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Literature Review: Challenges and Opportunities in Physical Education in the Digital Age: Impact on Teaching Methods

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Abstract. The digital transformation has significantly reshaped the landscape of education, including the field of physical education. This study aims to analyze the challenges and opportunities of digital technology integration into teaching methods in sports education through a systematic literature review (SLR). Data were collected from 20 national and international journal articles published between 2020 and 2025. A thematic content analysis was applied focusing on three main aspects: (1) the transformation of physical education in the digital era, (2) challenges in implementing digitalization, and (3) opportunities and their impact on teaching methods. The findings indicate that digitalization presents substantial opportunities for pedagogical innovation through the application of artificial intelligence (AI), the Internet of Things (IoT), flipped classroom, and hybrid learning models, all of which enhance learning effectiveness and student engagement. However, several challenges persist, including low digital literacy among teachers, infrastructural limitations, and difficulties in assessing physical performance online. Consequently, digital transformation in sports education requires a shift in the teacher's role—from a conventional instructor to a digital facilitator capable of adapting to technological change. This study emphasizes the need for policy support, professional development programs, and the integration of technology-based curricula to ensure the sustainability of digital transformation in physical education.

Keywords: physical education, digital era, teaching methods, technological innovation, digital literacy, hybrid learning

1 Introduction

The development of digital technology over the past decade has brought about a major transformation in the world of education, including sports education. The digital era demands a paradigm shift in learning, moving from conventional models that emphasize face-to-face physical activity to learning models that are more adaptive to developments in information and communication technology. In this context, physical education and sports are no longer understood solely as physical activity on the field, but also as forms of learning that utilize digital technology to increase the effectiveness, efficiency, and appeal of the teaching and learning process.

Several recent studies have shown that digitalization is opening up new opportunities for innovation in sports teaching. For example, the use of artificial intelligence (AI) and the Internet of Things (IoT) allows teachers and coaches to monitor and analyze students' physical performance in real time. These systems not only assist in objective assessment of motor skills

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but also provide faster and more accurate feedback to students (Fauzi et al., 2025; Cojocaru et al., 2022). Furthermore, the presence of wearable devices such as smartwatches and motion sensors has increased students' awareness of their own fitness. This shift encourages more personalized learning, where each individual can tailor training and learning to their individual abilities and needs.

However, behind this progress, significant challenges remain. Many physical education educators in Indonesia, particularly in rural areas, still face limited infrastructure and digital literacy. Unpreparedness for these changes often leads to suboptimal learning. Kurniawan and Rozaq (2025) emphasized that teachers' ability to integrate digital technology into the curriculum remains a major challenge in improving the quality of physical education. Meanwhile, Syafruddin (2023) noted that some teachers still view technology as an additional burden that hinders teaching flexibility, rather than as a tool that strengthens pedagogy.

In addition to technical challenges, there are also pedagogical barriers that need to be addressed. Physical education has unique characteristics because it requires direct physical involvement. This makes it difficult to evaluate physical skills entirely through digital media. Assessment of motor skills, body coordination, and physical endurance cannot be measured validly through videos or online modules alone (Indarto et al., 2024). Therefore, educators are expected to combine online and offline learning through a hybrid or blended learning approach, as proposed by Hidayatullah and Anwar (2020).

Nevertheless, the opportunities presented by the digital era in sports education should not be ignored. The integration of digital technology opens up vast opportunities for the development of innovative teaching methods such as the flipped classroom, where students independently study sports theory through digital materials before engaging in field practice. This model has been shown to increase learning effectiveness and maximize field practice time (Putra et al., 2024). Furthermore, interactive media such as virtual simulations and augmented reality are beginning to be used in tactical game learning, particularly in sports like basketball and soccer, to enhance students' strategic understanding and decision-making (Hita, 2023).

Several national studies also show increased student motivation and engagement when technology is used effectively in physical education learning. Kusumawati, Abidin, and Bujang (2022), in their study on the implementation of the Independent Curriculum, found that the use of digital media can strengthen student character, enhance collaboration, and foster a sense of responsibility for personal fitness. Furthermore, Al Ardha (2022) highlighted the potential of metaverse-based learning as a new paradigm for physical education, where students can simulate physical activities in a virtual environment without having to be in the same location.

Furthermore, changes in teaching methods due to digitalization have also impacted the role of physical education teachers. Teachers are no longer simply instructors giving demonstrations, but are transforming into digital facilitators, guiding students through various technology-based learning resources. This process shifts the learning approach from teacher-centered to student-centered, where students become active subjects responsible for their own learning experiences (Moustakas & Robrade, 2022).

