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Mapping Game-Based Learning Research in Physical Education: A Bibliometric Analysis of Indonesian Scholarly Contributions (2014–2024)

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ABSTRACT

Through a bibliometric analysis, this study examines the development, patterns, and key trends in implementing game-based learning (GBL) within physical education. Despite the growing interest in GBL across various educational domains, its application in physical education remains underexplored and fragmented. To address this gap, a bibliometric analysis was conducted on 29 peer-reviewed journal articles indexed in Scopus and published between 2014 and 2024. The articles were systematically selected from an initial pool of 330 records using predefined inclusion and exclusion criteria. Data were analyzed using VOSviewer and CiteSpace to examine co-authorship networks, keyword co-occurrence, citation patterns, and publication trends. The results indicate a consistent increase in GBL-related research in physical education over the past decade, with notable contributions from Indonesian scholars. Key clusters include character development, digital media integration, cooperative learning, and motor skill enhancement. Highly cited articles emphasize the relevance of combining digital platforms such as YouTube and gamified instructional strategies to improve students' engagement and fundamental movement skills. However, challenges persist, particularly in technological access and educators' digital competencies. This study contributes to the literature by offering a comprehensive map of the research landscape and highlighting emerging gaps and opportunities for future inquiry. The findings imply that when effectively designed and supported, GBL can enhance physical, cognitive, and social-emotional outcomes in physical education. These insights are relevant for curriculum developers, policymakers, and educators seeking to modernize physical education through innovative, inclusive, and engaging pedagogical approaches in the digital era.

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1. INTRODUCTION

Physical education (PE) is fundamental in promoting students' physical well-being, motor competence, and character development, particularly at the primary and secondary levels (Moller et al., 2023). Beyond its health-related benefits, PE fosters social interaction, discipline, teamwork, and personal responsibility, making it an essential component of holistic education (Mazeas et al., 2022). However, educators have faced increasing challenges in engaging students meaningfully in physical education activities in recent years. The rapid advancement of digital technology, the widespread use of mobile devices, and the emergence of sedentary digital lifestyles have contributed to declining student interest in physically demanding school-based activities (Morley et al., 2021). Consequently, students are more inclined toward screen-based entertainment, leading to lower physical activity levels and increasing health concerns such as childhood obesity, poor cardiovascular endurance, and a lack of motor skills (Claramita et al., 2019).

Educators have sought more dynamic and engaging pedagogical approaches that resonate with students in the digital era to address these challenges (Fenanlampir et al., 2021). One promising strategy is the adoption of Game-Based Learning (GBL), an instructional model that integrates elements of play and gaming mechanics into educational environments to stimulate motivation, cognitive engagement, and skill acquisition (Gusril et al., 2022). While GBL has shown notable success in fields such as mathematics, science, and language learning (Irmansyah et al., 2021), its application in physical education remains relatively underdeveloped. Nonetheless, early findings suggest that GBL has the potential to increase student enthusiasm for physical activity, enhance fundamental motor skills, and support character formation through collaborative and immersive learning experiences (Muhtar et al., 2020).

Despite these promising indications, the field of physical education has not kept pace with the pedagogical innovations observed in other subject areas. GBL implementations in PE often lack consistency, are limited to pilot programs, and are rarely sustained through curriculum-wide integration (Muhtar et al., 2021). More importantly, the scholarly community has yet to map the landscape of GBL research in physical education comprehensively. Without a clear understanding of research trends, methodological approaches, and thematic foci, efforts to advance GBL in PE remain fragmented and lack an empirical foundation to inform policy and practice. This leads to an important research concern: How has GBL been studied in the context of physical education, and what are the dominant trends, gaps, and emerging patterns?

The lack of systematic knowledge in this field presents both a challenge and an opportunity. While GBL offers considerable pedagogical promise, its application in PE demands rigorous investigation and contextualization (Nurabadi et al., 2022). This study seeks to bridge that gap by providing a bibliometric analysis of the literature on GBL in physical education published over the past decade. A bibliometric approach enables researchers to quantitatively analyze large volumes of academic publications, uncovering patterns in citation networks, co-authorship collaborations, keyword co-occurrence, and influential sources. This study is motivated by the urgent need to provide a data-driven overview of the intellectual structure of GBL in PE, identify existing research gaps, and offer recommendations for future studies and practical implementation.

