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Deep Learning as Artificial Intelligence Technology in Physical Education: A Literature Review Based on Bloom's Taxonomy

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Abstract

Technological advancements necessitate a shift in education, especially in physical education, which sometimes remains confined to gross motor skills without enhancing cognitive processes. This study seeks to analyze and assess the role of Deep Learning (DL) technology within Artificial Intelligence (AI) in enhancing the quality of physical education instruction based on Bloom's Taxonomy framework. The method used is a Systematic Literature Review (SLR) following the PRISMA standards. Data were collected through the Google Scholar, Scopus, and Elsevier databases using the Publish or Perish tool, which produced 10 selected articles to be synthesized after undergoing a rigorous selection process. The study's results indicate that the incorporation of Deep Learning can elevate learning from simple imitation of movement to profound analytical comprehension. The use of algorithms such as ResNet-101 and 3D pose estimation enables precise biomechanical analysis and objective performance evaluation that supports higher-order thinking skills (HOTS). In conclusion, this technology acts as a catalyst in achieving physical literacy and student learning independence. The integration of AI with student-centered pedagogical strategies is the key to the future of holistic physical education.

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INTRODUCTION

Education is constantly evolving based on the needs and capabilities of the times in implementing efforts to enhance the quality of the educational process. According to Bloom's Taxonomy Theory in the article by Momen et al., (2023), education has six main pillars, namely Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. An efficient educational process process can only be achieved if the transfer of knowledge takes place optimally and covers all of these cognitive stages, not stopping at remembering and understanding, but encouraging application, analysis, evaluation, and even the creation of new knowledge (Abinbuhaybeha, 2023). In physical education, this is important because learning requires the integration of conceptual understanding and practical skills. Therefore, the use of deep learning has the potential to strengthen the knowledge transfer process by providing adaptive analysis and feedback, thereby optimizing the achievement of all aspects of Bloom's Taxonomy.

Initially, deep learning was used for large-scale data processing methods to automatically apply complex patterns to artificial intelligence (AI). However, the concept of applying deep learning in system optimization has inspired the education sector to optimize learning and cognitive development in students. Deep learning makes an important contribution to physical education by encouraging learning that focuses not only on physical activity, but also on deep understanding, critical thinking, and the application of knowledge in real-world contexts. According to literature research, deep learning involves the integration of knowledge, active student engagement, and critical, creative, and collaborative thinking skills. This is highly relevant to the goals of 21st-century physical education (Akmal et al., 2025). In addition, deep learning technology innovations enable more personalized learning through adaptive systems and student performance analysis, thereby increasing engagement and learning effectiveness (Saadah et al., 2024). Thus, deep learning serves as a strategic approach in transforming physical education towards more holistic and meaningful learning.

The integration of deep learning methodologies in the contemporary curriculum is necessitated by the evolving demands of the era and the imperative to enhance 21st-century competencies that remain inadequately addressed by conventional education. The Merdeka Curriculum was developed in response to developments in science and technology and the deficient critical thinking skills of Indonesian students, as reflected in PISA results that are still below international standards (Cholifatunisa et al., 2025). Deep learning supports the principles of the Merdeka Curriculum, which is student-centered, flexible, and focused on developing students' character and holistic competencies such as critical thinking, creativity, collaboration, and communication. The deep learning technique is pertinent as it prioritizes meaningful, reflective, and contextual learning, enabling students to not only retain courses but also to relate, analyze, and apply their knowledge in real-life situations (Rosiyati et al., 2025). The concept of deep learning in education is a strategy that prioritizes profound comprehension by integrating attentive, meaningful, and enjoyable learning as a cohesive entity. Consequently, incorporating deep learning into the current curriculum is a crucial technique to enhance learning quality and equip students to confront global challenges adaptively and sustainably. (Prihantoro et al., 2025). Mindful Learning is defined as a learning process carried out with complete awareness, reflection, and self-regulation skills, such that students are able to comprehend how they learn and govern their thought process reflectively. Meaningful Learning emphasizes the connection between learning concepts and students' personal experiences and daily lives, so that the knowledge gained is relevant, contextual, and meaningful. Meanwhile, Joyful Learning focuses on generating a happy and engaging learning atmosphere through activities, games, and experiments that enhance students' emotional participation and intrinsic drive (Prihantoro et al., 2025). Therefore, it may be inferred that the application of deep learning in the Merdeka Curriculum is an important approach to improving 21st-century competencies because learning is student-centered and focuses on building their character and critical, creative, collaborative, and communicative thinking skills. The combination of deep learning, meaningful learning, and joyful learning enables learning to take place in a deep, reflective, contextual, and meaningful way.