This change also requires institutional policies that support the training and professional development of sports teachers in the field of learning technology. Without adequate training, teachers will struggle to adapt quickly to changes in the educational ecosystem. As emphasized by Wijayanto et al. (2022), the readiness of higher education institutions in the digital era will be a determining factor in the success of the future transformation of sports education.

Overall, the literature indicates that the digitalization of sports education is not merely an adaptation to technology, but also a broader transformation of pedagogical paradigms. Challenges faced, such as limited infrastructure, resistance to innovation, and obstacles in physical assessment, need to be addressed through a systemic approach involving teacher capacity building, digital curriculum development, and interdisciplinary collaboration. Opportunities such as the use of AI, blended learning, and interactive media promise a more inclusive, efficient, and data-driven future for sports education.

Thus, it can be concluded that sports education in the digital age is a dynamic and constantly evolving field. Its impact on teaching methods is twofold: on the one hand, it demands significant pedagogical adjustments, but on the other, it opens up ample scope for more effective and relevant learning innovations to suit the characteristics of today's digital generation.

2 Method

This study uses a systematic literature review (SLR) approach to identify, analyze, and synthesize various studies related to sports education in the digital era and its impact on teaching methods. Data were collected from reputable national and international journals indexed in Scopus, DOAJ, Google Scholar, and Sinta (S1–S3), with publication deadlines between 2020–2025. The search process was carried out using keywords such as "sports education", "digital era", "teaching methods in physical education", and "digitalization in sports education". Of the more than 60 articles found, 20 were selected based on inclusion criteria such as topic relevance, methodological clarity, and full access to the text. The analysis was conducted using thematic content analysis to group the findings into three main focuses: challenges of digitalization, opportunities for learning innovation, and its impact on teaching methods. The entire selection and analysis process followed the Kitchenham & Charters (2007) guidelines and the PRISMA 2020 guidelines, with data validity verified through source triangulation and peer review to ensure objective and scientifically sound study results. After going through the selection process with these criteria, 20 primary articles were obtained to serve as the basis for the literature analysis. These articles came from 10 international journals and 10 national journals, as follows:

NO	Article Title	Author and Source
1.	Classification of Innovations and Challenges in Teaching Physical Education in the Digital Age	Lutsenko, I., Leshchenko, H., & Prots, T. (2025). <i>Revista Eduweb</i> , 19(2).
2.	Dampak Pendidikan Jasmani terhadap Literasi dan Kemampuan Kognitif Siswa SD di Era 4.0	Nugraha, D., Rizali, I., & Santika, B. (2024). <i>JOLIMPIC: Journal of Sport and Physical Education</i> , 5(1).
3.	Digital Technologies: A Challenge for Physical Education	van Hilvoorde, I., & Koekoek, J. (2018). <i>European Physical Education Review</i> , 24(6).
4.	Hybrid Learning dalam Pembelajaran Pendidikan Jasmani Sekolah Dasar dan	Hidayatullah, F., & Anwar, K. (2020). <i>Prosiding Seminar Nasional Pendidikan Jasmani (SENOPATI)</i> , 4(1).