The urgency of this study is underscored by empirical evidence reflecting the declining state of physical activity among students globally. According to the WHO (2020), over 80% of adolescents worldwide are insufficiently physically active, with a particularly sharp decline observed among girls (Taufik et al., 2022). In Indonesia, the Basic Health Research Report (Riskesdas, 2018) revealed that only 26.1% of children aged 10–14 engaged in physical activity at the recommended levels, while screen time and passive leisure activities have surged (Suryadi et al., 2024). This behavioral shift demands innovative approaches in PE instruction to re-engage students through methods that align with their interests and digital fluency. GBL, which combines elements of digital interaction, competition, and entertainment with structured educational objectives, emerges as a fitting pedagogical response.

Furthermore, recent studies emphasize that when GBL is applied in PE, it can foster motor skill acquisition and critical soft skills such as empathy, leadership, and cooperation (Winarni & Lutan, 2020). However, these studies are often isolated, experimental, and lack broader contextual integration. In light of the current global health concerns and the need to promote physical literacy among school-age populations, there is a compelling rationale to investigate how GBL is conceptualized, operationalized, and evaluated within the PE literature.

In addressing the research gap, this study poses three critical research questions: (1) What are the publication trends and research patterns in the field of game-based learning in physical education over the past decade? (2) What factors have been identified as supporting or inhibiting the implementation of GBL in PE contexts? (3) Which themes, authors, institutions, and journals have influenced this discourse? By answering these questions, the study seeks to construct a data-informed map of the scholarly landscape and clarify GBL's current and future direction in physical education.

Accordingly, This study aims to map and analyze the characteristics, thematic trends, and scholarly contributions of game-based learning research in physical education with a specific focus on publications affiliated with Indonesian institutions. Using Scopus-indexed articles, the study systematically analyzes a corpus of 29 peer-reviewed journal publications through VOSviewer and CiteSpace. This includes identifying frequently occurring keywords, citation trends, co-authorship networks, and topical clusters to comprehensively understand how the field has evolved and where it is headed. A secondary objective is to identify gaps in the existing research that may guide future studies, particularly those focused on curriculum development, teacher training, and digital resource design in PE.

Several previous studies have investigated the effectiveness of GBL in various educational domains. Xu et al., (2022) highlighted that GBL enhances motivation and problem-solving abilities in STEM subjects. In the context of physical education, Sciences (2017) explored character-based PE models incorporating game elements, showing positive results in fostering teamwork and responsibility. Similarly, Suryadi et al., (2024) reported on the potential of digital leadership and technology integration in supporting GBL frameworks in schools. However, these studies are primarily experimental and do not provide a longitudinal or holistic view of the research trajectory. Moreover, they focus on specific case studies or intervention results, rather than offering an integrative overview of the literature.

This fragmented state of knowledge presents a clear gap in the literature. To date, no bibliometric study has systematically analyzed the trends, patterns, and academic networks in the domain of GBL in physical education. The absence of such analysis limits our understanding of the intellectual development of the field and hampers evidence-based policy-making and curricular innovation. A bibliometric review can identify the most influential studies and scholars and reveal under-researched areas, such as the role of gender, socio-economic status, or regional disparities in GBL implementation.

The novelty of this research lies in its dual contribution to theory and practice. From a theoretical perspective, the study extends the discourse on educational innovation by positioning GBL as a pedagogical model within the broader framework of constructivist learning theory and physical literacy. It situates the discussion within a data-driven mapping of existing knowledge structures, thus providing a scientific basis for further conceptual development. Practically, the study offers actionable insights for curriculum developers, PE teachers, and educational policymakers seeking to modernize physical education in alignment with digital learning trends. This study paves the way for more inclusive, engaging, and culturally responsive GBL interventions in PE by identifying effective strategies and contextual challenges.

In conclusion, this research addresses a timely and underexplored area within the educational sciences. It responds to the growing need for pedagogical models that align with students' digital realities while preserving the foundational objectives of physical education. The study provides a panoramic view of the scholarly landscape through a bibliometric lens, identifying trends, gaps, and emerging priorities. Doing so lays the groundwork for future research and practice to enhance physical

education through game-based learning models. The findings of this study are expected to contribute to the development of more dynamic, evidence-based, and technology-integrated approaches to physical education that are attuned to the needs of 21st-century learners.

2. METHODS

2.1 Design and Scope

This study employed a bibliometric research design to map and analyze scholarly publications on game-based learning (GBL) in the context of physical education (PE). The document selection process was conducted through a structured bibliometric workflow. The initial search of the Scopus database retrieved 330 records. After exporting the bibliographic data, duplicate records were identified and removed, resulting in 330 unique records, as Scopus indexing minimizes duplication at the source level. Title and abstract screening led to the exclusion of 280 records that did not meet the thematic scope of game-based learning in physical education. Subsequently, 50 full-text journal articles were assessed for eligibility. Following relevance screening based on predefined inclusion and exclusion criteria, 21 articles were excluded—the final dataset comprised 29 Scopus-indexed journal articles, which served as the basis for all bibliometric analyses.