Bloom's taxonomy emphasizes three main pillars in the learning process, namely cognitive, affective, and psychomotor. The cognitive domain relates to academic reasoning and problem-solving abilities, the affective domain covers aspects of feelings, values, motivation, attitudes, and appreciation of learners, while the psychomotor domain involves physical coordination, motor skills, and practical actions (Huseng et al., 2025). This framework is in line with the focus of modern education, which places the social and emotional development of children as an essential component because it directly influences adaptive behavior, psychological well-being, and long-term learning readiness. A developmentally appropriate preventive approach has proven effective when integrated into the educational environment, as it is able to tailor interventions to the cognitive and emotional developmental stages of learners (Scheithauer & Scheer, 2022). In addition, the implementation of social-emotional learning-based programs in schools contributes significantly to improving emotional regulation and social skills, as well as reducing the risk of behavioral problems, thereby supporting the goals of a curriculum oriented towards holistic learning for children (Raiola, 2025). Thus, strengthening the social-emotional aspects of the curriculum is not only preventive but also strategic in creating a healthy and sustainable learning environment.

Physical education is an important component of the educational curriculum, which aims to develop each student holistically through planned and meaningful physical activities. Physical education not only improves motor skills and physical fitness, but also builds students cognitively, affectively, socially, and morally. Physical education helps students learn critical thinking skills, physical fitness, emotional stability, moral values, and healthy lifestyles through exercise and physical activities (Bangun, 2013). According to Whitehead's perspective, the concept of physical literacy is the philosophical basis for physical education, which emphasizes how important it is for everyone to be able to move effectively, confidently, and meaningfully as part of the full realization of human potential (Whitehead, 2001). In addition, research shows that an embodiment-based pedagogical approach in physical education has the ability to broaden students' learning experiences because it places the body at the center of learning and facilitates critical reflection, body awareness, and meaningful movement experiences (Aartun et al., 2020). Thus, physical education can be understood as an educational process that utilizes physical activity to develop the whole person through the continuous integration of physical, mental, emotional, and social aspects.

Consequently, the literature evaluation indicates that deep learning significantly contributes to the transformation of physical education into a comprehensive and meaningful learning experience that aligns with the requirements of 21st-century competences. Deep learning is recognized not only as an artificial intelligence technology for data processing but also as a pedagogical method that fosters profound comprehension, critical analysis, reflection, and contextual reasoning, aligning with all levels of Bloom's Taxonomy across the cognitive, affective, and psychomotor domains. The incorporation of this methodology within the Merdeka Curriculum enhances student-centered learning by implementing mindful, meaningful, and joyful learning, thereby expanding physical education beyond mere physical skill development to encompass physical literacy, body awareness, social-emotional competence, and the ongoing character development of students. This study employs a systematic literature review method to thoroughly analyze, synthesize, and assess scientific findings regarding the application of deep learning in physical education, with the objective of identifying relevant, effective, and potentially developable contributions within the context of learning and curriculum in Indonesia.

METHOD

In this study, the systematic literature review (SLR) methodology was utilized to analyze research results connected to specific research questions, topics, or phenomena. Basically, SLR is a research process that combines preliminary research findings to provide more comprehensive and objective information. Data collection was carried out by searching for relevant and reliable scientific publications in the Scopus, Google Scholar, Elsevier, and Sage Journals databases, which were selected for their high credibility and wide international coverage of publications. The literature search method was carried out using terms such as deep learning, physical education, sports education, and artificial intelligence in education paired with Boolean operators (AND, OR) to produce comprehensive search results. The articles found were then selected based on inclusion and exclusion criteria, including application to the research topic, indexed journal articles, specific publication year range, and relevance to the physical education environment. The selected literature was then evaluated and synthesized descriptively and analytically to identify forms of contribution, research trends, and implications of utilization of deep learning in physical education instruction (Febriatama, 2023).