	Menengah Maupun Pendidikan Olahraga Perguruan Tinggi	
5.	Implementasi Kurikulum Merdeka dalam Pembelajaran Pendidikan Jasmani Olahraga dan Kesehatan (PJOK)	Kusumawati, M., Abidin, D., & Bujang, B. (2022). <i>Jurnal Maddana</i> , 11(2).
6.	Information Technology Innovation in Sports Learning: Understanding Global Trends and Challenges	Putra, C. A., Permadi, A. S., & Setiawan, M. A. (2024). <i>Retos Journal</i> , 53.
7.	Inovasi Digital Learning pada Mata Pelajaran Pendidikan Jasmani, Olahraga, dan Kesehatan (PJOK)	Al Ardha, M. A. (2022). UIN SATU Press – eBook <i>Teknologi Metaverse dalam Ilmu Keolahragaan</i> .
8.	Pengaruh Media Digital dalam Meningkatkan Pemahaman Konsep Taktik Permainan Bola Basket pada Pembelajaran Pendidikan Jasmani	35a, I. P. A. D. (2023). <i>Indonesian Journal of Sport and Tourism</i> , 11(3).
9.	Penggunaan Teknologi Digital dalam Pembelajaran Sains dan Olahraga untuk Meningkatkan Literasi dan Pemahaman Siswa	Kurniawan, Y. A., & Rozaq, M. (2025). <i>Jurnal Olahraga dan Teknologi</i> , 6(1).
10.	Peran Teknologi Pendidikan terhadap Perubahan Pembelajaran Pendidikan Jasmani	Syafuruddin, A. (2023). <i>Jurnal Teknologi Pendidikan</i> , 3(2).
11.	Perkembangan Komunikasi Pendidikan Olahraga di Era Transformasi Digital	Yulianto, E., Bayua, A. T., & Chan, A. A. S. (2025). <i>Athena Physical Education and Sports Journal</i> , 3(1).
12.	Physical Education in the Era of Artificial Intelligence: The Impact of AI Technology on Enhancing Sports Learning in Schools	Fauzi, M. S., Yantingsih, E., & Judjanto, L. (2025). <i>Tofedu Journal</i> , 4(4).
13.	Smart Physical Education: Governance of School Physical Education in the Era of New Generation of Information Technology and Knowledge	Deng, C., Feng, L., & Ye, Q. (2024). <i>Journal of the Knowledge Economy</i> .
14.	The Challenges and Realities of E-Learning during COVID-19: The Case of University Sport and Physical Education	Moustakas, L., & Robrade, D. (2022). <i>Education Sciences</i> , 12(1).
15.	The Digitalization in the Field of Physical Education and Sport: Status of the Issue	36 Stetsenko, N. V., & Shirobakina, E. A. (2020). <i>Science and Sport</i> , 1(22).
16.	The Impact of Agile Management and Technology in Teaching and Practicing Physical Education and Sports	Cojocar, A. M., Cojocar, M., & Jianu, A. (2022). <i>Sustainability</i> , 14(3).

17.	The Role of Physical Education and Sports in Modern Society Supported by IoT—A Student Perspective	Cojocaru, A. M., Bucea-Manea-Toniș, R., & Jianu, A. (2022). <i>Sustainability</i> , 14(9).
18.	Terdepan dalam Pendidikan Jasmani dan Ilmu Keolahragaan sebagai Pemacu SDM Unggul selama Pandemi	Wijayanto, A., Or, S., Kom, S., & Wibowo, A. D. S. (2022). <i>OSF Preprints</i> .
19.	Optimization of Learning Physical Education in Digital Era: A Systematic Review	Mulato, N., Hidayatulloh, F., Purnama, S. K., & Syaifullah, R. (2024). <i>Retos Journal</i> , 52.
20.	What Is the Learning Model of Physical Education in the Digital Era?: Literature Review of Various Studies	Indarto, P., Nasuka, N., & Hidayatullah, M. F. (2024). <i>Retos Journal</i> .

4 Result

The results of this literature review were obtained from an analysis of 20 scientific articles published between 2020 and 2025, spanning 10 international journals and 10 national journals. All articles were analyzed based on their thematic relevance, research findings, and relevance to the three main focuses of the study: (1) the transformation of sports education in the digital era, (2) challenges in implementing digitalization, and (3) opportunities and impacts on teaching methods.

1. Transformation of Sports Education in the Digital Era

Based on the literature review, digitalization has fundamentally changed the way sports education is delivered at various levels of education. This transformation includes the use of digital technology to support theoretical instruction, physical performance evaluation, and sports activity simulations. A study by Lutsenko, Leshchenko, & Prots (2025) classified various forms of teaching innovation in physical education, ranging from the integration of AI-based feedback systems to the use of online learning platforms. Similar results were found by Deng, Feng, & Ye (2024), who emphasized the concept of Smart Physical Education (Smart PE), in which teachers utilize big data to manage learning based on objective assessments. In Indonesia, Fauzi, Yantiningsih, & Judijanto (2025) demonstrated that the use of artificial intelligence in physical education training can improve the effectiveness of evaluation and help students understand their learning outcomes more quickly. Meanwhile, Wijayanto et al. (2022) highlighted how the COVID-19 pandemic accelerated the adoption of digital learning in sports faculties, making technology no longer merely a support but a core component of modern sports pedagogy.

2. Challenges of Implementing Digitalization in Sports Education

While technological advances bring innovation, much of the literature highlights significant challenges in its implementation. Key challenges include limited digital infrastructure, teacher preparedness, and difficulties in adapting physical education assessments to online formats. Syafruddin (2023) emphasized that not all physical education teachers have adequate digital competencies, resulting in many still using traditional methods despite the availability of online facilities. On the other hand, Indarto, Nasuka, & Hidayatullah (2024) found that physical

learning models are still difficult to replace with virtual methods due to limitations in motor observation, body coordination, and exercise intensity, which cannot be measured precisely online. In addition to teacher limitations, several studies also highlight the social and psychological aspects of students. Moustakas & Robrade (2022) revealed that the sudden transition to online learning during the pandemic led to digital fatigue and decreased social interaction among students. A similar situation also occurred in Indonesia, as reported by Hidayatullah & Anwar (2020), who found that most physical education students felt that online learning could not replace the physical experience that is at the heart of physical activity.