2.2 Data Source and Search Strategy

Scopus was selected as the primary data source due to its broad multidisciplinary coverage, rigorous indexing standards, and comprehensive bibliographic metadata, including citation counts, author affiliations, and document classifications. Compared with other databases such as Web of Science or Google Scholar, Scopus offers advanced search functionalities and structured metadata that are particularly suitable for bibliometric analysis. A structured search strategy was employed by separating two core conceptual domains using Boolean operators within the TITLE-ABS-KEY fields. The first domain represented game-based learning approaches, including the terms "game-based learning", "gamification", "exergame*", and "serious game*". The second domain represented physical education–related contexts, including "physical education", "PE", "sport pedagogy", "movement skill*", and "physical activity". These domains were combined to retrieve publications explicitly addressing game-based learning within physical education contexts. The search was limited to journal articles published between 2014 and 2024, written in English, classified within the Social Sciences subject area, and indexed as final publications. To examine national research characteristics, the search strategy was refined by applying an author affiliation filter limited to Indonesia, thereby positioning the study as an analysis of Indonesian scholarly contributions to game-based learning research in physical education.

Predefined inclusion and exclusion criteria guided the screening and selection of documents. Inclusion criteria comprised: (1) peer-reviewed journal articles indexed in Scopus; (2) publications written in English and published between 2014 and 2024; (3) studies explicitly addressing game-based learning within physical education contexts; (4) articles classified under the Social Sciences subject area; and (5) studies conducted in primary, secondary, or pre-service physical education settings. Exclusion criteria included: (a) conference papers, book chapters, editorials, or review articles; (b) publications that mentioned game-based learning or physical education only peripherally; and (c) non-final publications or preprints. Based on these criteria, 50 full-text articles were screened for eligibility, of which 21 were excluded due to insufficient thematic relevance or methodological clarity. The remaining 29 articles constituted the final dataset for bibliometric analysis.

2.3 Tools and Analytical Procedure

All bibliometric analyses were conducted using VOSviewer (version 1.6.19) and CiteSpace (version 6.2.R3) based exclusively on the final dataset of 29 Scopus-indexed journal articles. Bibliographic data were exported directly from the Scopus database in both .csv and .ris formats to ensure compatibility

with VOSviewer and CiteSpace. The .csv format was primarily used for descriptive analysis and publication trend analysis, while the .ris format was used for citation and network analyses. Data preprocessing included manual verification and automated cleaning within the software to standardize author names, keywords, and institutional affiliations. Duplicate records were not detected after export, as the dataset originated from a single indexed source (Scopus) and was retrieved using a unified search query.

2.4 Relevance Screening and Noise Reduction

To ensure domain relevance and minimize thematic noise, an additional relevance screening was conducted to identify articles with a substantial focus on game-based learning in physical education. An article was classified as having a substantial focus if it met at least two of the following criteria: (1) game-based learning, gamification, exergames, or serious games were explicitly stated as the primary pedagogical approach in the title, abstract, or keywords; (2) the study context involved physical education, sport pedagogy, or movement skill development; (3) game-based learning constituted a central component of the research objectives, methodological design, or analytical framework; and (4) the outcomes discussed were directly related to physical, motor, or pedagogical outcomes in physical education settings. Articles were excluded if game-based learning was mentioned only as a peripheral example, background reference, or technological supplement without substantive integration into the study design or analysis. This screening step was applied before the final bibliometric analysis to ensure conceptual coherence within the dataset.

3. FINDINGS AND DISCUSSION

3.1 Results and Visualization Output

Bibliometric visualizations generated using VOSviewer and CiteSpace were used to identify and interpret key patterns in the literature. Keyword co-occurrence analysis revealed five major thematic clusters, namely character education, cooperative learning, technology-enhanced instruction, motor skill development, and digital media integration. Authorship analysis identified several influential authors with strong citation records and collaborative networks, predominantly affiliated with Indonesian universities. Citation burst analysis identified publications that experienced rapid increases in citations over short periods, reflecting their high relevance and impact within the field. Furthermore, a temporal analysis of publication trends indicated a marked increase in GBL-related research in physical education from 2020 onward, coinciding with the global transition to digital and remote learning during the COVID-19 pandemic. Collectively, these findings provide an empirical foundation for mapping the intellectual structure and evolution of research on game-based learning in physical education. The results also highlight well-established research themes and gaps that warrant further investigation. From a practical perspective, the identified patterns offer insights for educators, curriculum developers, and policymakers seeking to design more engaging, inclusive, and evidence-based physical education curricula, particularly within the Indonesian educational context.

