



Implementation of the Sport Pedagogy Model to Improve Students' Spatial Intelligence in Volleyball: Bibliometric Study 2020-2025

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ABSTRACT

Purpose of the study: This study aims to analyze the development of publication trends and identify and examine the main factors influencing the implementation of the sports pedagogy model to improve students' spatial intelligence in volleyball learning.

Methodology: This study uses bibliometric analysis and a Systematic Literature Review (PRISMA) based on Scopus data from 2020-2025 on sports pedagogy for developing students' spatial intelligence in volleyball learning. The data obtained were then systematically selected, subjected to VOSviewer-based visualization analysis, and interpreted to identify patterns, relationships, and research trends related to the comprehensive and objective development of students' spatial intelligence.

Main Findings: Research results show that implementing sports pedagogy in volleyball instruction improves students' spatial intelligence through game-based cognitive and motor integration. The growing body of research indicates the high relevance of learning implementation, which is influenced by engagement, tactical skills, decision-making, and the roles of teachers and learning design. However, this research remains limited by data sources, design variations, country dominance, and a lack of longitudinal studies, necessitating innovative development, expanded research, and technology integration.

Novelty/Originality of this study: This study offers a comprehensive bibliometric perspective by integrating trend analysis, spatial intelligence, and sport pedagogy in the context of volleyball learning. It enriches existing research by emphasizing the relationship between cognitive and motor aspects and providing a conceptual basis for the development of innovative learning models.

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1. INTRODUCTION

Physical education plays a central role in holistic students' development, fostering not only motor competencies but also cognitive, affective, and social capacities through structured learning [1]-[5]. Among the

sports integrated into physical education curricula, volleyball occupies a distinctive position because it simultaneously demands rapid decision-making, spatial awareness, and cooperative engagements under dynamic game conditions [6]-[10]. These demands make volleyball an especially rich medium for developing higher-order cognitive skills alongside technical and physical ones.

A central cognitive competency in volleyball is spatial intelligence, defined as the ability to perceive, visualize, and interpret the spatial relationships, positional arrangements, and movement trajectories of players and subjects within a dynamic game environment [11]-[15]. Spatial intelligence is not a supplementary attribute; it is a prerequisite for tactical understanding, effective positioning, and the construction of meaningful learning experiences in volleyball [12], [14]. Students who possess strong spatial intelligence are better able to read the game, anticipate play, and make accurate decisions in real time.

Despite this recognized importance, spatial intelligence remains critically underdeveloped among students in a practical volleyball setting. Field observations consistently document difficulties in tracking ball trajectories, selecting optimal positions, and executing sound tactical judgments under the time pressure of live gameplay [16]-[20]. These deficiencies directly impair playing effectiveness and reduce the overall quality of learning outcomes [21]-[24]. The core problem, therefore, is a persistent mismatch between what students need cognitively to perform effectively in volleyball and what conventional instruction actually develops.

The root cause of this deficiency lies in the persistent dominance of technique-centered instructional approaches. Conventional volleyball instruction prioritizes isolated skill drills and technical repetition, systematically neglecting the cognitive and spatial dimensions of the game [25]-[28]. As a result, students are rarely placed in conditions that require spatial intelligence to develop. This instructional imbalance constitutes the central pedagogy problem this study seeks to address.

The sports pedagogy model has emerged as a theoretically grounded and empirically promising solution to this instructional problem. By immersing students in authentic, game-based environments that replicate the cognitive and physical demands of competitive sports, the model simultaneously develops technical proficiency, tactical reasoning, and spatial intelligence [29]-[33]. Its emphasis on experiential, context-rich learning creates conditions in which spatial understanding is built through active game participation rather than passive drill reaction. The growing volume of Scopus-indexed publications on sport pedagogy between 2020 and 2025 reflects rising scholarly interest in its transformative potential for physical education.

However, despite this proliferating body of scholarship, there are critical gaps that remain unaddressed in the existing literature [34]-[37]. First, no comprehensive bibliometric study has systematically mapped publication trends, thematic clusters, or citation patterns in research on sport pedagogy and spatial intelligence in volleyball instruction. Second, the specific pedagogical and contextual factors that studies. Third, the field lacks a structured, evidence-based conceptual framework that practitioners and curriculum designers can use to inform instructional decision-making. Without such a synthesis, the growing body of individual studies remains fragmented and difficult to translate into practice.

Addressing these gaps is both timely and necessary. The urgency of this study is reinforced by two converging realities. First, the rapid growth in sports pedagogy publications between 2020 and 2025 signals a field at a critical juncture, one requiring systematic synthesis to consolidate knowledge and prevent theoretical fragmentation [38]-[42]. Second, the persistent underperformance of students in spatial and tactical dimensions of volleyball instruction, as documented across multiple educational contexts, demands evidence-based instructional guidance that the existing literature has yet to provide. Without a rigorous synthesis, practitioners lack the conceptual tools to design interventions capable of addressing this well-documented development gap.

