Journal of ASEAN University Sport Vol. 1, No. 1, Tahun 2026, pp. 1-24
ISSN: 3164-2543 (Online)
https://journals.smartmotionedu.id/index.php/jaus

Evaluation of Innovations in Physical Education: A Systematic Review with a Digital Approach

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Article Info:
Received: *19-04-2026*
Revised: *25-04-2026*
Accepted: *29-04-2026*
Online: *30-04-2026*

Keywords:
learning methods development; physical educator; digitalization of learning; sport education

ABSTRACT

Physical Education (PE) has undergone a significant paradigm shift, moving from conventional direct instruction to a student-centered learning model supported by digital integration. This transformation aims to foster 21st-century skills and physical literacy holistically. This systematic review aims to evaluate the evolution of learning innovations in PE. This study adapted the PRISMA guidelines using the SCOPUS database and identified 327 documents. After the screening phase, 185 articles met the inclusion criteria. A total of 54 articles were further extracted for qualitative synthesis. Analysis of publication distribution revealed significant geographical gaps, with a global publication dominance centered in China. Thematic synthesis classified PE innovations into four evolutionary phases and conclude that the integration of advanced technology offers highly precise physical education assessment. However, its success depends on the design of the learning process and the pedagogy of the PE teacher. Future research is recommended to focus on experimental studies aimed at validating the effectiveness of digital instruments across diverse physical education ecosystems.

Journal of ASEAN University Sport Vol. 1, No. 1, Tahun 2026, pp. 1-24
ISSN: 3164-2543 (Online)
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INTRODUCTION

Physical Education (PE) is a field of study that integrates students' physical and cognitive aspects. As times change and call for a revolution toward a more holistic approach to education, PE is no longer merely about imparting motor skills and knowledge of movement to students. The shift in PE to align with the era of modernization and the demands of supporting the Sustainable Development Goals (SDGs) has made PE a means of shaping character, critical thinking skills, and lifelong physical activity (Baena-Morales et al., 2024).

Historically, PE in its early stages placed a significant burden on teachers (Alsalhe et al., 2021). The learning process remained teacher-centered, relying on direct instruction methods (Triansyah et al., 2025). This indirectly turned students into "robots," performing movement activities based solely on the PE teacher's commands. It was not uncommon for students to be denied opportunities for movement exploration. This phenomenon results in limitations for students in improving their physical literacy.

To provide an appropriate solution, theories have emerged that begin to place students at the center of the learning process. The emergence of constructivism and student-centered learning has played a role in innovating learning models that are more participatory and contextual (Moya & Cara, 2021). Innovative learning models have garnered significant attention in recent literature. These models, such as the Sport Education Model (SEM), Teaching Games for Understanding (TGfU), Cooperative Learning, Teaching Personal and Social Responsibility (TPSR), and physical literacy-based approaches, demonstrate a stronger focus on character development and 21st-century competencies (Prat et al., 2019; Zhang et al., 2022). Competencies in collaboration, creativity, communication, and critical thinking are essential in today's world (Bernate et al., 2024).

Although these learning models have been extensively explored, there is a need for literature that synthesizes the effectiveness of implementing these innovative learning models. Therefore, this study aims to systematically review previous research regarding the development of innovations in the PE learning process that have been developed and implemented. Through the analysis and synthesis of the findings in this study, it is hoped that relevant data can be presented to serve as a basis for evaluation and the development of better physical education in the future.

METHODS

This study adapted the data screening process from PRISMA, a reliable systematic review methodology. This study used only one database, namely SCOPUS, with the search terms "physical education" AND "development" AND "innovation" OR "innovative" AND "theory" OR "model." Based on the results of the search conducted through this database on February 9, 2026, a total of 327 research documents were identified (Figure 1). These results were then screened again directly using the features on the SCOPUS website.