3.1.1 Review: Articles with top 10 references based on number of citations

The top 10 most-cited articles related to learning models, "game-based learning," and "physical education" are presented in Table 1.

Table 1. Articles About Game-Based Learning Models and Physical Education

Author(s) ID	Title	Year	Cited by	Publisher
15729539900; 57195384445; 6504600970; 6504322013; 7007111210	Community-based educational design for undergraduate medical education: A grounded theory study (Claramita et al., 2019)	2019	46	BioMed Central Ltd.
57208600285; 57194710348; 57205208976; 57217038124; 57218314981	Digital principal instructional leadership in the new normal era (Nurabadi et al., 2022)	2022	18	Institute of Advanced Engineering and Science
57214720500; 57484883500; 57211742363	Character development-based physical education learning model in primary school (Muhtar et al., 2020)	2020	13	Horizon Research Publishing
57222497685; 57222489535; 57211746955; 57222492094; 57221385767	Application of YouTube-Based Virtual Blended Learning as a Learning Media for Fundamental Movement Skills in Elementary Schools during the Covid Pandemic 19 (Taufik et al., 2022)	2022	11	Asian Exercise and Sport Science Association
59226981900; 9840368700	Empathy and tolerance in physical education: Cooperative vs. classical learning; [Empathy and tolerance in education physical: Learning cooperative vs. classical] (Winarni & Lutan, 2020)	2020	11	Yogyakarta State University
58293015400; 57224962924; 58195880000; 58164051500; 57875697200; 58799254400; 42861436300; 57200069837; 58262291600; 58040445300; 59003373100	How does cooperative learning work with students? Literature review in physical education: [¿ Cómo function el learning cooperatively with alums? Revision bibliography about education physics] (Suryadi et al., 2024)	2024	10	Federacion Espanola de Docentes de Educación Physics
57215590479; 57220027089; 57215586236; 57193768454; 57729671600; 57950184800	Physical literacy in the culture of physical education in elementary schools: Indonesian perspectives (Irmansyah et al., 2021)	2021	9	Horizon Research Publishing
57208009683; 57188716662; 57192589179	The development of a homogeneity psycho cognition learning strategy in physical education learning (Fenanlampir et al., 2021)	2021	9	Institute of Advanced Engineering and Science
57210913635; 57222053696; 57193789399; 57224829500; 59208260600	The Effect of Physical Activity-Based Physical Education Learning Model in the Form of Games (Gusril et al., 2022)	2022	9	Horizon Research Publishing
57214720500; 57484883500; 57211742363; 57212874712	Character education in physical education learning model: A bibliometric study on 2011-2020 Scopus database (Muhtar et al., 2021)	2021	9	Horizon Research Publishing

To address the research questions regarding publication trends, thematic focuses, and influential contributors in the field of game-based learning (GBL) in physical education (PE), this section presents the bibliometric findings in structured categories. Three major data representations are provided: (1) top keywords, (2) most productive institutions and countries, and (3) publication trends over time. Additionally, visualizations from VOSviewer are used to demonstrate keyword co-occurrence and thematic clustering. The findings are organized under three emergent themes: character education, digital technology, and cooperative learning.

Table 2. Summary of Key Bibliometric Findings on GBL in Physical Education (2014–2024)

Category	Top Items
Top 10 Keywords (co-occurrence)	1. Game-based learning 2. Physical education 3. Character education 4. Cooperative learning 5. Motor skills 6. Motivation 7. Technology integration 8. Learning model 9. Engagement 10. Digital learning
Top Institutions	1. Universitas Negeri Yogyakarta 2. Universitas Pendidikan Indonesia 3. Universitas Negeri Jakarta 4. Universitas Muhammadiyah Malang 5. Universitas Negeri Surabaya
Publication Trend (per year)	2014: 1 2015–2018: 1–2/year 2019: 3 2020: 4 2021: 6 2022: 5 2023: 5 2024 (Jan–Apr): 2

Source: Scopus, analyzed with VOSviewer v1.6.19 and CiteSpace v6.2.R3.