This study responds to these gaps by employing a bibliometric analysis integrated with a Systematic Literature Review (SLR) following the PRISMA protocol, drawing on Scopus-indexed publications from 2020 to 2025. This dual methodological approach enables a transparent examination of publication trends, keyword co-occurrence networks, and citation patterns, while simultaneously synthesizing empirical findings on the factors influencing spatial intelligence development through sport pedagogy. This study pursues two clearly defined objectives: (1) To analyze publication trends and thematic development in research on sport pedagogy and spatial intelligence in volleyball learning from 2020 to 2025; and (2) To identify and synthesize the key factors that determine the effectiveness of the sport pedagogy model in improving students' spatial intelligence in volleyball instruction.

These objectives are operationalized through two research questions: (RQ1) What are that dominants publication trends from 2020 to 2025 in research on the implementation of the sport pedagogy model for enhancing students' spatial intelligence in volleyball instruction? (RQ2) What factors significantly influence the improvement of students' spatial intelligence in volleyball through this implementation of the sport pedagogy model? By answering these questions, this study aims to provide both a structured knowledge map of the field and a conceptual foundation for the design of evidence-based, game-centered, and spatially oriented physical education interventions.

2. RESEARCH METHOD

The present study uses a quantitative descriptive approach with the bibliometric analysis method and systematic literature review (SLR). This is a type of secondary research that focuses on analyzing and synthesizing previous results related to the use of the sport pedagogy model for volleyball learning with spatial intelligence in students. The data utilized for this research are secondary and derived from the scientific articles or conference proceedings indexed by Scopus. The research process consists of data collection, literature choice, extraction of the two types of bibliometric analysis, and visualization in a unique tool (VOS viewer), as well as obtaining conclusions.

Article screening was performed through several systematic and independent stages by the researchers. In the first step, duplicate articles were identified and excluded manually. Then, titles and abstracts of all the articles identified in the initial searches were screened to determine their relevance to this study. After the initial screening phase, articles that satisfied these criteria then underwent full-text review to ascertain their compatibility with study objectives, research variables, and methodological quality. This screening was performed to reduce selection bias and only retain studies that were relevant for the final analysis.

The research data on previous literature studies were retrieved from Scopus with the keywords of sport pedagogy, learning, and volleyball, in addition to spatial intelligence. All publications were selected as articles published between 2020 and 2026, to ensure that the research would be up-to-date. The research article & conference proceeding paper data sample is relevant to the subject area of study. That study used a purposive sampling technique with the following criteria: Articles discussing sport pedagogy in volleyball learning and spatial intelligence, written in Indonesian or English, indexed by Scopus. Irrelevant articles and books or book chapters that did not have a sports pedagogy context were excluded.

This review employs a systematic procedure based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, aiming to address the research question through four stages: identification, screening, eligibility assessment, and inclusion. The application of this framework helps enhance transparency, consistency, and completeness in reporting the results of systematic reviews and meta-analyses. Data sources were obtained from Scopus-indexed journal articles using the keywords “sport pedagogy; AND volleyball learning; AND spatial intelligence,” as well as other relevant keyword combinations aligned with the research focus. The literature selection process was conducted by referring to the inclusion and exclusion criteria applied to primary studies to minimize ambiguity and reduce potential bias in the literature review process, as presented in Figure 1.

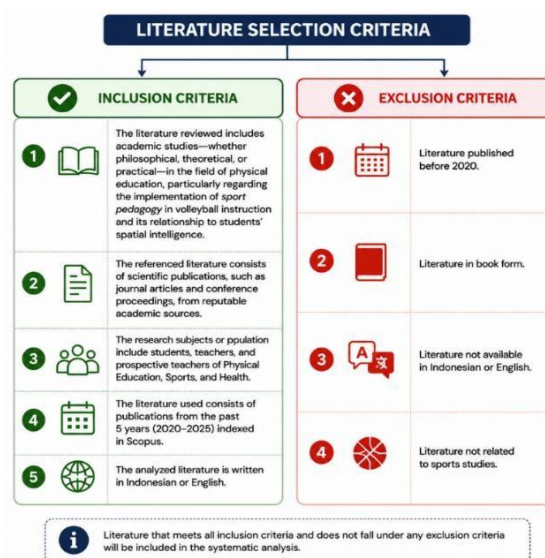


Figure 1. Exclusion and Inclusion Criteria

The criteria for inclusion in this study contained all empirical studies which, if discussed at a specific implementation of sport pedagogy on students' spatial intelligence/tactical understanding/motor skills and/or learning outcomes in the context of volleyball learning physical education. The inclusion criteria of the selected literature are journal articles and conference proceedings indexed in Scopus published between 2020–2026, written in English or Indonesian language to ensure that data sources were relevant, high-quality, current, and widely accessible. The types of study subjects discussed in the included articles were students, teachers, prospective teachers or participants in physical education, sports and health. Meanwhile, the exclusion criteria were publications that were published prior to 2020, book or book chapters, duplicate articles, review or non-empirical studies, literature not available in English or Indonesian language also studies which was out of scope

that related to sport pedagogy especially volleyball learning and spatial intelligence. Moreover, the selection criteria also ensured that articles with poor methodological reporting or inaccessible full texts were excluded to prevent unrepresentative coverage and inconsistency in the systematic review process.