The literature search strategy in this study used the Google Scholar database because this platform is considered one of the most significant and widely used sources of scientific references by researchers and academics. Google Scholar contains peer-reviewed literature from various fields, providing a broad perspective on the importance of deep learning in physical education. Data collection was conducted using Harzing's Publish or Perish tool with the appropriate database configuration in Google Scholar (Iswanti et al., 2025). This application is free software intended to simplify systematic searching, organizing, and analyzing scientific papers through the integration of various academic sources.

To obtain literature relevant to the research objectives, inclusion criteria were established as the basis for article selection. The inclusion criteria in this study included: (1) studies discussing the use or development of deep learning as artificial intelligence technology in the context of physical education; (2) studies analyzing the contribution of deep learning to the learning process, evaluation, or improvement of learning performance in physical education; (3) studies examining the impact of deep learning on students' cognitive processes that can be mapped to Bloom's Taxonomy levels, including the abilities to remember, understand, apply, analyze, synthesize, and create; (4) learning involving the context of physical education, either through physical education subjects, teachers, or movement-based learning activities; (5) scientific articles published between 2019 and 2025; (6) research that clearly explains the deep learning approach or method used; and (7) research that presents a description of the data, instruments, or materials analyzed in the study. Articles that do not meet these criteria are excluded from the systematic literature review process.

This review adhered to PRISMA principles to guarantee transparency and repeatability. To uphold rigorous scientific standards, we employed the Critical Appraisal Skills Program (CASP) checklist to assess the methodological quality and validity of each primary stud y prior to data synthesis. Mengist et al., (2020) This dual methodology mitigates bias and guarantees the dependability of our conclusions concerning deep learning in physical education.

The preliminary assessment entailed examining titles and abstracts for pertinence to deep learning in physical education. We omitted items that did not specifically pertain to AI or learning technologies within a PE context. Furthermore, duplicates, non-journal publications, and papers beyond the designated date range were eliminated to guarantee that only thematically pertinent literature advanced to the subsequent step.

Table 1. Inclusion and Exclusion Criteria

Aspects	Inclusion Criteria	Exclusion Criteria
Publication Type	Scientific journal articles (peer-reviewed)	Unreviewed proceedings, blogs, non-academic reports
Publication Year	2019–2025	< 2019
Language	English and Indonesian	Languages other than English & Indonesian
Main Topic	Deep learning / artificial intelligence in education	Learning without AI / deep learning
Educational Context	Physical education, activity-based education, or cognitively relevant	general education Purely pedagogical PE without AI technology support
Cognitive Focus	Discusses cognitive processes, adaptive learning, evaluation, or learning analytics	Focuses only on physical activities or conventional teaching methods
Theoretical Framework	Contains discussions of learning, cognition, or learning evaluation (e.g., Bloom, learning analytics)	Lacks a theoretical foundation for learning
Article Access	Full text available	Only abstract / not fully accessible
Relevance	Provides conceptual or empirical contributions to the use of deep learning in education	Not directly relevant to the research objectives

During the data screening stage, the identified articles were further selected using systematically established inclusion and exclusion criteria. The inclusion criteria included scientific journal articles that had undergone peer review, were published between 2019 and 2025, and were written in English or Indonesian. Selected articles must discuss the application of deep learning or artificial intelligence in the context of education, particularly physical education or education based on cognitively relevant physical activities. In addition, articles are expected to discuss aspects of the cognitive learning process, such as adaptive learning, evaluation, or learning analytics, and have a clear theoretical basis related to learning, cognition, or learning evaluation. Access to articles is also a consideration, whereby only articles with full text available are included. Conversely, articles are excluded if they are unreviewed proceedings, non-academic reports, blogs, or publications prior to 2019, written in languages other than English and Indonesian, do not discuss AI or deep learning, focus purely on physical activities or conventional teaching methods without technological support, do not have an adequate theoretical framework for learning, or are not directly relevant to the research objectives. This screening process aims to ensure that only articles that are of high quality, relevant, and aligned with the research focus are included in the literature synthesis.