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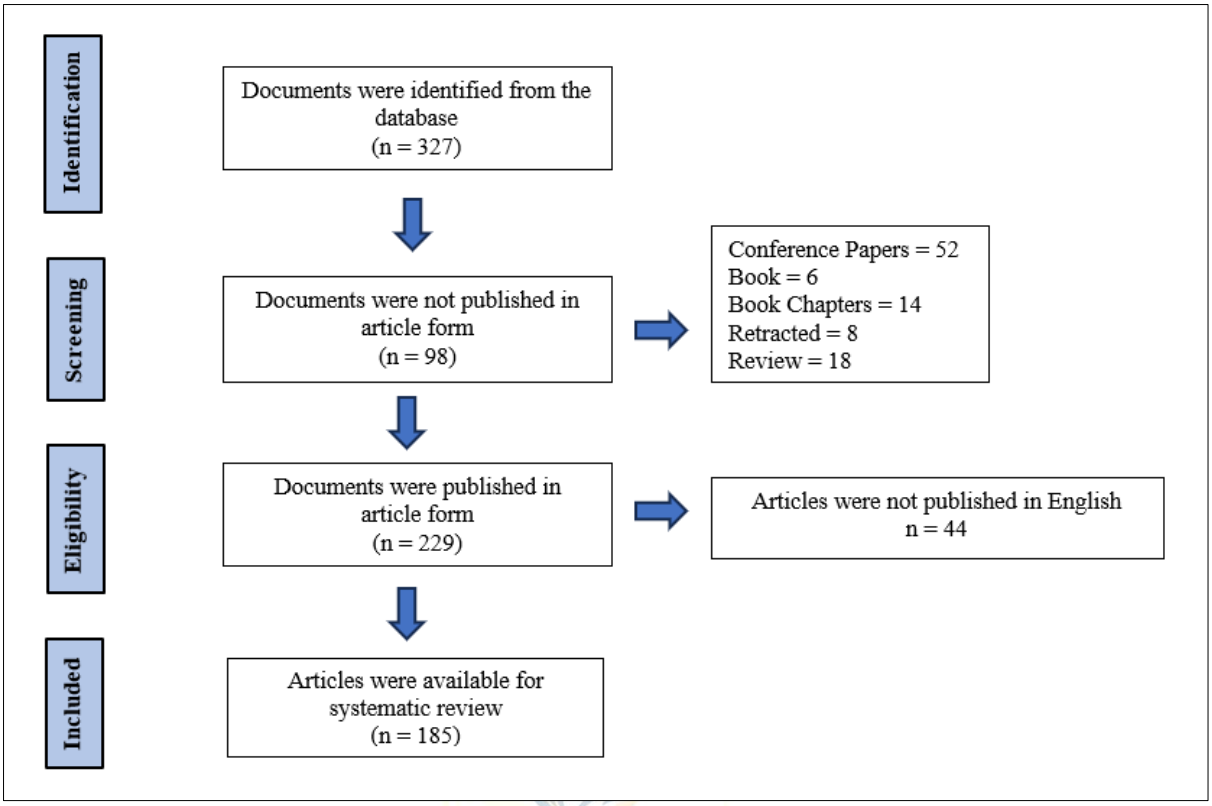

Figure 1. Screening Process

Procedures

The screening process included document type and language. These two factors served as exclusion criteria established for this study. The inclusion criteria were research documents published exclusively as articles and written in English. The final result of the screening process yielded 185 relevant research articles. Subsequently, these 185 articles will undergo further screening to identify the most relevant ones. These articles are those that examine innovations in physical education. Subsequently, a qualitative synthesis will be conducted to coherently and comprehensively review all findings and provide relevant and impactful implications. Through the identification of these innovations, the researcher will be able to present comprehensive data reviewing innovations in physical education from the beginning to the present.

RESULTS

The findings presented in this study are divided into two sections, which will be discussed in a coherent and comprehensive manner. These two sections are the contributions made through publications by countries around the world and the innovations in physical education that have been implemented from the early stages of development to the present day.

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Research Contribution

The data presented in this subsection consists of research documents identified during the "Identification" stage of the PRISMA flowchart (Figure 1). A total of 327 research documents has been mapped based on publications by the relevant countries. As shown in the map visualization in Figure 2, the distribution of research contributing to innovations in PE is not yet comprehensive. The gray color on the map indicates that research related to PE innovation has not yet been conducted in those regions.