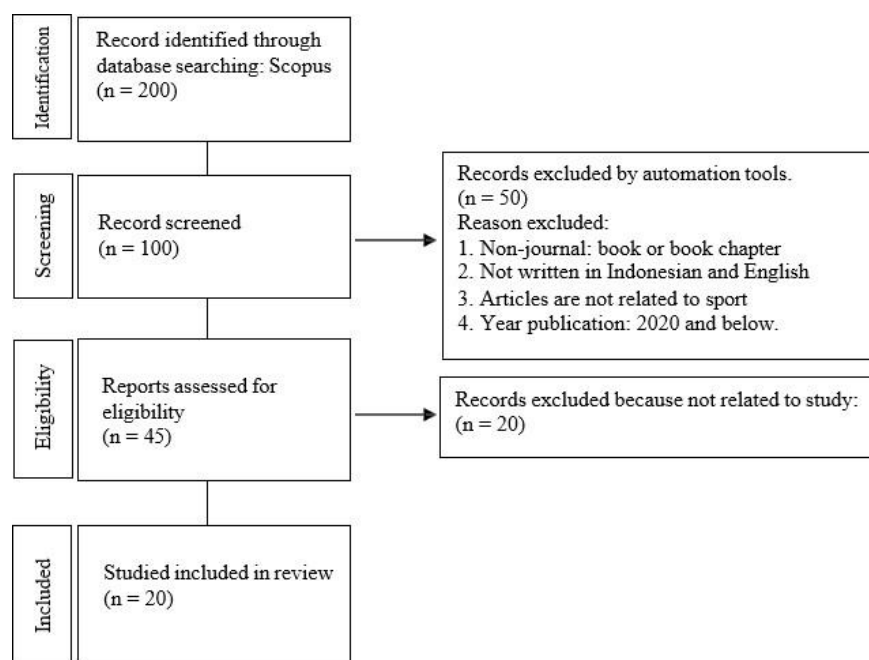


Figure 2. Flowchart PRISMA

Based on Figure 2, during the literature identification phase, a search was conducted using keywords such as “sport pedagogy,” “volleyball instruction,” and “spatial intelligence” in the Scopus database, yielding a total of 200 initial studies. During the screening phase, 100 studies were eliminated because they were books or book chapters, were not relevant to the context of physical education specifically volleyball instruction were not written in Indonesian or English, or were published before 2020. Consequently, the literature retained at this stage consists of articles published in Scopus-indexed journals or conference proceedings. In the eligibility assessment stage, 50 articles were identified as meeting the initial criteria. Subsequently, in the final inclusion stage, 45 articles were excluded because they lacked a direct connection to the research focus. Consequently, 20 articles were determined to meet all inclusion criteria and were used as the basis for analysis in this systematic literature review. These articles were subsequently classified and presented in Table 2.

Table 1. List of Synthesized Articles

Title	Author	Journal
The Effect of Learning Models on Creativity, Knowledge, and Big Ball Game Skills in High School Students	NugrohoSusanto, Nurhasan, Edy Mintarto	Journal of Hunan University (Natural Sciences)
Sport and Peace: Physical Education for Papuan Student Awareness.	Ewendi W Mangolo, Rif'iy Qomarrullah	International Journal of Human Movement and Sports Sciences
Motion extrapolation in sport expertise: representational momentum and representational gravity in volleyball athletes.	Mariana M, Rodrigues, Nuno De Sa Teixeira	Jounal Cognition: Elsevier
Spatial evolution characteristics and influencing factors of sports brand resources in Chinese urban agglomerations	Xuesi Zhong, Jingling Wang & Zejun Zhong1	Scientific Reports
Comparative Effects of Drill and Play Methods on Volleyball Underhand Passing and Learning Motivation Across Motor Educability Levels	Mimi Yulianti, Subagyo, Sujarwo, Nevitaningrum	Slobozhanskyi Herald Of Science And Sport