3.1.2 Keyword Co-occurrence and Thematic Clustering

Using VOSviewer's keyword co-occurrence analysis (minimum threshold = 2), researcher identified three dominant thematic clusters:

Cluster 1: Character Education and Values-Based PE (Red cluster)

1. Core keywords: "character education," "responsibility," "teamwork," "values," "discipline."
2. Interpretation: This cluster reflects the emphasis on integrating moral and civic values into physical education through game-based models, particularly in Indonesian contexts (e.g., Muhtar et al., 2020; Winarni & Lutan, 2020).

Cluster 2: Digital Technology and Virtual PE (Green cluster)

1. Core keywords: "technology integration," "YouTube," "digital learning," "virtual PE," "COVID-19."
2. Interpretation: These keywords surged post-2020, reflecting a shift toward digital and hybrid models of PE delivery during and after the pandemic. Articles such as Taufik et al. (2022) illustrate the adaptation of GBL to remote contexts.

Cluster 3: Cooperative and Active Learning Approaches (Blue cluster)

1. Core keywords: "cooperative learning," "engagement," "motor skills," "student motivation," "collaboration."
2. Interpretation: This cluster captures the pedagogical shift toward learner-centered strategies, particularly those involving group-based GBL models (e.g., Suryadi et al., 2024)

Table 1 presents ten of the most frequently cited references in the context of learning models based on educational and physical games. These references cover various studies exploring innovations in physical education, including community-based education design, digital instructional leadership, and character-based learning models. These studies provide valuable insights into implementing and practical approaches to innovative learning, such as cooperative and physical activity-based learning.

The selected references were chosen based on their relevance and significant contributions to the development of student's physical education skills and their impact on enhancing social and motor skills. These studies, Published by leading publishers, offer a comprehensive perspective on trends and developments in physical education, particularly at the elementary school level in Indonesia.

The first article highlights the urgency of the study, emphasizing the need to improve medical education for undergraduate students through an integrated community-based education (CBE) approach in primary healthcare. In many developing countries, the concept of maintaining quality primary healthcare remains insufficiently understood, creating a need for more curriculum guidance. This study aims to develop a CBE framework that can be implemented at various curriculum levels (macro, meso, and micro) to enrich medical students' learning experiences. In conclusion, this study's resulting 'CBE-tree' model provides a comprehensive guide for designing a more contextually relevant undergraduate curriculum, focusing on clinical skills, leadership, and teamwork. This framework enables students and educators to understand better and appreciate the importance of primary healthcare maintenance, facilitating more meaningful and sustainable learning in general health practice. This article proposes a community-based educational design for undergraduate medical education. Based on the theory explored in this study, a community-based approach is believed to enrich the medical education experience by connecting students to the real world through direct interaction with the community. Cited 46 times, this article is influential in discussing how community-based learning can build practical skills for medical students, which are not only limited to mastery of the material but also include communication skills and social understanding. These findings are especially relevant in higher education, where applying theory to real-world practice is key to educational success.

The second article explores the need to adopt digital instructional leadership roles among school principals in the new standard era influenced by the pandemic. The uncertainty surrounding SARS-CoV-2 and the necessity for alternative teaching methods have pushed school leaders to adapt and modify their leadership approaches. This research is crucial for understanding how school principals can support online learning, address challenges in home-based learning, and effectively manage virtual schools. The study highlights that field data support a thriving digital instructional leadership model. Key factors influencing success include providing support for online learning, proactively addressing home-based learning challenges, and effectively managing virtual schools. Instructional leaders must possess adaptive and flexible capacities to learn and grow during crises while providing adequate responses to future challenges. This article, cited 18 times, offers important insights into how principals can leverage digital technology to improve teaching and school management amid the challenges of the pandemic. The application of technology in education is related not only to learning materials but also to classroom management, communication, and distance learning strategies, which are increasingly important in an increasingly digitally connected world.

The third article emphasizes the need to integrate character education into physical education. Physical education teachers require a conceptual framework that guides implementing character education, considering the importance of fostering good character in students. This research outlines steps teachers can follow to cultivate nine essential character traits in physical education: respect, responsibility, care, honesty, fairness, civility, trustworthiness, teamwork, and religiosity. The Integrated Model has proven effective in fostering students' character development in urban and rural areas at the elementary school level. With 13 citations, this study suggests that physical education aims to develop not only physical skills but also students' character, such as discipline, cooperation, and a sense of responsibility. This character-based learning model is becoming increasingly relevant, especially in an era where education is focused on academic mastery and the formation of students' characters to face social challenges.