Although no innovation has occurred in those regions, it is possible that they (gray areas) have implemented PE learning innovations carried out by major countries. China is the only country to have published extensively, with a volume four times that of other countries. A total of 121 research documents were identified, indicating that China is serious about improving the PE learning process in its country. This evidence cannot yet be considered strong proof that China contributes significantly. Such a high number suggests that some research may merely test the effectiveness or implement existing PE learning models or theories.

Countries with fewer publications can also make more significant contributions if they incorporate innovations in each of their publications. Therefore, qualitative data is needed to support the visualization of this distribution map. In this regard, the following subsection will present qualitative data on the innovations that have occurred from the beginning to the present. Through the coherence of these two subsections, the data presentation will be comprehensive and holistic.

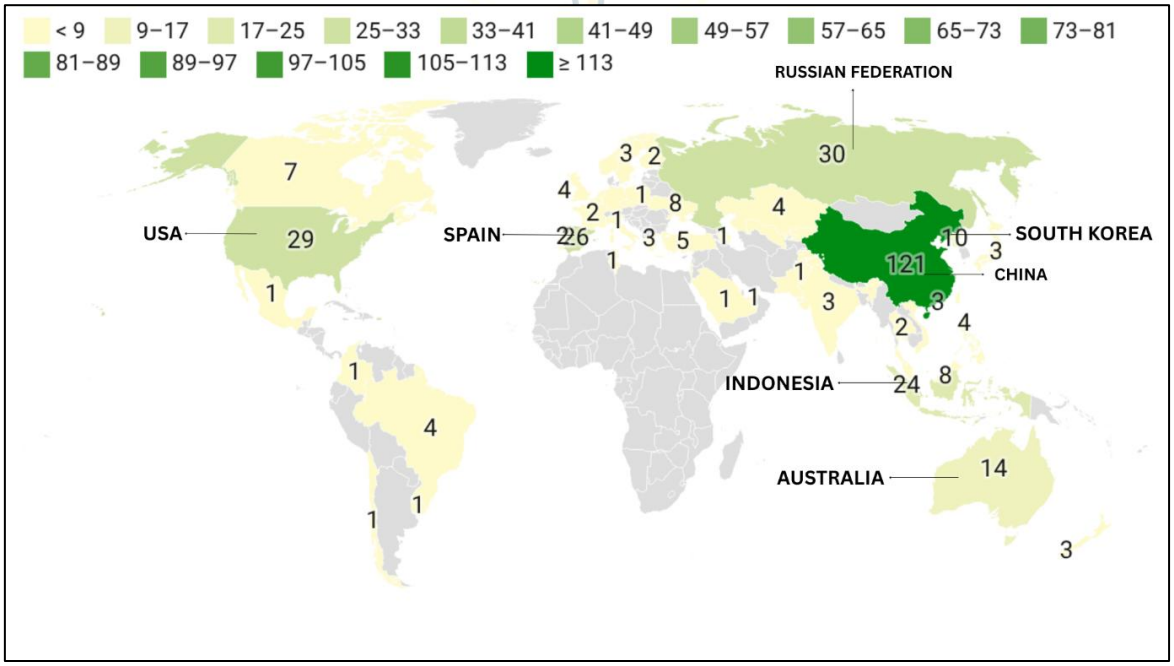

Figure 2. Countries Contributed

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Research Innovation

185 articles that met the inclusion criteria in screening process, the researchers conducted the final stage of qualitative data extraction. At this stage, the selection focused specifically on articles presenting empirical interventions, implemented innovation models, or the development of technological tools within the Physical Education (PE) ecosystem. The final reduction identified 54 of the most representative published documents for further analysis, synthesis, and mapping of learning innovations in PE.

Based on the innovation identification results in Table 1, the development of innovations in PE learning can be classified into four phases representing the evolution from conventional structural approaches toward technology integration.

During the initiation period of 1996–1997, innovations focused on structural levels oriented toward public health and educational inclusivity. This was marked by the implementation of large-scale programs such as the Child and Adolescent Trial for Cardiovascular Health (CATCH), which targeted students' cardiovascular health, as well as the development of a curriculum specifically adapted for children with various physical and intellectual disabilities.