Title	Author	Journal
The Effects of Peer and Self-Assessment on Students' Self Regulation, Perceived Motivational Climate and Volleyball Skill in Physical Education	Yasemin Azzaloulidine Gökçe Erturan	Pamukkale Journal of Sport Since
Visual spatial attention and its impact on the accuracy of the diagonal spike in volleyball.	Jinan Naji Zwayen	SPORT TK-Euro American Journal of Sport Sciences
Evaluation of basic volleyball technical abilities among sport education students.	Gatot Jariyono, Nur Hidayat	SPORT TK: Euro American Journal Of Sport Sciences
How functional movement variability facilitates successful skill adaptation during the volleyball attack	Pauolo Calderia, Ana Pauolo, Anatio Veloso Jorge Infante	International Journal Of Sport Sciences & Coaching (Sage)
Optimizing the deployment of space-temporal orientation in physical education and sport lessons for students aged 8-11 years	Denisa Maddalina Balanean, Cristian Negrea, Eugen Bota	Jurnal Children (MPDI)
Life skills and volleyball teaching: comparison between TGFU and direct instruction model.	Debora Arantes, Caroline Goncalves, Marcelo Rodrigues, Josse Correa	Journal Education Sciences
Optimizing learning outcomes in physical education: A comprehensive systematic review of hybrid pedagogical models integrated with the sport education model.	Junlong Zhang, Kim Geok Soh, Xiaorong Bai, Mofid Ashraff Mohd Anuar, Wesheng Xiao.	Journal PLOS ONE
Recognition of volleyball player's arm motion trajectory and muscle injury mechanism analysis based upon neural network model.	Inxiang Zhao, Zengli Li	Journal of Healthcare Engineering
Technical-Tactical Analysis of Serving Strategies in Elite Women's Volleyball: Insights from the Santiago 2023 Pan American Games	Guillermo Laclote-Gutierrez, Jairo Azócar Gallardo, Tiago Vera-Assaoka, Mauricio Cresp-Barria, Exal Garcia-Carrillo, Víctor Campos-Urbe, Eduardo Báez-San Martín.	Applied Sciences
Thinking Before Doing: A Pilot Study on the Application of Motor Imagery as a Learning Method During Physical Education Lesson in High School	Patrizio Canepa, Antonella Sbragi, Filippo Saino, Monica Biggio, Marco Bove and Ambra Bisio	Front. Sports Act. Living
Nonlinear pedagogy and its application in a volleyball didactic unit: a practical approach.	Carlos Gomes-Criado, Teresa Valverde, Esteve	Journal Retos
Deep Learning-Driven Assessment of Student Movement and Performance Using Physiological Data in Physical Education Information Systems: An S-AIoT Solution	Ping Liu and Elaheh Dastbaravardeh	Wiley International Journal of Intelligent Systems
Design of Computer-Aided Volleyball Teaching System in Colleges and Universities.	Qilin Han	Journal of Physics: Conference Series
Development and application of a physical fitness pedagogy model based on the sport education model framework: an instructional innovation in physical fitness curriculum.	Hongliang guo, rui xue, hongqin chai, yazi long, trung thanh le, gui nong, sisi li & xiajian tang.	Journal BMC Public Health

Title	Author	Journal
The effect of the cube model on visual-spatial intelligence and learning the skill of spiking in volleyball for female students.	Alya Hussein Farhan, Tahsen Husni Tahseen, badra malik shihab, maher amer jabar, nab	Journal Retos

The instruments used two primary data collection: a data extraction form, and document analysis guidelines were based on PRISMA (Preferred Reporting items for Systematic reviews and Meta-Analyses) framework along with bibliometric analysis using VOS viewer. This has been a common approach in bibliometric and systematic literature review papers such as research by Zhang et al [43] in a study of hybrid pedagogical models in physical education learning and related to the development of a physical fitness pedagogy model based on sport education. A data extraction form was developed to extract key information from each included article related to the names of authors, publication year, study design, characteristics of participants, instruments used, results, and keywords.

The bibliographic data processed in this study were exported from all selected publications via the Scopus database and saved as a .csv (comma-separated values) file format. This data includes information such as authors, affiliation institutions, article titles, and abstracts, including their keywords & citations. In addition, the data were saved in Microsoft Excel (in a similar format) for convenience when processing and verifying. These data were then imported into the VOS viewer software to perform a bibliometric analysis in terms of network mapping and visualization of relationships among publications related to sport pedagogy in volleyball teaching for improving students' spatial intelligence. Next, the outcomes of article classification and synthesis were collated into broad categories by publication year, journal type, educational level sampled and sample size. The classification was carried out in order to analysis the characteristics of studies context related pedagogical implementation model function its appropriateness on volleyball teaching space controlled students' exploratory phase, sport pedagogy towards spatial intelligence development. Moreover, prior to the analysis process additional threshold values for frequency and minimum occurrence were calculated due to an increase of data complexity as well as better understanding of results visualisation. Normalization is performed in VOS viewer to have proportional relationships among nodes and improve interpretability of bibliometric networks. The coding of the article data sources is systematically presented in Table 2.

Table 2. Synthesized Article Coding

Coding Categories	Sub-Category	Code
Research Characteristics	Publication Media	Journal of Hunan University
		Journal of Human Movement and Sports Sciences Journal cognition
		Journal scientific reports
		Jurnal herald of science and sport Jurnal pamukkale sport
		since Journal of sport sciences
		Journal of sport sciences & coaching (sage) Jurnal children (mpdi)
		Journal education sciences Journal plos one
		Journal of healthcare engineering Journal applied since
		Journal front act living Journal intelligent systems Journal retos
		Journal of physic
Intervention characteristics	Publication Year	Journal bmc public health
	Research Design	2020,2021,2022,2023,2024,2025,2026
	Number of Participants	Experimental, Quantitative, and Research Developoment (R&D)
	Level : Students and Participants	20-200
	College Partisipants	Secondary school, teachers, and prospective teachers
Result	CT Result	Sport Education
	Academic outcomes	Improved spatial intelligence and tactical skills in volleyball learning.
		Improved volleyball learning includes spatial intelligence, tactical skills, technical skills, game understanding, and active student involvement in sports pedagogy-based learning.