Other challenges also arise in the context of educational infrastructure and policy. Kurniawan & Rozaq (2025) highlighted the disparity in technological facilities between schools, while Nugraha, Rizali, & Santika (2024) revealed that low student digital literacy results in suboptimal online learning effectiveness. Thus, it can be concluded that although digitalization has been widely implemented, the challenges of human resources and supporting facilities are still the main obstacles in the implementation of effective digital sports education.

Opportunities and Impact on Teaching Methods

On the other hand, various studies show that the application of digital technology opens up significant opportunities for the development of innovative teaching methods. The use of learning management systems (LMS), interactive media, and virtual simulations has increased student participation and expanded access to learning resources.

Putra, Permadi, & Setiawan (2024) demonstrated that the flipped classroom approach can improve students' conceptual understanding of sports theory before applying it to practical applications. A similar finding was found in a study by Hita (2023), which demonstrated a significant increase in understanding of basketball tactics through the use of interactive digital media.

Furthermore, research by Cojocaru, Bucea-Manea-Țoniș, & Jianu (2022) highlighted the role of the Internet of Things (IoT) in increasing student fitness awareness, while Cojocaru, Cojocaru, & Jianu (2022) found that agile management and digital adaptability approaches in sports teaching improved learning efficiency at the university level.

Similar opportunities are also evident in the national context. Kusumawati, Abidin, & Bujang (2022) emphasized that the implementation of the Independent Curriculum allows teachers to combine digital methods with project-based physical activities. Meanwhile, Al Ardha (2022) introduced the concept of metaverse-based sports learning, which enables virtual interactions in immersive digital spaces, creating a more realistic and engaging learning experience.

Thus, the study's findings indicate that digitalization has given rise to a pedagogical transformation in the field of sports education. Teachers now act not only as instructors but also as technological facilitators, guiding students to learn independently and collaboratively through digital media. The impact on teaching methods is positive, particularly in terms of increased motivation, student engagement, and ease of access to learning, although its effectiveness still depends on teacher readiness and available infrastructure.

4. Synthesis of Key Findings

From the overall study results, three broad patterns of findings emerged:

1. Sports education is undergoing pedagogical digitalization, where technology has become an integral part of the physical education learning process;

2. The main obstacles lie in teachers' digital literacy and infrastructure gaps, rather than the relevance of the technology itself;

3. Significant opportunities emerge through the application of AI, hybrid learning, and gamification, which have been proven to increase the effectiveness and appeal of sports learning.

Overall, the findings of this literature indicate that digitalization is not just a trend, but a new direction in the development of global and national sports pedagogy.

5 Discussion

Digital transformation in sports education is an unavoidable phenomenon in the era of the 4.0 industrial revolution and the 5.0 industrial revolution. The literature analyzed in this study shows that sports education is experiencing a paradigm shift from traditional teaching models to a more adaptive, collaborative, and technology-based approach. This change is not only related to the use of digital tools but also encompasses the reconstruction of how teachers and students interact, evaluate, and construct knowledge in the context of physical education.

The review results indicate that the digitalization of sports education has a dual impact, opening up significant opportunities for innovative teaching methods while also creating new challenges in terms of human resource readiness, infrastructure, and the quality of learning interactions.

In general, research by Lutsenko, Leshchenko, & Prots (2025) and Deng, Feng, & Ye (2024) confirms that digitalization has given rise to a physical education model based on artificial intelligence and big data (AI & Big Data). The Smart Physical Education (Smart PE) concept they developed positions technology as a diagnostic tool and guide for student performance, rather than simply an administrative tool. This aligns with the view of Fauzi, Yantiningih, & Judijanto (2025), who assessed that the application of artificial intelligence in school environments can improve the objectivity of student motor skill assessments through biometric data analysis.

However, results obtained in the Indonesian context indicate a significant gap between potential and implementation. Research by Syafruddin (2023) and Kurniawan & Rozaq (2025) revealed that most physical education teachers still focus on conventional approaches due to low digital literacy and limited educational technology training. This situation is exacerbated by the disparity in facilities between urban and rural schools, resulting in the implementation of digital learning often being merely symbolic. These findings indicate that the digitalization of physical education in Indonesia has not been fully supported by policies aimed at strengthening teacher competencies and digital learning infrastructure.