Entering the pedagogical transition period from 2012 to 2019, a significant paradigm shift occurred toward student-centered learning models. Innovations during this period included the implementation of learning models such as the Sport Education Model (SEM), Teaching Games for Understanding (TGfU), and Teaching Personal and Social Responsibility (TPSR). The focus of learning extended beyond character development to laying the foundational groundwork for children's physical activities.

From 2020 to 2023, developments began to center on digital and hybrid learning. This marked the massive integration of technology into the PE curriculum. Hybrid or blended learning processes encouraged the use of digital devices such as wearable devices, Virtual Reality (VR), the internet, and Artificial Intelligence (AI). Additionally, pedagogical approaches began incorporating gamification and interactive multimedia into online learning (hybrid or blended).

The use of more advanced technologies began to be applied in 2024–2026. Innovations in physical education are no longer limited to methods of delivering content but have entered the realm of precise motion assessment. AI technology and virtual simulation applications are used for posture training that integrates biomechanical principles. Advanced innovations are evident in the use of motion detection algorithms such as the Spatial Temporal-Graph Convolutional Network (ST-GCN), which provides real-time feedback, and evaluation through the integration of data from wearable sensors, video recordings, and audio signals for holistic assessment in PE.

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Table 1. Physical Education Innovations

No	Author	Citation	Country	Innovation	Participant
1	(McKenzie et al., 1996)	263	United States	The Child and Adolescent Trial for Cardiovascular Health (CATCH) were a pioneering initiative focused on health-related physical education (PE).	For 2.5 years, a systematic analysis of 2,096 physical education classes was conducted across 96 public schools in four states.
2	(Doll-Tepper, 1997)	0	Germany	Targeted curricula for children with disabilities, including physical disabilities, hearing and vision impairments, speech and behavioral issues, and intellectual disabilities.	Not Available.
3	(Lubans et al., 2012)	48	Australia	The Supporting Children's Outcomes Using Rewards Exercise and Skills (SCORES) intervention is a multifaceted physical activity and fundamental movement skills program designed for primary schools.	Teachers, Parents, and Students.
4	(Casey et al., 2013)	13	Australia	The Triple G program sought to enhance physical activity levels among secondary school girls.	Secondary school girls (12-15 years).
5	(Nathan & Haynes, 2013)	19	Malaysia	A hybrid instructional framework for teaching games — The Style 'E' Tactical (SET) Model.	Two hundred twenty-five lads from a high school in Penang.
6	(Chen et al., 2013)	18	Taiwan	Sport Education Model	One professional educator and 43 students (18 females and 25 males).

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No	Author	Citation	Country	Innovation	Participant
7	(Budiana, 2014)	2	Indonesia	Self-regulation and conventional educational frameworks.	60 junior high school students.
8	(Dalziell et al., 2015)	13	United Kingdom	Better Movers and Thinkers (BMT) learning approach.	Forty-six pupils from two primary schools in Scotland.
9	(Chan et al., 2016)	19	China	The A + FMS intervention aimed to enhance FMS proficiency among Hong Kong Chinese pupils.	282 from grade 3.
10	(Yili, 2017)	4	China	Computer Simulation Technology	Not Available.
11	(Maksymchuk et al., 2018)	27	Ukraine	Pedagogical proficiency of prospective physical education instructors.	468 students and 19 physical education instructors in higher education.
12	(Prat et al., 2019)	39	Spain	Pedagogical framework of Teaching Personal and Social Responsibility through physical activity (TPSR) and student motivation in Physical Education (PE).	44 students in secondary school.
13	(Webster et al., 2020)	12	America	A comprehensive school physical activity program (CSPAP) aims to assist school-aged adolescents in adhering to physical activity requirements while cultivating the knowledge, skills, and attitudes necessary for sustained lifelong engagement in physical activity.	407 physical educators.
14	(Cheng, 2021)	50	China	The application framework of Virtual Reality (VR) technology.	Not Available.
15	(Jia, 2021)	8	China	Teaching Games for Understanding integrated with the Sport Education	224 students at a university in Hainan Province.