The bibliometric visualization tool used in this study was developed by the Centre for Science and Technology Studies (CWTS) at Leiden University. The visualization analysis utilized link strength to evaluate networks, including network visualization, overlay visualization, and density visualization during the cluster normalization process. This tool is capable of processing various data formats from scientific databases such as Scopus, Web of Science, PubMed, and RIS. The types of analysis that can be performed include author relationships (co-authorship), keyword co-occurrence, citation analysis, and literature interconnections. VOS viewer is an effective tool for mapping and visualizing scientific information, particularly for systematically and clearly displaying large-scale bibliometric maps based on item selection according to occurrence frequency or a specified threshold. Setting a threshold that is too low can result in highly complex data, while a threshold that is too high can lead to a reduction in data representation. Therefore, the threshold value was determined carefully to produce a proportional and informative visualization in line with the focus of the study, namely sport pedagogy in volleyball learning and its relationship to students' spatial intelligence, so that the data analysis process would be more efficient and structured, and would facilitate users in developing and adding new analysis functions according to research needs, including in the study of sport pedagogy in volleyball learning in relation to students' spatial intelligence.

The visualization results were interpreted using a holistic bibliometric approach to the structure of the scientific literature to identify connections, relationship patterns, and influences among publications, thereby providing a new perspective on knowledge development in the field under study, particularly regarding the application of sport pedagogy models in volleyball instruction in relation to the development of students' spatial intelligence. Furthermore, the interpretation of the bibliometric analysis results is generalized to previous related research to produce more objective and careful theoretical findings, so that the analysis results can still be used to examine past research developments and identify future research trends. Therefore, caution in interpreting the results is crucial for the interpretation of the research data obtained. The visualization results were interpreted included not only tasks such as finding clusters and connections of keywords but also analyzing new trends and main topics in research as well as their gaps with regards to previous studies. The color scale, node size and link strength in visualization maps were decoded as indications of relationship intensity and the evolution of research topics throughout time. This information allowed the researchers to offer a more in-depth explanation of how sport pedagogy research with respect to volleyball learning has evolved and what students spatial intelligence development can result from this.

3. RESULTS AND DISCUSSION

Yearly trend of publication citations as well as most influential countries

Based on the synthesis of the articles, it can be shown that the implementation of sport pedagogy in volleyball instruction focuses on several key characteristics, namely: (1) characteristics of instructional interventions, which include research designs such as experimental, quantitative, qualitative, and research and development studies, and (2) characteristics of learning outcomes, which include improvements in spatial intelligence, tactical understanding, technical skills, and student engagement. Furthermore, the reviewed studies also considered the characteristics of the research subjects, which included school students, pre-service teachers, and Physical Education, Sports, and Health teachers. Additionally, all synthesized articles emphasized the trend of applying sport pedagogy models that directly contribute to improving the quality of volleyball instruction, particularly in integrating cognitive aspects and motor skills [43], [44]. This approach is considered effective because it places students in a game-based learning environment that simultaneously requires spatial awareness, decision-making, and social interaction. Thus, the sport pedagogy model focuses not only on mastering basic techniques but also on developing students' tactical thinking skills and spatial intelligence [45]-[47].

Future research trends based on the results of the literature review indicate the need to develop more innovative and adaptive learning models to support the continuous improvement of the quality of physical education, as shown in Figure 3.

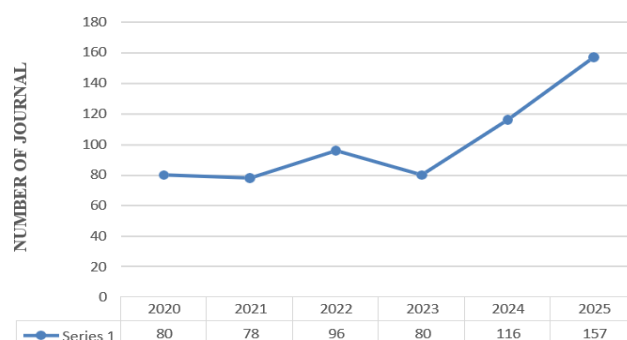


Figure 3. Synthesis Results by Year

In addition, based on the literature review conducted in the database used, a number of scientific publications were identified through a Scopus web search using specific keywords, and the research data were visualized using VOSviewer, as shown in Figure 4.