The article selection method in this study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. (PRISMA) flow, which consists of the identification, screening, eligibility, and inclusion stages.

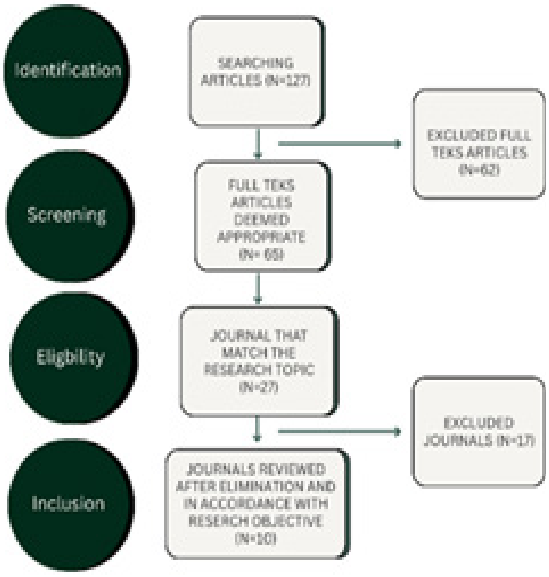

Figure 1. Data Selection Process.

In the identification stage, 127 articles were obtained from searching various databases relevant to the research topic. Next, in the screening stage, an initial review of the titles and abstracts was conducted, as well as checking the availability of the full text, resulting in 65 articles that were deemed eligible for further review, while 62 articles were excluded because they were not available in full-text form. In the eligibility stage, articles that met the criteria were then evaluated for their suitability to the research topic, resulting in 27 relevant articles. Articles that did not meet the topic suitability criteria were excluded from the analysis. The final stage, namely inclusion, was carried out through an in-depth review based on the inclusion and exclusion criteria and alignment with the research objectives, resulting in 10 journal articles that met the requirements and were subsequently used in the literature synthesis process.

RESULTS AND DISCUSSION

The data gathering for this study involved a review of multiple scientific papers that focus on the use and advancement of deep learning within the realm of physical education. The data collection process commenced with the identification of the research topic, encompassing critical elements such as the incorporation of deep learning in physical education, the creation of a system for assessing student movement and performance, the application of artificial intelligence for learning evaluation, and its.

The integration of Deep Learning (DL) in physical education demonstrates a hierarchical transformation that aligns with Bloom's Taxonomy spectrum, ranging from basic to high cognitive levels. At the Remembering (C1) and Understanding (C2) levels, this technology plays a role in the automatic identification of physical activities and the classification of cognitive levels through digital interaction, as evidenced by Cheng et al., (2021) and Pajak et al., (2022). Entering the Applying (C3) level, AI techniques have been proven to significantly accelerate students' mastery of basic motor skills through intelligent assistance (Kadhim et al., 2025). The leap to Higher Order Thinking Skills (HOTS) is evident at the Analyzing (C4) and Evaluating (C5) levels, where the ResNet-101 model and 3D pose estimation enable precise biomechanical analysis of movement and objective physiological data-based performance evaluation (Deng, 2025; Liu & Dastbaravardeh, 2025; Wang & Shi, 2024). Finally, at the Creating (C6) level, the flipped classroom model and IoT-based personalized learning framework encourage students to design adaptive independent fitness strategies (Wei et al., 2025; Xing & Zhang, 2025).

These findings are consistent with Contemporary Sports Pedagogy theory, which emphasizes that physical education is not merely physical activity, but rather a process of physical literacy that involves guided reflection. As stated by Hasyim & Lasmi, (2025), The Deep Learning methodology enhances conceptual comprehension and fosters active engagement, aligning with the perspectives of physical education specialists that technology integration must be able to facilitate "learning through movement" in order to achieve greater learning independence and instructional effectiveness (Li, 2025).