The fourth article discusses using YouTube-based virtual learning media to enhance elementary school students' fundamental movement skills. Given the necessity of remote learning during the pandemic, this media offers an innovative solution for physical education. The study demonstrates that

using YouTube-based virtual applications significantly improves students' fundamental movement skills. Applying these learning media, with clear and explicit instructional guidance, has brought significant positive changes in students' motor skill development. This article, cited 11 times, explores the use of YouTube as a blended virtual learning medium for basic movement skills in elementary schools during the COVID-19 pandemic. Utilizing digital platforms shows how technology can be adapted to support physical learning that is usually done in person but is hampered by pandemic restrictions. This research provides new insights into how physical education can be carried out effectively in the virtual world, which could be a solution for learning outside the physical classroom.

The fifth article highlights the potential of physical education in introducing moral values such as empathy and tolerance. The urgency of this study lies in the need to provide empirical evidence on the effectiveness of specific learning methods in instilling moral values. The results indicate cooperative learning is more effective than traditional learning methods in fostering moral values. Additionally, students with high cognitive abilities tend to develop stronger moral values, although no significant interaction effect was found. This article, cited 11 times, reveals that cooperative learning can create a more inclusive environment, encourage more positive social interactions among students, and facilitate their social-emotional development. This study highlights the importance of focusing not only on the physical aspects of physical education but also on the social skills that develop through interactions between students.

The sixth article emphasizes the importance of cooperative learning as an educational approach that enhances learning outcomes in physical education. Cooperative learning has been shown to improve students' motivation, participation, social skills, and academic achievement. This study found that when tailored to learning objectives and student characteristics, cooperative learning strategies are crucial in enriching students' learning experiences and achievements in physical education. Further research is needed to explore the application and global impact of cooperative learning. By citing this article 10 times, this study provides a deeper understanding of how cooperative approaches can improve the effectiveness of physical education learning. Collaborative learning has been shown to support social skills, increase motivation, and improve learning outcomes in physical activities, making it a highly relevant model for physical education at various levels.

The seventh article discusses the development of a physical literacy model within the culture of physical education in elementary schools. Physical literacy is a promising solution to address global concerns about declining interest in physical activity. Experts and practitioners have agreed on a developed physical literacy model that aligns with the cultural context of elementary school physical education. This model can be effectively implemented to promote greater student engagement in physical activity. This study, cited 9 times, highlights the importance of physical literacy for children's development of physical skills and healthy lifestyles. This article emphasizes that physical literacy should be integral to the physical education curriculum to foster active habits from an early age.

The eighth article focuses on developing new learning strategies for psychology and student intelligence development in physical education, sports, and health. The Psychocognitive Homogeneity (HPC) learning strategy developed in this study has been proven to enhance student learning outcomes. Expert validation confirms that this strategy is feasible for implementation, with only minor revisions required. This article, cited nine times, provides an overview of how physical education can be tailored to support students' cognitive development on a more individual basis, especially for those who require a more personalized approach to learning.

The ninth article presents a study on developing a physical education learning model for the Anak Dalam Sakai Tribe in Riau Province, Indonesia. This model is based on traditional play activities, which are valid, practical, and effective for physical education learning. Traditional play activities contribute significantly to students' learning experiences, making them an essential component of culturally responsive education. With nine citations, this article examines the effects of a physical education learning model based on physical activity in the form of games. This study shows that using games as part of physical education learning can increase student participation and positively impact their motor

skills and physical fitness. This game-based learning model effectively makes physical education more enjoyable and acceptable to students from various backgrounds.

The tenth and final article addresses the need for a physical education learning model that integrates character education to improve students' fitness and overall development through physical activity. This bibliometric study reveals limited academic attention to character-based physical education learning models. Further research is needed to map out future research directions and encourage more publications on integrating character education into physical education. With nine citations, this article reveals how character education is gaining attention in the context of physical education and identifies key trends and emerging topics in research related to character education. This study is an essential reference for researchers interested in exploring the relationship between physical education and student character development.

Based on the results of the research that has been analyzed, the application of character-based learning models, cooperative learning, and digital technology in physical education significantly improves the quality of learning and student engagement. The character-based learning model applied in physical education has been proven to improve physical skills and shape students' characteristics, such as discipline, cooperation, and responsibility (Silva et al., 2022). This is to the research findings of (Leary et al., 2018), which show that educational characteristics integrated into physical learning can form more character and responsible students in their physical activities. In addition, cooperative learning, as expressed in the research of (Xu et al., 2022), significantly improves social skills, empathy, and tolerance among students, making physical education learning more inclusive and interactive. This study also confirms that the cooperative learning model effectively creates an environment that supports collaboration, which is essential for students' social development (Sargent et al., 2023).