No	Author	Citation	Country	Innovation	Participant
				Model on college students' cognitive performance and motor skills in football.	
16	(Zhen et al., 2021)	8	China	Development of an ecological model for collegiate physical education in the context of health and environmental sustainability.	Not Available.
17	(Festiawan et al., 2021)	12	Indonesia	Traditional Sport-based Learning.	The research sample consisted of 68 students
18	(Fenanlampir et al., 2021)	10	Indonesia	Homogeneity Psycho Cognition (HPC) Learning Strategy.	Students in the fourth and fifth grades from four primary schools in Ambon City.
19	(Wang et al., 2021)	13	China	Development of talent and curriculum design for early childhood physical education majors at higher education institutions.	Undergraduate student majoring in early childhood education.
20	(Chaloupský et al., 2021)	9	Czech Republic	The application of fitness trackers in smartphones for fitness running instruction within a blended learning framework.	278 students.
21	(Moya & Cara, 2021)	18	Spain	Advancement of student-centered approaches.	A sample of 303 students enrolled in physical education at the University of Granada.
22	(Kryshtanovych et al., 2021)	0	Ukraine	Framework for establishing a healthcare system to promote sports instruction among schoolchildren.	School children.
23	(Liu, 2022)	1	China	Innovative pedagogical approaches in football	Students at school.

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No	Author	Citation	Country	Innovation	Participant
				using big data and the Internet.	
24	(Zhang & Yang, 2022)	2	China	Structural equation modeling (SEM) to examine the augmentative effect of cooperative learning-based physical education (CL-PE).	Preschool-aged students from three schools.
25	(Zhou et al., 2022)	2	China	Instruction in online sports games utilizing artificial intelligence.	Not Available.
26	(Yu & Mi, 2023)	20	China	The integration of IoT and AI is utilized to examine the deployment of innovative practical teaching methods in college physical education.	400 students in a sports department.
27	(Wang & Zhao, 2023)	0	China	A novel physical education initiative and technique, grounded in the principles of self-determination theory, aimed at enhancing physical activity and motivation.	256 participants at a university in China.
28	(Satyawan et al., 2023)	1	Indonesia	Interactive multimedia in E-learning.	Not Available.
29	(Sotos-Martínez et al., 2023)	29	Spain	Innovative gamification methodology for enhancing the motivation of basic physical education pupils.	Seventy-two elementary school kids from two distinct Spanish primary institutions.
30	(Bai, 2024)	0	China	Innovation of physical education theory.	99 students in college.
31	(Qian, 2024)	3	China	Intelligent teaching *model.*	Students at school.
32	(Sunardianta et al., 2024)	4	Indonesia	Formulating educational management frameworks.	Comprising school supervisors, principals, educators,

No	Author	Citation	Country	Innovation	Participant
					students, and committees.
33	(Chen, 2024)	1	China	The instruction of prescription education in collegiate physical education.	Student.
34	(Bernate et al., 2024)	4	Colombia	The formulation of novel pedagogical tactics inside educational environments to enhance capabilities.	Undergraduates enrolled in the Bachelor's program in Physical Education at a Colombian institution.
35	(Shao, 2024)	0	China	The theory of sports psychology is refined, and the instructional framework is modified to use PCA (principal component analysis) from multivariate statistical analysis for teaching assessment.	Students at school.
36	(Çakto & Akin, 2024)	1	Turkey	The situated game teaching paradigm with set plays is an innovative approach to basic motor skills.	62 second grade students.
37	(Park, 2024)	1	South Korea	The "Sports DreamCatcher" program is an innovative career education approach seamlessly incorporated into elementary physical education (PE).	114 sixth-grade students.
38	(Baena-Morales et al., 2024)	7	Spain	The Physical Education Sustainable Development Intervention Model (PESDIM) framework integrates psychological theories with targeted instructional practices for	Not Available.