The implementation of Deep Learning (DL) reinforces this C1 level through an automated cognitive evaluation system and personalized materials. The findings of Cheng et al., (2021) prove that Deep Neural Network models are capable of classifying students' rote and factual learning interactions with an accuracy of 78.21%, enabling real-time monitoring of cognitive progress. Additionally, the integration of DL

Table 2. Description of Research Results

Authors & Journal	Methods	Physical Education & Sports Context	Relevance of Bloom's Taxonomy (C1-C6)	Key Findings / Results
(Cheng et al., 2021) Frontiers in Psychology	Quantitative (BiGRU, CNN, Attention Mechanism)	Evaluation of cognitive levels in online learning environments in general.	C1 - C6 (Comprehensive)	The model successfully classified 6 Bloom cognitive levels with an average accuracy of 78.21%.
(Wang & Shi, 2024) Journal of Multimedia Information System	Quantitative (ResNet-101 & Pose Estimation)	Assessment of human posture in physical education instruction.	C4 (Analyzing)	The use of ResNet-101 improves pose recognition precision compared to traditional IPR/ LAIPR methods.
(Hasyim & Lasmi, 2025) Jurnal Dunia Pendidikan	Qualitative (Systematic Literature Review - PRISMA)	Implementation of deep learning methodologies in physical education instruction inside educational institutions.	C2, C3, & C4	Emphasis on guided reflection and collaboration to increase motivation and conceptual understanding.
(Deng, 2025) Systems and Soft Computing	Quantitative (Faster R-CNN & 3D Pose Estimation)	Prediction of the probability of success of a basketball free throw.	C4 (Analyzing) & C5 (Evaluating)	The accuracy of shooting arm angle prediction reached 92.06%, helping to evaluate technique objectively.
(Xing & Zhang, 2025) International Journal of Web-Based Learning and Teaching Technologies (IJWLTT)	Mix Method (Integrated Flipped Classroom & Empirical Study)	Instructional design for physical education at the university level.	C1 - C6	Improving learning independence and teaching effectiveness through personalized digital content.
(Liu & Dastbaravardeh, 2025) Wiley International Journal of Intelligent Systems	Quantitative (Machine Learning & S-AIoT)	Evaluation of student mobility and performance by physiological data analysis.	C4 (Analyzing) & C5 (Evaluating)	A new framework for athletic performance analysis that integrates real-time physical signals from students.
(Kadhim et al., 2025) Retos	Quantitative (AI Impact Study & Statistical Analysis)	Enhancing kids' fundamental and motor skills through physical education classes.	C3 (Applying)	AI techniques have a significant impact on accelerating the process of mastering students' basic motor skills.
(Pajak et al., 2022) Sensors and Actuators A: Physical	Quantitative (CNN & Inertial Sensor Recognition)	Recognition of specific sports activities (squats, pull-ups, dips).	C2 (Understanding) & C4 (Analyzing)	The system is capable of recognizing and counting sports activities with an accuracy of up to 95%.
(Wei et al., 2025) International Journal of Learning and Teaching	Qualitative (Theoretical Framework & Literature Review)	Personalized learning and health monitoring in physical education.	C5 (Evaluating) & C6 (Creating)	Developing a closed-loop mechanism for decision-making and adaptive learning feedback.
(Li, 2025) International Journal of Information and Communication Technology Education	Mix Method (Field Study & Deep Learning Assessment)	Curriculum and assessment in international sports communication education..	C5 (Assessing)	The DL model provides lower error predictions and is consistent with human expert assessments.

into the flipped classroom model as proposed by Xing & Zhang, (2025) ensures that students can independently master procedural knowledge and basic sports rules through adaptive digital content before entering the field practice stage. Meanwhile, Hasyim & Lasmi, (2025) emphasize that conceptual mastery at this level, if supported by digital technology, will increase student motivation and active participation because they have a strong knowledge foundation. Thus, DL technology acts as a cognitive validation instrument that ensures students have adequate theoretical readiness (physical literacy), in line with (Tsangaridou & Lefteratos, 2013) view that understanding the rules is the main structure in an effective sports education model

