# Effects of the Sport Education Model on Content Knowledge, Technical Skill, and Game Performance Among Students: A Systematic Review and Meta-Analysis

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**Abstract**

The Sport Education Model (SEM) has emerged as a promising approach for enhancing content comprehension, technical proficiency, and game performance in educational settings. This systematic review and meta-analysis synthesize findings from ten moderate-quality studies involving 750 participants aged 10-20. These studies implemented SEM programs lasting 4 to 16 weeks, with one to five sessions per week. The analysis indicates significant improvements attributable to SEM, with effect sizes of 0.70 for content knowledge ($p < 0.01$), 0.70 for technical skills ($p < 0.01$), and 0.92 for game performance ($p < 0.01$). However, due to the moderate confidence in these results, caution is warranted in their interpretation. Subgroup analyses reveal that variations in student learning stages and game performance measurement methods, rather than intervention frequency and duration, influence the outcomes. Despite these encouraging results, further high-quality research across various sports is necessary to fully understand SEM's impact. Such research is essential for educators to effectively implement SEM and maximize its potential in educational contexts.

**Keywords**: Game Performance, Technical Skill, Content Knowledge, Sport Education.

## Introduction

### The Sport Education Model as Implemented within Physical Education Pedagogy

The SEM is a pedagogical approach that plays a pivotal role in physical education. Designed to provide students with authentic sports experiences, SEM aims to develop not only their physical abilities but also their sports literacy and enthusiasm for participation (Siedentop et al., 2019). Unlike traditional physical education methods, SEM immerses students in a comprehensive sports experience where they actively engage as athletes, teammates, and advocates for sportsmanship (Bessa et al., 2021; Segovia & Gutiérrez, 2020). Furthermore, a systematic review by researchers in the field of Hybrid Pedagogical Models revealed that the predominant hybrid approach is the "SEM + 1 model," which integrates the organizational structure of SEM's seasons. This finding highlights the significant role of SEM within contemporary pedagogical frameworks (Shen & Shao, 2022).

Through the SEM, students not only acquire technical sports skills but also develop a comprehensive understanding of sports rules, etiquette, and traditional customs (Siedentop et al., 2019). This educational approach equips students with the ability to distinguish between exemplary and unsportsmanlike behaviour, fostering an appreciation for the intrinsic values of sports (Abălaşei et al., 2017). Active participation in SEM cultivates students' passion for sports, integrates them as essential team members, and encourages consistent demonstration of exemplary athletic performance throughout the season. In summary, SEM is a crucial teaching method in physical education.

### The Significance of Assess Content Knowledge, Technical Skill, and Game Performance

The evaluation of students' content knowledge, technical skills, and play performance serves as a valuable tool for academics and front-line educators in determining the effectiveness of specific teaching methods and strategies in promoting overall student development (Sun et al., 2023). Conversely, scholars and educators can customize teaching methods and strategies based on students' current levels and stages of development in these areas (Bessa et al., 2021). Thus, reviewing the impact of the Sport Education Model on students' content knowledge, technical skills, and game performance is of significant importance for both scholars and teachers.

The SEM is an essential pedagogical approach in physical

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education, combining constructivist and game theories with a student-centred philosophy to provide experiential and practical learning opportunities (Bessa et al., 2021). SEM enhances students' content knowledge (Iserbyt et al., 2015) (Farias et al., 2017; Pritchard et al., 2008), technical skills (Pritchard et al., 2008) (McMahon et al., 2019), and game performance (Bessa et al., 2019; Pritchard et al., 2008). Despite the foundational findings, systematic reviews on SEM's effects are lacking. This research aims to explore SEM's impact on these areas, encouraging educators to adopt SEM and promoting comprehensive scientific investigation into its effectiveness.