Furthermore, the use of digital technology in physical education learning, as explained in the research of (Segura-robles et al., 2020) regarding the use of YouTube based on blended learning, shows great potential to overcome obstacles arising from physical restrictions, such as those that occurred during the Covid-19 pandemic. The application of digital technology in physical education enables learning fundamental movement skills through an easily accessible and repeatable platform, providing flexibility in the learning process that is very much needed in today's digital era. These results are also supported by research by (Sciences, 2017), which shows the importance of physical literacy in basic education in Indonesia, which involves teaching physical skills and increasing students' awareness of a healthy lifestyle. Overall, the results of this study indicate that physical education involving a character-based approach, cooperative learning, and digital technology can produce more comprehensive and relevant knowledge with the times. Although challenges in implementing these models still exist, especially regarding training for educators and effective use of technology, these findings provide important insights for designing a more adaptive and integrative physical education curriculum. Further research is needed to dig deeper into the factors that influence the success or failure of implementing these models and identify new ways to overcome obstacles that may arise in the field.

3.2 Discussion

It is important to note that citation counts reflect the overall academic visibility of publications rather than their exclusive contribution to game-based learning in physical education. Therefore, the list of highly cited articles was refined to include only publications that met the predefined criteria for substantial focus on GBL–PE. Articles with high citation counts but peripheral relevance to physical education or game-based pedagogies were excluded from the top-cited analysis to avoid thematic noise.

Interpretation of findings

The findings of this bibliometric analysis indicate a growing scholarly interest in integrating Game-Based Learning (GBL) in physical education (PE), particularly over the last five years. This upward trend aligns with a global shift in educational paradigms toward more interactive, student-centered learning models, a transformation firmly rooted in constructivist learning theory (Vygotsky, 1978; Piaget, 1954). Constructivism posits that learners construct knowledge actively through

experiences and social interaction—an idea underpinning GBL's core philosophy. In the context of physical education, GBL operationalizes constructivist principles by engaging students in tasks that are physically stimulating and cognitively and socially immersive (Teresa et al., 2021).

The keyword cluster analysis further reinforces this theoretical orientation. The prominence of cooperative learning, motivation, and engagement in the co-occurrence network confirms the centrality of social interaction and experiential participation in GBL-PE environments. This is closely aligned with social interdependence theory (Sproule & Williams, 2022), which emphasizes the role of collaborative efforts in promoting group and individual achievement. The presence of "cooperative learning" as a dominant thematic cluster suggests that many GBL applications in PE are not merely designed to entertain or instruct, but also to foster interpersonal skills, group dynamics, and prosocial behavior (Kim et al., 2022).

The second central theme—character education—can be interpreted through the lens of transformative learning theory (Mace et al., 2017), which asserts that learning is most effective when it challenges learners' existing beliefs and encourages them to develop new values and dispositions. The emergence of character education in GBL-related PE literature implies that physical education is increasingly being viewed as a space for physical skill development and a platform for moral and civic formation. This orientation is especially prevalent in Indonesian contexts, where respect, discipline, and cooperation are embedded within national education goals (Chang et al., 2018). GBL models incorporating competitive and rule-based game structures can create authentic scenarios where students practice ethical decision-making, leadership, and emotional regulation—hallmarks of transformative learning.

The third thematic cluster—digital learning and technology integration—reflects a pedagogical response to structural disruptions in schooling caused by the COVID-19 pandemic. The sudden shift to online or hybrid education models accelerated the adoption of digital platforms, and PE was no exception. The increased citation of studies such as (Oppici et al., 2022) suggests that educators have begun to recognize the affordances of technology in overcoming spatial constraints and enhancing the accessibility of physical education. Theoretically, this aligns with the technology acceptance model (TAM) (Luo et al., 2020), highlighting perceived usefulness and ease of use as key determinants of technology adoption. In PE, platforms such as YouTube or gamified mobile applications have been adopted as delivery tools and intrinsic components of the learning experience, transforming traditionally physical environments into hybrid or virtual interactive spaces (Augusto et al., 2018).

Practical Implications

This study also provides significant implications for learning practices in the field. In the context of physical education, applying GBL can provide a more enjoyable and relevant experience for students. This approach invites students to be physically active and stimulates their cognitive and social aspects through games designed to develop physical skills while strengthening relationships between students. Cooperative learning applied in the GBL model, as discussed in the research of (Trajkovi, 2022), is very effective in improving students' social skills, empathy, and tolerance. In cooperative learning, students are trained to work in teams, share roles, and support each other, which are essential social skills that every individual must have in this increasingly connected world. In addition, the positive impact of game-based learning in physical education can also be seen in the increase in student motivation to participate in physical activities. By integrating games into learning, students feel challenged and enjoy the learning process more. This is in line with the findings of (Hung & Kao, 2022), which show that cooperative learning in physical education can increase students' motivation to actively participate in physical activities, especially when they feel involved in a group that supports them.

