (Juniu et al., 2013);reliable infrastructure, pedagogical alignment (Martín-

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Rodríguez & Madrigal-Cerezo, 2025);and affordable/suitable devices (Tolentino et al., 2024).

CONCLUSION

The use of technology in physical education learning in schools essentially aims not only to keep up with developments in science and technology, but also to improve the learning process to make it more effective and efficient, increase student engagement and interaction, and enhance student motivation. In physical education learning, technology commonly used includes:Learning Management System (LMS) and digital content, videomodelling/video playback,augmented reality, virtual reality, gamification, and fitness devices.

The integration of technology in physical education has also proven highly effective in improving student learning outcomes across various aspects, particularly motivation, motor skills, and knowledge acquisition. While the use of technology in the learning process does have a positive impact on students, it does present several challenges, such as: technology gaps/unequal access, teacher readiness and confidence, pedagogical design and alignment, maintenance and sustainability costs, validity, data privacy, inclusion, and accessibility.

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