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No	Author	Citation	Country	Innovation	Participant
				sustainable development in physical education.	
39	(Ritonga et al., 2024)	5	Indonesia	The Teaching Games for Understanding (TGFU) methodology for core movement skills.	156 students from fifth grade at elementary school.
40	(Gao, 2025)	9	China	Artificial intelligence (AI) technology in physical education.	Not Available.
41	(Ilahi et al., 2025)	0	Indonesia	Android-based interactive educational media employing AI and VR technologies to augment the teaching and learning experience for badminton courses within the Physical Education Study Programme at a university.	Not Available.
42	(Priambodo et al., 2025)	0	Indonesia	Task-oriented physical education learning paradigm to enhance students' intrinsic motivation and motor learning results in physical education.	70 students in junior high school.
43	(Chang, 2025)	1	China	A comprehensive virtual simulation training platform aimed at improving physical education through the integration of biomechanics for accurate posture instruction.	Not Available.
44	(Zha et al., 2025)	0	China	Cognitive Activation Teaching Strategies (CATS), to enhance higher-order thinking.	929 elementary school students and their parents.
45	(Risma et al., 2025)	1	Indonesia	The Physical Education, Sports, and Health module integrates pencak silat content with	Seventh grade students in junior high school.

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No	Author	Citation	Country	Innovation	Participant
				physical fitness activities to improve the physical fitness of seventh-grade pupils.	
46	(Ghorbel et al., 2025)	2	Tunisia	Innovative gamified blended learning model on the educational experiences of secondary school pupils in gymnastics.	127 students at secondary school.
47	(Wu & Zhan, 2025)	0	China	Data-driven intelligent instructional support systems have emerged as a vital avenue for educational improvement in physical education.	Not Available.
48	(Sun et al., 2025)	2	China	An innovative Multi-Criteria Decision Making (MCDM) approach, grounded in the Analytic Hierarchy Process (AHP), to enhance the teaching and implementation of physical education programs.	Not Available.
49	(Nelson et al., 2025)	0	Indonesia	Interactive digital educational resources for Pencak Silat training on the Articulate Storyline platform.	Not Available.
50	(Kwon et al., 2025)	0	South Korea	Maker-based physical education is a collaborative and student-centered methodology that fosters inclusive engagement and learning within school physical education curricula.	Not Available.
51	(Ji et al., 2025)	2	Malaysia	Action detection technique utilizing the Spatial Temporal-Graph Convolutional Network	Junior high school students

No	Author	Citation	Country	Innovation	Participant
				(ST-GCN) within the MediaPipe framework, focusing on the precision of action recognition in junior middle school students' athletic activities, and delivering prompt and precise feedback.	
52	(Wen, 2026)	0	China	A unique Multimodal Attention-based Transformer-Enhanced Deep Fusion Model (MAT-DFM) for intelligent assessment in physical education, utilizing wearable sensor data, video records, and audio inputs to establish a robust, real-time evaluation framework.	Not Available.
53	(Bagayas et al., 2026)	0	Philippines	Innovative game in physical education called Futenvol.	Three hundred twenty-seven students enrolled in the Bachelor of Physical Education program.
54	(Ning & Liu, 2026)	0	South Korea	An integrated approach that merges Quality Function Deployment (QFD) with the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy TOPSIS) for evaluating the quality of kindergarten physical education curricula.	Not Available.

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DISCUSSION

Innovations in the physical education learning process contribute significantly to improving the quality of the learning process. These innovations involve various aspects that extend beyond physical education alone. Other aspects or fields such as health and information technology, are also involved in developing innovations in physical education. To explore these findings in greater depth, the discussion is organized into several main subtopics.

The Digital Age and the Constructivist Approach

The transformation of education in the digital age has shifted the learning paradigm from a teacher-centered approach to one that is more participatory, innovative, and learner-centered. In the context of physical education, this change involves not only the use of digital technology but also a shift in the pedagogical approaches that underpin the learning process. The constructivist approach is particularly relevant because it emphasizes that knowledge is actively constructed by students through learning experiences, social interaction, and reflection on their activities. This approach aligns with the characteristics of physical education, which relies on movement experiences as the primary source for building students' understanding and skills. Research indicates that the constructivist approach can enhance student engagement, conceptual understanding, and critical thinking skills in physical education (Zha et al., 2025).