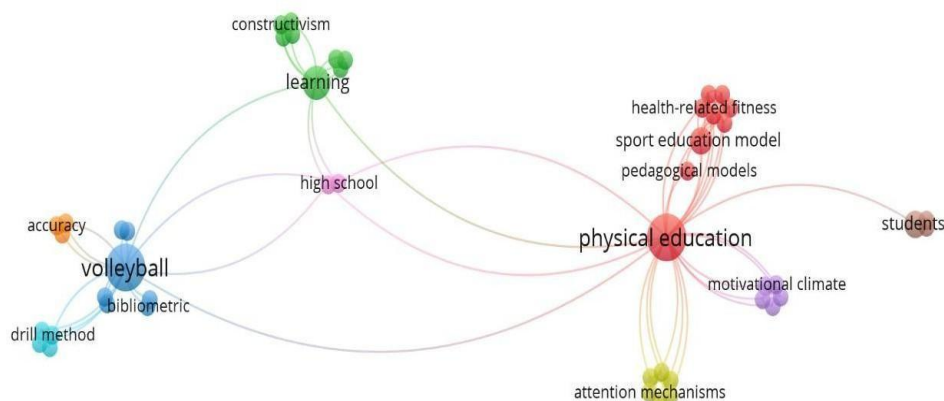


Figure 4. Keyword Visualization

Based on the distribution of the number of publications, it can be concluded that research in the field of sport pedagogy models for the development of spatial intelligence has experienced significant growth over the past five years. This indicates increasing attention and intensity of scientific exploration by researchers on this topic, as shown in Figure 2. This is also evident from the number of published and cited articles related to sport pedagogy, which shows a steadily increasing trend. Data for the 2020–2026 period shows that the number of publications has never fallen below 80 articles per year. Since 2021, there has been a consistent year-over-year increase, with the number of publications remaining above 80 articles starting in 2022. The peak in publications was recorded in 2025 with a total of 158 articles, confirming that this topic is growing and becoming a key focus in physical education research based on sport pedagogy. The regional distribution of the highest number of research publications during the 2020–2026 period related to the implementation of sport pedagogy for the development of spatial intelligence is presented in detail in Figure 5.

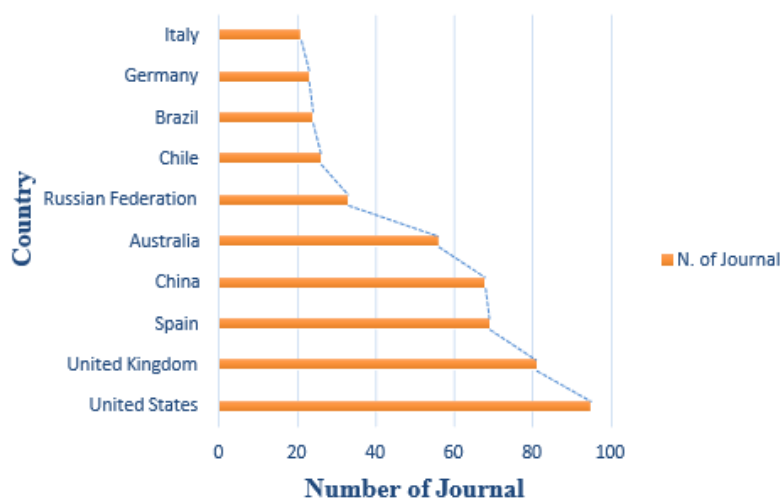


Figure 5. Country/Region Publication Results

Based on Figure 5, there are the top 10 publications with the highest number of citations related to the implementation of sports pedagogy in volleyball instruction and its relationship to the development of students' spatial intelligence between 2020 and 2025. Additionally, the article with the most significant number of citations was written by researchers from reputable international institutions and published in a high-impact scientific journal. The study thoroughly examines the application of the sports pedagogy approach in the context of physical education, with an emphasis on the development of cognitive aspects, particularly spatial intelligence, through structured game activities [48]–[50].

Furthermore, based on the results of a systematic review of the literature, the sport pedagogy model plays a role in transferring learning experiences from formal learning environments to more contextual game situations, thereby encouraging students to be more active in understanding spatial dynamics and positioning, as well as making quick and accurate decisions [51], [52]. The high citation count for these articles reflects the

significant interest among academics in the integration of sport pedagogy models and the development of spatial intelligence in volleyball instruction [53], [54]. Additionally, the publications with the highest citation counts tend to originate from the early years of the analysis period, with a relatively higher citation range compared to articles published in subsequent years. This phenomenon suggests that articles published earlier have a greater chance of receiving citations, while also indicating a trend of increasing research interest in the application of sport pedagogy in volleyball instruction. These findings are also consistent with the distribution of annual citation counts, which reveal specific periods as peaks in citation intensity over the past five years.

The results of the research data visualization were also interpreted through keywords into several clusters, showing the grouping of keywords into distinct clusters differentiated by color. Node size represents the frequency of keyword occurrence, while connecting lines indicate the strength of relationships between themes; thus, the larger the node and the thicker the line, the stronger the conceptual connection. The red cluster indicates that sport-based pedagogy remains the dominant cluster in the development of volleyball instruction, particularly regarding the development of spatial intelligence, encompassing activities, skill development, learning quality, interventions, and program effectiveness [55]-[57]. This dominance suggests that research has largely focused on the processes and outcomes of learning, specifically using volleyball activities as the foundation for developing spatial intelligence within the context. The green cluster depicts cognitive and pedagogical aspects, including motivation, student engagement, the teacher's role, and support for learning autonomy; thus, it can be affirmed that the teacher's role and the learning environment play dominant roles in fostering students' spatial intelligence in volleyball game-based learning through the implementation of the sport pedagogy model [58], [59]. In addition, the blue cluster indicates the influence of demographic characteristics, such as age and gender, which provide context for the variation in research findings. Based on this mapping, the co-occurrence analysis shows that studies of the sport pedagogy model in volleyball instruction are always closely related to pedagogical and cognitive aspects, as well as student characteristics particularly in the process of developing spatial intelligence. This is supported by the view that improvements in students' spatial intelligence in volleyball are influenced by learning activities, motivation, and the teacher's role in creating contextual learning experiences through the sport pedagogy model. Figure 6 shows a visualization of the co-occurrence network created using VOS viewer.