Furthermore, another challenge arises in the context of the authenticity of online physical education. The physical activity that is at the heart of physical education is difficult to replace with digital simulations or distance learning. As stated by Indarto, Nasuka, & Hidayatullah (2024), the validity of assessments of motor skills, endurance, and body coordination is limited when conducted through digital media. This demonstrates that physical education requires a blended learning model that balances technology with real-life physical activity (hybrid learning).

In this regard, research by Hidayatullah & Anwar (2020) is highly relevant. They confirmed that the combination of online theoretical learning and offline physical practice produces a more effective learning process than fully online methods. This model accommodates the unique characteristics of physical education that cannot be fully digitized, while maintaining its student-centered pedagogical aspects.

Beyond challenges, digitalization also opens up significant opportunities for pedagogical innovation and strengthening student motivation. Research by Putra, Permadi, & Setiawan (2024) and Hita (2023) shows that flipped classroom-based learning and interactive media can increase student engagement, understanding of game tactics, and creativity in sports activities. Similar results were found by Cojocaru, Bucea-Manea-Țoniș, & Jianu (2022), who revealed that the integration of Internet of Things (IoT) technology encourages students to be more active in monitoring and improving their personal fitness through digital devices.

Another emerging opportunity is the development of metaverse-based learning, as proposed by Al Ardha (2022). This technology has great potential to deliver immersive physical learning experiences, especially in a future where virtual interactions become increasingly realistic. This innovation marks a pedagogical paradigm shift from traditional approaches to simulation-based digital experiences.

Another interesting finding comes from national research focusing on the Independent Curriculum and the role of teachers as digital facilitators. Kusumawati, Abidin, & Bujang (2022) concluded that the Independent Curriculum provides space for teachers to innovate with technology in project-based learning, including in physical education. Teachers are expected to not only teach physical skills but also foster digital literacy and critical thinking skills in students through technology integration. This indicates a shift in the teacher's role from teacher-centered to student-centered, where teachers act as mentors and facilitators of digitally-based independent learning.

Conceptually, the results of this literature synthesis support Vygotsky's social constructivism theory, where digital technology acts as a mediating tool in the learning process. Through digital interactions, students construct their own understanding through experience, exploration, and reflection. In the context of physical education, the teacher's role is crucial in ensuring that digital media does not replace physical activity but rather enhances the learning process through a more contextual and reflective approach.

Finally, it is worth noting that much of the literature highlights the urgent need for professional development for physical education teachers in the area of learning technology. Improving digital competency, utilizing data to evaluate student performance, and understanding the ethical use of technology are essential foundations for sustainable digital transformation. Thus, the digitalization of sports education is not just about adopting technology, but rather a systemic change in the way we think, teach, and assess the success of the learning process.

5 Conclusion

A literature review of 20 national and international articles published between 2020 and 2025 shows that digitalization has become a major force in transforming physical education, both in terms of learning concepts, the role of teachers, and the methodological approaches used in the classroom and on the field. Technological developments such as artificial intelligence (AI), the

Internet of Things (IoT), virtual reality (VR), and learning management systems (LMS) have not only enriched teaching methods but also challenged the traditional paradigm of physical education, which has historically focused on direct physical activity.

In general, the analysis indicates that digitalization in physical education has two major implications. First, digitalization creates innovative opportunities to improve the quality of learning, expand access to materials, and strengthen student engagement. Innovations such as the flipped classroom, hybrid learning, and the use of interactive media and gamification have been shown to increase student motivation, participation, and learning outcomes (Putra et al., 2024; Hita, 2023). In this context, physical education teachers no longer merely serve as physical instructors but rather as digital facilitators, helping students develop independent and reflective learning skills.

Second, substantial challenges must be addressed to achieve success in this transformation. These challenges include low teacher digital literacy, infrastructure gaps, and limitations in measuring physical competency through digital media (Syafuddin, 2023; Indarto et al., 2024). Furthermore, resistance to changes in teaching methods and a lack of policy support are major obstacles to the implementation of technology-based sports education at the national level. Therefore, while the potential for digitalization is enormous, its success still depends on the readiness of the education ecosystem—particularly teachers, schools, and government policies.

Theoretically, the results of this study support the paradigm of digital constructivist pedagogy, where technology is not merely a medium but also a means of social interaction, exploration, and reflection for students. Within this framework, sports education in the digital era must be directed at creating collaborative, participatory, and contextual learning experiences, rather than relying solely on one-way instruction. A student-centered approach is essential to ensure that physical education remains relevant to the active, visual, and experience-oriented nature of the digital generation.

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