The development of digital technology in the era of the 5.0 industrial revolution further expands opportunities for applying the constructivist approach in physical education. Technologies such as motion analysis video, fitness apps, online learning platforms, and wearable devices (Cheng, 2021; Satyawan et al., 2023). These technological advancements help students receive real-time feedback and support the evaluation process in physical education. The integration of this technology also enables the implementation of various constructivist learning models, such as problem-based learning, project-based learning, and flipped learning, which encourage active student engagement. Several studies indicate that the pedagogically designed use of digital technology can enhance learning motivation, the quality of learning interactions, and students' understanding of motor skills (Chaloupský et al., 2021; Sotos-Martínez et al., 2023). Nevertheless, the use of technology also faces challenges, particularly regarding teachers' digital literacy readiness and the availability of infrastructure. Therefore, the use of technology must be designed proportionally as a learning support tool, not a substitute for physical activities, because fundamentally, physical education aims to increase students' physical activity, physical fitness, and movement literacy (Webster et al., 2020).

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The 21st-Century Learning Ecosystem and the Paradigm Shift in Deep Learning within Physical Education

The 21st-century learning ecosystem has sparked a shift in the learning process within Physical Education (PE). The teaching and learning process is moving away from traditional instructional models toward the integration of various educational aspects, thereby creating a holistic learning experience. The role of the teacher has significantly transformed into that of a facilitator who stimulates student engagement. This transformation fosters higher-order thinking skills (HOTS) in students (Zha et al., 2025). Through this supportive and interactive learning ecosystem, students are given the freedom to explore their potential during the PE learning process.

The development of essential 21st-century competencies includes critical thinking, creativity, collaboration, and communication (4Cs). These elements must be integrated into PE objectives. The implementation of problem-solving and strategy-based pedagogical innovations, such as Teaching Games for Understanding (TGfU) or the Sport Education Model (SEM), serves as a relevant framework for cultivating these competencies (Chen et al., 2013; Jia, 2021; Ritonga et al., 2024). Sports activities are no longer viewed as daily physical routines but rather as simulations of social dynamics related to teamwork, role negotiation, and decision-making. Students are required to formulate strategies and solve problems collaboratively during the learning process. Consequently, this indirectly hones their emotional and social intelligence.

The advancement of this learning ecosystem is further strengthened by the integration of digital technology as a catalyst for objective evaluation (Wen, 2026). The use of data-driven instructional support systems provides instant and precise movement feedback (Ji et al., 2025; Wu & Zhan, 2025). The synergy between pedagogy and technology serves as a bridge to close the gap between students' cognitive understanding and motor execution. Through this, the 21st-century PE ecosystem does not merely transform how students learn within the school environment but also builds a strong foundation of physical literacy, enabling them to grow into independent, adaptive, and active individuals throughout their lives.

Global Publishing Hegemony and the Challenges of Implementing an Adaptive Curriculum

The distribution of publications in the literature reveals an imbalance in knowledge production within physical education research, with the majority of studies originating from countries with stronger research capacity and academic infrastructure (Qian et al., 2025). This dominance has the potential to establish significant hegemony in the development of instructional models. This impacts pedagogical innovations emerging globally, which are often widely adopted without adequate adaptation to the national curriculum context (Zhang et al., 2024).

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On the other hand, the implementation of an adaptive physical education curriculum still faces various structural challenges, such as disparities in facilities, teachers' pedagogical readiness, and limited integration of educational technology in school settings (Saiz-González et al., 2025). Therefore, curriculum innovation is not merely about adopting pedagogical models developed in the global literature; rather, it must be contextually adapted by integrating the needs of students and the sociocultural characteristics of the learning environment (Alfrey & O'Connor, 2022).

The development of an adaptive physical education curriculum also requires a collaborative approach involving teachers, policymakers, and the educational community (Aasland et al., 2025). This approach enables the integration of global pedagogical practices with the contextual needs of schools. The resulting innovations in learning will not merely involve the transfer of knowledge between teachers and students, but will also lead to more inclusive, responsive, and sustainable physical education practices across various educational contexts (Wiggers et al., 2025).

The phenomenon of publication hegemony identified in this study provides empirical evidence for PE researchers and activists to drive more significant innovation in PE. Collaboration across various fields and among stakeholders is highly feasible to bring about meaningful changes in PE education. Consequently, the PE learning process can be conducted holistically, providing students with a meaningful learning experience.