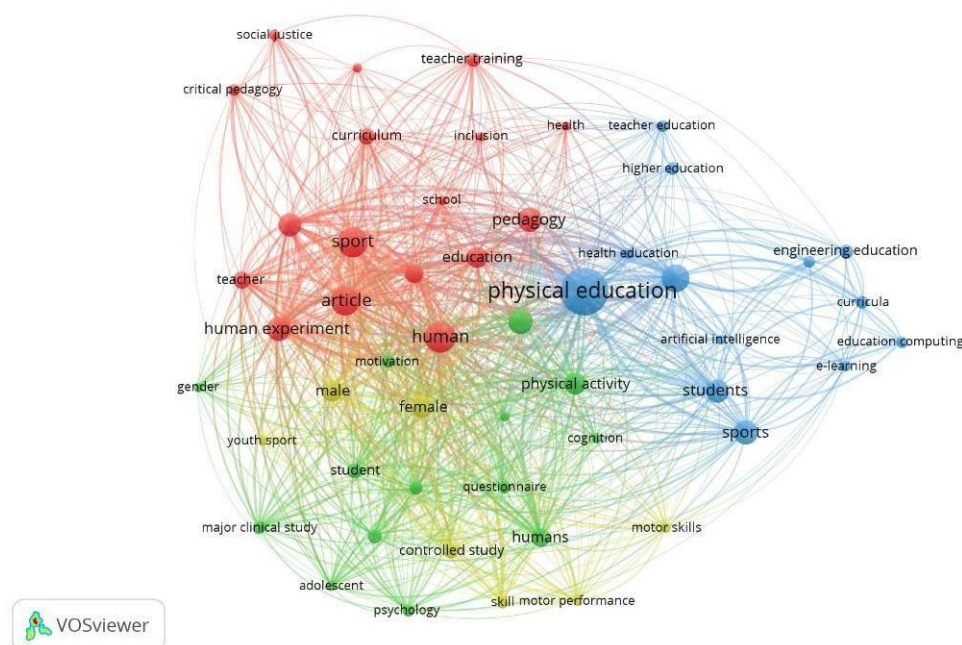


Figure 6. VOSviewer Visualization of Co-occurrence Network

Based on the results of data visualization, an analysis of publication trends reveals that the implementation of sport pedagogy in the context of volleyball instruction has shown a consistent increase year over year [60]-[63]. This finding aligns with the need for instructional innovations capable of addressing the issue of low spatial intelligence among students, as identified in the research background [64], [65]. Furthermore, the increase in the number of publications, particularly in recent years, indicates that this topic is increasingly viewed as relevant in the development of modern physical education. This also points to a paradigm shift from learning focused solely on technique toward learning that emphasizes playing experience, spatial understanding, and contextual decision-making [66], [67]. Furthermore, regarding the distribution of countries or regions with the highest number of publications,

The analysis results indicate that research contributions are dominated by countries such as the United States, the United Kingdom, Spain, and Australia [68], [69]. This dominance reflects the strength of the research ecosystem and academic collaboration in these countries in developing various volleyball-based learning activities grounded in the sport pedagogy model to foster students' spatial intelligence. Furthermore, the high number of publications also indicates that the integration of cognitive aspects, including spatial intelligence, is a primary focus in the development of physical education at the global level. This finding aligns with the background literature, which emphasizes that volleyball instruction requires not only technical skills but also complex cognitive abilities [70], [71]. Thus, the geographical distribution of publications and trends in both publications and research indicate that the development of a sports pedagogy model for volleyball is part of a global trend toward improving the quality of game-based learning and, in particular, enhancing students' spatial intelligence [72], [56].

Factors Influencing the Improvement of Students's Spatial Intelligence in Volleyball Games towards the Implementation of the Sport Pedagogy Model

Based on the results of the literature review, it was found that improvements in students' spatial intelligence in volleyball are significantly influenced by the application of learning models, one of which is the sport pedagogy model, which is contextual and game-based [73], [74]. In addition, students' active engagement, the intensity of interaction during the game, and the variety of learning strategies are key factors that support the development of spatial awareness, positional awareness, and movement skills in volleyball [44], [75]. Based on the results of the literature review, it was also found that tactical ability and decision-making are the most prominent indicators, particularly in enhancing students' spatial intelligence in volleyball, because both are closely related to students' ability to respond to dynamic game situations [76], [77].