## Literature Review

The SEM encompasses six core elements: season, affiliation, formal competition, culminating event, record-keeping, and festivity. These components are often neglected in traditional physical education programs. However, recent research indicates that SEM has a positive impact on students' knowledge, skills, and game performance. For example, SEM significantly enhances students' creativity in team sports (Susanto et al., 2023), knowledge (Mahedero et al., 2015; Susanto et al., 2023), skill mastery (Hastie et al., 2009; Mahedero et al., 2015; Susanto et al., 2023), game execution ability (Hastie et al., 2009; Mahedero et al., 2015), tactical understanding (Hastie et al., 2009), tactical decision-making (Mahedero et al., 2015) (Salimin et al., 2020), game performance, and game involvement (Farias et al., 2017; Mahedero et al., 2015).

Research comparing students with varying skill levels has yielded insightful findings. Mahedero et al. (2015) reported that students with moderate skill levels showed significantly greater improvements in knowledge and game performance within SEM compared to their high and low skill level peers, indicating differential skill development across skill levels. However, Salimin et al. (2020) found no significant impact of grouping strategies on improving game performance and knowledge among students of different skill levels, highlighting some conflicting results.

Additionally, Farias et al. (2017) investigated the progression of game performance and involvement over three consecutive SEM seasons, noting significant improvements in the second and third seasons, but not in the first. This underscores the importance of sustained participation and team continuity for enhancing game performance. To the best of the author's knowledge, there's a lack of systematic reviews on the impact of SEM on students' Knowledge, Technical Skill, and Game Performance. Previous reviews primarily focused on enhancing personal and social skills, motor and cognitive development, motivation, basic needs, prosocial attitudes, and learning outcomes through SEM implementation (Bessa et al., 2019; Bessa et al., 2021; Evangelio et al., 2018; Manninen & Campbell, 2022; Tendinha et al., 2021). These findings collectively support the positive outcomes of SEM in enhancing student performance across these dimensions.

## Methods

### Procedures for Registration and Protocol

This study adhered to the PRISMA statement (Page et al., 2021) for reporting the systematic review and meta-analysis, with the review protocol registered on Inplasy.com (INPLASY2023100019).

### Criteria for Eligibility

The PICO framework (McKenzie et al., 2019) was utilized to evaluate the eligibility of studies according to the specified criteria:

**Population**

The study's cohort comprises physically fit students spanning from elementary to high school and university levels, devoid of any health conditions impeding their routine physical engagement.

**Intervention**

The methodology explicitly delineates the utilization of the SEM as the intervention approach, with SEM sessions conducted within an educational setting.

**Comparison**

The comparison involves controlled trials comprising multiple groups as well as single-group trials with a control group, where the control group receives conventional instruction.

**Outcomes**

The outcomes of interest must encompass at least one facet of SEM's influence on participants, particularly focusing on content knowledge, technical skill, and game performance.

Moreover, research published in languages other than English, along with articles, books, theses, conference papers, systematic reviews, and theoretical papers, were excluded from the scope of this review.

### Approach to Search and Selection Methodology

On September 2, 2023, we systematically searched four electronic databases (Web of Science, SPORTDiscus, PubMed, and SCOPUS) using keywords like "Sport Education Model," "athletic performance," "technical skill," "knowledge," and "content knowledge" combined with ("student*"). Additionally, we reviewed articles published before September 2, 2023, and conducted a manual search on Google Scholar for supplementary materials. Scrutinizing reference lists and seeking guidance from experienced librarians ensured the accuracy of our search process.

The study selection process involved four stages: identifying and removing duplicate articles, screening titles and abstracts, examining full texts against eligibility criteria, and resolving discrepancies through discussion among two independent reviewers, J.Z. and H.M., with input from a third reviewer, S.Z., if needed, until a consensus was reached. The review exclusively included English-written articles to avoid potential translation challenges, excluding conference abstracts, books, book chapters, pilot studies, and non-peer-reviewed papers.