Research Implications: The Future Direction of Physical Education

A literature review conducted by identifying innovations in physical education instruction reveals significant shifts from year to year. This evolution has been accompanied by a transition from conventional teaching methods to more modern approaches. The use of digital technologies, ranging from those commonly used by the general public to advanced digital technologies, has become a hallmark of innovation in the physical education process in schools.

This study provides an overview or visualization for physical education practitioners, particularly physical education teachers. The implications presented in this study take the form of recommendations for more innovative learning processes in the future. Innovations implemented by physical education teachers will impact student engagement and participation in the learning process.

This is evidenced by research conducted by Jia, (2021), through innovative teaching methods in the soccer learning process. The innovation implemented was Teaching Games for Understanding (TGfU), which yielded positive results in the form of improved learning adaptation. Students found the learning process to be creative and enjoyable. Other instructional innovations, such as a learning model incorporating traditional sports, have proven effective in enhancing students' basic motor and affective skills (Mujriah et al., 2022).

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In addition to innovations in teaching methods and models, innovations have also emerged in teaching tools and media. The development of teaching media such as movement task cards has made them an efficient tool due to their low cost and portability. Research by Bikalawan et al., (2024) demonstrates that learning materials based on movement task cards are effective in improving students' locomotor skills. Furthermore, this study also recommends that the movement task cards developed can be adapted for use in various types of games in physical education.

Another innovation in digital technology is demonstrated through the integration of Android applications into the physical education learning process. Research by (Chaloupský et al., 2021) demonstrates that such integration can boost student motivation and participation. In addition to the school setting, innovation is also taking place on college campuses through the integration of the internet and artificial intelligence (AI). According to research by (Yu & Mi, 2023), This integration has led to improvements in the quality of the learning process and serves as a platform for developing students' athletic talents.

These studies provide empirical evidence that innovations in physical education have facilitated a more optimal learning process. Based on this, the researchers recommend that physical education teachers deliver the learning process through creative and engaging innovations. Innovation can begin with the development of learning media, such as movement task cards, or the use of digital technology, such as Android devices. Through these innovations, it is hoped that physical education can be transformed to become more adaptable to the current curriculum. Thus, physical education is not merely an expository learning process but is capable of providing meaningful learning outcomes for students.

CONCLUSION

Based on the systematic review conducted, it can be concluded that innovation in Physical Education (PE) has evolved in a linear and progressive manner across four main phases. This development began with interventions focused on physical health and curriculum inclusivity, eventually leading to an era of advanced technology integration. Current innovation trends show a strong emphasis on the utilization of digital ecosystems, such as the integration of Artificial Intelligence (AI), Virtual Reality (VR), Internet of Things (IoT), and digital data, including the incorporation of sports biomechanics. This evolution demonstrates that physical education is no longer practiced through concrete instruction but has evolved into the use of digital technology as an interactive pedagogical model.

Although previous research has presented attractive innovations, this study reveals methodological limitations in a number of prior studies. These limitations are related to the predominance of observational designs using small-scale research samples. Further research is highly recommended to adopt large-scale experimental designs and longitudinal studies. Statistically rigorous validation of effectiveness is considered effective in validating the suitability of pedagogical and digital tools across various contexts. This is important to ensure that the adopted innovations have empirical evidence supporting the holistic development of students.

ACKNOWLEDGMENTS

The authors wish to express their deepest appreciation to the Faculty of Sport Science and Health, Universitas Negeri Surabaya, for providing the essential resources and academic support that laid the foundation for this research. We are equally grateful to the Faculty of Sport and Exercise Science, Universiti Malaya, for their expert technical guidance and significant contributions to the advancement of the study's methodology. Furthermore, we extend our sincere thanks to the College of Huilan, National Dong Hwa University, for their invaluable collaborative insights and dedication to fostering cross-disciplinary excellence. Finally, we thank all participants and staff from these esteemed institutions whose cooperation made this international synergy possible.

FUNDING STATEMENT

This study is an independent research project and did not receive any specific funding grants from any funding agencies.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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