Cognitive transformation in Physical Education (PE) after the implementation of Deep Learning (DL) shows a crucial shift from mere motor imitation to deep analytical understanding. At the Comprehending (C2) level, DL technology facilitates "directed reflection," enabling students to internalize movement principles beyond verbal instructions, a process that, according to Hasyim & Lasmi, (2025), significantly enhances conceptual understanding and learning motivation. This capacity for understanding forms the foundation for the Applying (C3) level, where AI systems provide intelligent assistance to optimize the mastery of basic motor skills with precision (Kadhim et al., 2025). This is consistent with Schmidt's Schema Theory (1975), which asserts that the effectiveness of movement depends on the strength of the relationship between cognitive representation and physical execution. The peak of this phase is reached at the Analyzing level (C4), where computer vision technologies such as the ResNet-101 algorithm (Wang & Shi, 2024) and 3D pose estimation (Deng, 2025) enable real-time biomechanical deconstruction of movement. Through joint coordinate detection and accurate shot angle calculations up to 92.06%, students can perform self-diagnosis of their body's mechanical efficiency. This digital analytical capability supports Knudson's Task Analysis, which shifts the evaluation paradigm from subjective teacher observation to objective data analysis by students, thereby strengthening physical literacy and critical thinking skills in the context of sports.

At the top of the cognitive hierarchy, Deep Learning (DL) integration facilitates students' transition from analysts to evaluators and independent strategy designers. At the Assessing level (C5), Smart Artificial Intelligence of Things (S-AIoT) technology and DL-based assessment models enable students to conduct objective performance evaluations through real-time synchronization of physiological data and motor movements (Liu & Dastbaravardeh, 2025). Li's (2025) findings reinforce this by showing that DL-based automatic assessment has a level of precision that is consistent with human expert evaluation, thus providing credible feedback for students to assess the effectiveness of their own exercises. The pinnacle of this process is reached at the Creating level (C6), where students are able to construct personalized fitness programs and sports strategies. Through an adaptive flipped classroom model Xing & Zhang, (2025) and an IoT-based learning framework (Wei et al., 2025), DL technology acts as a decision support system that helps students creatively design physical activity solutions based on their performance data. Theoretically, achieving this HOTS level realizes Whitehead, (2001) concept of Physical Literacy, where the integration of artificial intelligence technology aims not only to master movement but also to build students' intellectual independence in managing their health and physical performance sustainably.

Imagine if physical education classes were no longer just about running or kicking a ball, but were assisted by highly intelligent "digital assistants." In the early stages, this technology helps students to remember and understand (C1-C2) the basics of sports; for example, instead of just reading a rule book, students can learn through interactive videos that immediately tell them if they answer a quiz question incorrectly. When it comes to practicing (C3) movements, there are sensors or smart cameras that can immediately tell them, "Hey, your back isn't straight enough when squatting," so students learn faster without having to wait for the teacher's correction.

Even more sophisticated, this technology can "dissect" students' movements in detail or Analyze (C4). Through the cell phone screen, the skeletal lines of students' feet or hands when shooting a basketball will be visible digitally, so that students know exactly where their mistakes are. With this data, students are encouraged to evaluate (C5) themselves, much like reviewing a digital report card that indicates whether their practice today was optimal or not. Ultimately, the goal is for students to Create (C6) their own training schedules or routines that best suit their bodies. Thus, this technology is not meant to replace teachers but to serve as "smart glasses" that help students not only excel in movement but also become intelligent and independent in maintaining their fitness.

CONCLUSION

The integration of Deep Learning in Physical Education (PE) has proven to be a significant transformation in mapping and improving students' cognitive abilities in accordance with Bloom's Taxonomy hierarchy. Through the use of cutting-edge algorithms such as ResNet-101, CNN, and BiGRU, this technology not only supports basic cognitive levels (C1-C2) in the automatic mastery of factual and procedural knowledge, but also acts as a catalyst for higher-order thinking skills (HOTS). The AI's ability to estimate body posture and perform physiological analysis in real-time enables students to achieve the Analyzing (C4) and Evaluating (C5) levels with a degree of biomechanical precision that was previously difficult to achieve manually. Furthermore, the synergy between AI and IoT encourages the creation of an adaptive learning ecosystem, where students are able to Create (C6) independent personal training strategies. Theoretically, this implementation is in line with the principles of modern physical literacy, which emphasizes that the effectiveness of current physical education teaching is highly dependent on the ability of technology to provide objective feedback and personalized learning. In conclusion, a review of key literature confirms that the future of physical education lies in combining artificial intelligence with student-centered pedagogical strategies to produce students who are not only motorically skilled but also cognitively intelligent.

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