In addition, the characteristics of a learning model based on sports pedagogy, which emphasizes game-based activities, have proven effective in creating a contextual learning environment [50]. This allows students to actively construct an understanding of space, position, and direction of movement in volleyball, as outlined in the introduction regarding the importance of spatial intelligence in understanding the dynamics of the game [78]. Based on the findings of the synthesis, it is also evident that students' active engagement is a dominant factor in supporting the development of spatial intelligence, primarily through the implementation of the sport pedagogy model. Learning designed using the sport pedagogy model encourages students to engage directly in game-based situations, thereby enhancing meaningful learning experiences. These findings align with the view that active engagement and interaction in games are key indicators of improved learning quality, particularly in the development of students' spatial intelligence.

Another influential factor is tactical ability and decision-making. This aligns with the assertion that, in the context of volleyball instruction, spatial intelligence does not develop in isolation but is integrated with students' ability to read game situations, identify opportunities, and determine appropriate strategies [57]. This reinforces the argument that sport-based pedagogy is capable of developing higher-order thinking skills, primarily spatial intelligence, simultaneously with motor skills [79]. In addition, the roles of teachers and instructional design also play a key role in determining the success of the model's implementation. Through the implementation of this sport pedagogy model, teachers serve not only as facilitators but also as designers of learning experiences capable of accommodating students' cognitive and motor needs. This aligns with research indicating that the instructional design of the sport pedagogy model creates an adaptive, varied, and contextual learning process, as evidenced by the significant improvement in students' spatial intelligence compared to conventional approaches [80].

In addition, student characteristics such as educational level, prior experience, and the number of participants also influence the effectiveness of learning [81]. This indicates that there are still gaps in the implementation of the sport pedagogy model, which needs to be adapted to the students' context and circumstances so that the development of their spatial intelligence in the volleyball learning process can be optimized. However, overall, the research findings have shown that the implementation of the sport pedagogy model is effective in addressing the issue of low spatial intelligence in volleyball instruction. This is supported by the view that the sport pedagogy model not only improves technical skills but also enhances cognitive abilities, particularly in understanding spatial relationships, positioning, and game dynamics, as well as students' spatial intelligence in volleyball instruction [80], [82]. These findings also underscore that the integration of cognitive and motor skills is key to creating effective and meaningful physical education instruction [82], [83]. Thus, this study makes both theoretical and practical contributions to the development of sports pedagogy. Therefore, it is hoped that the results of this study will enrich the discussion regarding the role of sports pedagogy in the development of spatial intelligence, particularly in volleyball instruction. Practically, these findings can serve as a reference in designing more innovative, contextual, and student-centered learning experiences focused on developing spatial intelligence, particularly in holistic volleyball instruction. Additionally, the growing trend in research highlights the need for further exploration to develop more adaptive and sustainable learning models in the future [84], [85].

In general, the results of this study confirm that research on volleyball pedagogy still has significant room for development. Several keywords that have not been extensively studied can serve as a basis for future research, such as those related to collaboration between authors and journal publishers. The data sources for this study were limited to Scopus-indexed articles from 2020 to 2025; therefore, there may still be relevant research from other databases that has not been included. Furthermore, research could focus on developing technology-based sport pedagogy models, as well as examining other variables such as motivation, learning environment, creativity, and individual differences among students [8]. Research on other sports is also important to expand the application of sport pedagogy models in holistically enhancing students'.

4. CONCLUSION

The synthesis results show that the implementation of the sports pedagogy model in volleyball learning contributes significantly to improving students' spatial intelligence through the integration of cognitive aspects and motor skills in a game-based learning context. The increasing trend of publications in the last five years indicates that this topic has high urgency and relevance in the development of contemporary physical education. Factors such as active student involvement, tactical ability, decision-making, as well as the role of teachers and learning design are the main determinants of the success of the model's implementation. This study has limitations in the scope of data sources used, the diversity of designs and characteristics of research subjects that have the potential to cause variations in results, the dominance of contributions from certain countries, and the limited longitudinal research examining the long-term impact of model implementation. Therefore, further development of learning based on sports pedagogy models that are more innovative and adaptive to student characteristics is needed, by conducting various studies to expand the scope of literature and geographical context, and conducting longitudinal studies to test the sustainability of the impact on spatial intelligence, especially in volleyball learning or other sports education learning materials. In addition, the integration of learning technology and exploration of other variables such as motivation, learning environment, and individual differences are needed to enrich the research in this field so that it is hoped that there will be practical implications in the process of developing students' spatial intelligence.

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AUTHOR CONTRIBUTIONS

For research articles with multiple authors, the following is a detailed description of each author's contribution: Conceptualization by author 1, and author 6; Methodology, author 1, author 2, and author 3; Software, author 4 and author 5; Validation or Review, author 1, author 6, and author 7; Supervision and Proofreading, author 1, author 6, and author 7; and the last Project Administration, by author 1.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

INFORMED CONSENT STATEMENT

This research did not use humans or animals. All images in this article have been authorized and are the property of the authors.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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