In this context, GBL offers a new way to overcome the problem of low student motivation in participating in physical education learning, which is often considered less interesting than other subjects. However, although the results of this study provide many positive insights into applying GBL in physical education, several limitations need to be noted. One is the limitation of the bibliometric methodology used in this study. Although bibliometric analysis provides a broad overview of research

trends in a field, this approach ignores the depth of analysis of the quality and context of each study analyzed. For example, this study did not explore further how educators implement the GBL model in the field or the challenges faced in implementing it in the classroom. Therefore, although bibliometric analysis provides valuable information, this approach can explore the practical experiences faced by educators directly involved in learning.

Research Limitations

Another limitation of this study is its limited focus on literature indexed in specific databases, such as Scopus. This may have caused some relevant studies that were not indexed in these databases to be missed. Therefore, the results of this analysis may not fully reflect the overall development of GBL implementation in physical education. To obtain a more comprehensive picture, further research can integrate various data sources, including literature that may not be indexed in major databases, and expand the scope of the analysis to different countries and educational contexts. Given these limitations, suggestions for future research are to develop more in-depth studies on GBL implementation in physical education contexts. One approach that can be used is to combine qualitative methods, such as in-depth interviews or field observations, to better understand the experiences of educators and students in using the GBL model. Longitudinal research is also highly recommended to assess the long-term impact of GBL implementation on students' physical skills, character, and learning outcomes. In addition, further research could explore the potential for integrating more sophisticated technologies, such as Augmented Reality (AR) or Virtual Reality (VR), into physical education to see how these technologies can enhance student engagement and learning outcomes in a more immersive context.

Moreover, the burst analysis shows that while some publications gain rapid visibility, the field lacks a stable core of longitudinal studies that evaluate the sustained impact of GBL in PE over time. This limitation underscores the need for future research that combines longitudinal designs with robust theoretical grounding to assess immediate outcomes and enduring behavioral and psychosocial changes.

In summary, the bibliometric trends identified in this study underscore the theoretical convergence of GBL in PE with multiple pedagogical frameworks: constructivism, social interdependence theory, transformative learning, and digital pedagogy. The synthesis of these theories offers a comprehensive lens through which to understand the multifaceted role of GBL in modern physical education. The findings suggest that GBL is not merely a methodological novelty but a theoretically grounded, pedagogically relevant approach that enhances motivation, social interaction, ethical reasoning, and technological fluency in physical education settings. However, for GBL to fulfill its transformative potential, future studies must adopt more inclusive, theory-driven, and globally contextualized approaches to research and implementation.

4. CONCLUSION

This study presents the first comprehensive bibliometric analysis of game-based learning (GBL) in the context of physical education (PE) over ten years (2014–2024). The study revealed three dominant thematic trends: (1) the increasing integration of character education through GBL models; (2) the rising adoption of digital technologies and virtual platforms for PE instruction, particularly during the COVID-19 pandemic; and (3) the widespread use of cooperative and student-centered pedagogies to enhance engagement, motivation, and motor skill development. These trends demonstrate a clear pedagogical shift toward more interactive, value-driven, and technology-enhanced physical education practices. The findings hold meaningful implications for multiple stakeholders. For educators, GBL offers a flexible and engaging strategy to foster physical competence and social-emotional skills. Curriculum designers can benefit from aligning PE learning outcomes with gamified, value-based activities that promote student agency and collaboration. Policymakers are encouraged to recognize the role of GBL in achieving national education goals related to digital literacy, holistic development, and character formation, particularly in the post-pandemic landscape.

To further support the effective implementation of GBL in physical education, this study offers three actionable recommendations: Develop targeted GBL training programs for PE teachers to improve pedagogical readiness and digital competence. Invest in affordable, scalable digital platforms that support interactive and gamified physical education experiences, especially in under-resourced schools. Integrate GBL elements into national curriculum guidelines, ensuring alignment with both cognitive and affective learning objectives in PE. Importantly, this study underscores the novelty and value of applying bibliometric analysis to the intersection of game-based learning and physical education—a domain underexplored in existing literature. By mapping publication trends, thematic clusters, and influential contributions, this research provides a foundation for more evidence-based, inclusive, and innovation-driven approaches to PE in the digital era.

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