For more detailed information on the search strategy and study selection process, please refer to Table 1 and Figure 1. These methodological decisions enhanced the validity and reliability of the study by guaranteeing the incorporation of pertinent, top-tier literature and mitigating biases. The meticulous selection procedure, encompassing duplicate removal, language constraints, and comprehensive full-text assessment, augmented the general quality of the review outcomes. Furthermore, the engagement of impartial reviewers addressed discrepancies and mitigated subjective biases.

**Extraction of Data**

The data collection process was meticulously conducted by two evaluators, J.Z. and H.M., using Microsoft Excel spreadsheets (Microsoft Corporation, Redmond, WA, United States). To ensure the accuracy and reliability of the collected data, a third evaluator, S.Z., conducted verification.

The recorded information for each study included the following:

a) Name of the primary author and publication year.
b) Country where the study was conducted.
c) Details regarding the frequency, duration, and number of sessions comprising the intervention.
d) Participant characteristics, including the participating school(s), participant count, and age.
e) Specific inclusion and exclusion criteria applied to the subjects.
f) Information concerning the comparison group(s).
g) Sports included in the study.
h) Model fidelity, indicating the extent to which SEM was faithfully implemented.
i) Assessment methods used to evaluate game performance or content knowledge.
j) Outcomes assessed in the study.

Through this meticulous record-keeping and verification procedure, the reliability and accuracy of the data gathered from each study were ensured, thereby augmenting the overall quality of the research.

**Study Quality Assessment**

Two independent assessors, J.Z. and H.M., utilized the PEDro scale as a tool to rate the methodological quality of the studies. The PEDro scale, validated by De Morton (2009) and deemed reliable by Maher et al. (2003), is recognized for its ability to assess study quality. Their evaluations were subsequently cross-verified by a third assessor, S.Z., leading to consensus among all three assessors. The PEDro scale allocates scores from 1 to 10, with specific score ranges denoting different levels of quality: scores of 0-3 indicate poor quality, 4-5 denote fair quality, and 6-10 represent high-quality research. Comprising 11 items, the PEDro scale assesses various aspects of methodological quality, with each completed item contributing one point to the total PEDro score, which ranges from 0 to 10. Notably, item 1's score does not impact the assessment of study quality to preserve external validity. To mitigate the potential introduction of high-bias risk into the analysis, a post hoc decision was made to exclude studies with a PEDro score of 3 or lower.

**Certainty of Evidence**

Two reviewers, J.Z. and H.M., utilized the GRADE methodology to assess the certainty of evidence, categorizing it as very low, low, moderate, or high (Chu & Zhang, 2018; Guyatt et al., 2011; Zhang et al., 2019a; Zhang et al., 2019b). Initially appraised as high, evidence for each outcome was subsequently downgraded based on specific criteria:

a) If the median PEDro score was moderate (less than 6), the certainty of evidence was downgraded by one level (Guyatt et al., 2021).
b) Indirectness: Given that the inclusion and exclusion criteria ensured specificity in terms of the population, intervention, comparison, and outcomes, the risk of indirectness was considered low by default.
c) Publication bias: If there were indications of potential publication bias, the certainty of evidence was downgraded by one level (Guyatt et al., 2011).
d) Inconsistency: When substantial statistical heterogeneity was observed ($I^2 > 75\%$), the certainty of evidence was downgraded by one level (Guyatt et al., 2011).
e) Imprecision: Downgrading occurred when there were fewer than 800 participants available for comparison (Guyatt et al., 2021) and/or when the direction of the effect was unclear. Certainty was downgraded by two

levels if both conditions were met.

## Statistical Analysis

To calculate effect sizes (ES) (Hedges' g), we used pre- and post-intervention mean and standard deviation of performance indicators. Data standardization was based on post-intervention data. In cases of missing data, efforts were made to contact study authors for necessary information.

The meta-analysis utilized an approach where trial weights were determined by the inverse of their standard errors, allowing for the consideration of variation among studies (Deeks et al., 2019). Study heterogeneity was evaluated using the $I^2$ statistic, with thresholds indicating different levels of heterogeneity (Higgins & Thompson, 2002). The Extended Egger's test was applied to assess publication bias risk, with sensitivity analyses conducted as needed (Egger et al., 1997). Data analysis was conducted using Comprehensive Meta-Analysis software (Version 3; Biostat, Englewood, NJ, USA), with statistical significance set at $p < 0.05$.

### Subgroup Analysis

Subgroup analyses were undertaken to investigate potential moderating factors impacting teaching effectiveness. The following moderating factors were assessed:

a) Intervention Duration (weeks): Categorized as ≤8 weeks vs. >8 weeks, using the median as the threshold (Deng et al., 2023; Ramirez-Campillo et al., 2022).

b) Intervention Frequency (number of training sessions per week): Due to the predominance of twice-weekly interventions and limited data for other frequencies, subgroup comparisons were not conducted.

c) Total Intervention Sessions: Divided into <20 sessions vs. ≥20 sessions based on the large unit session count recommended by Siedentop et al. (Siedentop et al., 2019).

d) Weekly Intervention Time: SEM intervention time per session (main portion) categorized as ≤50 minutes vs. >50 minutes.

Additionally, student gender (male vs. female) and educational level (elementary vs. middle vs. high school vs. university) were examined as potential moderating factors. Subgroup analyses were conducted for each factor when data were available from at least two studies. Median values were used for each moderating factor to facilitate analysis.

## Results

### Study Selection

Figure 1 illustrates the initial phase of our study, during which a total of 706 papers were identified through comprehensive database searches. Additionally, 8 additional studies were found via Google Scholar and by examining reference lists. Subsequently, after meticulously removing duplicate records, 405 unique records remained. A thorough screening process was then conducted, involving the evaluation of titles and abstracts of these 405 records. As a result of this screening, 72 papers were identified as potentially meeting the criteria warranting full-text analysis. However, after conducting a rigorous full-text review, we excluded 73 publications, ultimately resulting in the inclusion of 10 papers that met our stringent inclusion criteria.

## Study Quality Assessment

All 10 articles met at least a moderate quality standard according to the PEDro checklist. Four studies ranked moderately with 4 to 5 points, while six scored high with 6 to 8 points (Table 1).

### Certainty of Evidence

Table 2 presents the findings of the GRADE analysis, wherein the certainty of evidence for all outcomes and group comparisons is assessed as low. This reduction in certainty primarily stems from concerns regarding the risk of bias and inconsistency in the studies included.

### Study Characteristics

Table 3 offers an extensive summary of participant and intervention characteristics observed in the studies encompassed in this review. These studies, spanning from 2004 to 2023, were all published in English, satisfying our inclusion criteria.

Among the 10 reviewed papers, 8 conducted assessments of content knowledge (Browne et al., 2004; Hastie et al., 2013; Layne & Yli-Piipari, 2015; Li et al., 2022; Liu et al., 2022; Pereira et al., 2015; Pritchard et al., 2008; Tendinha et al., 2021), 6 examined technical skills (Browne et al., 2004; Hastie et al., 2013; Pereira et al., 2015; Tendinha et al., 2021), and 5 addressed game performance aspects (Layne et al., 2015; Li et al., 2022; Liu et al., 2022; Pritchard et al., 2008). Geographically, research was diverse, with 4 studies in Europe (3 in Portugal, 1 in Spain) (Hastie et al., 2013; Layne et al., 2015; Pereira et al., 2016; Pereira et al., 2015), 4 in Asia (3 in China, 1 in Indonesia) (Bessa et al., 2021; Browne et al., 2004; Li et al., 2022; Liu et al., 2022), 1 in the Americas (United States) (Pritchard et al., 2008), and 1 in Oceania (Australia) (Tendinha et al., 2021). Various sports were covered, with 3 focusing on volleyball (Li et al., 2022; Liu et al., 2022; Pritchard et al., 2008), 3 on track and field (Hastie et al., 2013; Pereira et al., 2016; Pereira et al., 2015), 2 on basketball (Bessa et al., 2021; Liu et al., 2022), and 1 each on yoga (Tendinha et al., 2021) and handball (Layne et al., 2015). Moreover, one study specifically examined teaching research within major ball sports (Browne et al., 2004). In total, 750 participants were involved, with 373 males (49.7%), 213 females (28.4%), and 164 participants (21.9%) with unreported or mixed-gender group information. Participant ages ranged from 10 to 20 years. Regarding educational levels, 4 studies included elementary school students, 4 middle school students, and 2 university students. Additionally, 4 studies outlined inclusion/exclusion criteria, with 2 specifying no prior SEM experience. Notably, one study did not specify intervention duration and weekly frequency, while the others had an average duration of 9.3 weeks and a weekly frequency of 2.3 sessions, varying from 1 to 5 sessions. Five studies reported intervention durations not exceeding 50 minutes, while the remaining five exceeded this duration.

## Findings of the Meta-Analysis

This meta-analysis focused on eight studies assessing student content knowledge, six studies examining student technical skill, and five studies evaluating student game performance, including measures of game involvement, decision-making, skill execution, and overall game performance. The pertinent data for the meta-analysis are detailed in Table S2.

**Content Knowledge**

Data from eight studies, including twelve experimental and ten control groups, involving 898 participants, revealed a moderate effect of SEM on content knowledge (ES = 0.70; 95% CI = 0.40–1.00; $p < 0.001$; $I^2 = 76.6\%$; Egger's test $p = 0.40$; Figure 2), with each study contributing weights ranging from 3.97% to 6.80% in the analysis.

**Technical Skill Performance**

From six studies, with six experimental and six control groups, involving 377 participants, SEM showed a small effect on technical skill performance (ES = 0.362; 95% CI = 0.11–0.61; $p < 0.01$; $I^2 = 80.82\%$; Egger's test $p = 0.80$; Figure 3), with each study contributing weights ranging from 2.87% to 5.10% in the analysis.

**Game Performance**

Findings from five studies, including nine experimental and seven control groups, involving 376 participants, revealed a moderate effect of SEM on game performance (ES = 0.92; 95% CI = 0.66–1.18; $p < 0.01$; $I^2 = 81.43\%$; Egger's test $p = 0.52$; Figure 4). Each study contributed weights ranging from 3.79% to 5.08% in the analysis.

**Additional Analysis**

Given the limited number of trials (3 for each moderator), subgroup analyses were performed to investigate influential factors on variables. Concerning content knowledge, participants were stratified by intervention frequency (20 or more sessions vs. less than 20), demonstrating significant improvement in both groups with no notable distinction between them (Intervention sessions < 20 times, ES = 0.90; Intervention sessions ≥20 times, ES = 0.60; $p = 0.35$). Similarly, no significant differences emerged in content knowledge enhancement concerning intervention duration (≤8 weeks vs. >8 weeks) or durations of SEM teaching sessions (>50 minutes vs. ≤50 minutes). However, subgroup analysis by student's learning stage unveiled notable differences, particularly among middle school students (Primary school, ES = 0.66; Middle school, ES = 0.33; University, ES = 1.32; $p = 0.007$). Moreover, significant discrepancies were observed in game performance measures across various indicators (Decision Making, ES = 0.95; Game Involvement, ES = 1.14; Game Execution, ES = 0.27; Game Performance, ES = 0.64; Skill Execution, ES = 1.06; $p = 0.027$).

## Adverse Effects

Within the analysis, no adverse effects, including injury, harm, pain, discomfort, fatigue, or other health-related concerns associated with the utilized SEM interventions, were documented across all studies.

## Discussion

**The Effect of SEM on Content Knowledge**

According to NASPE, the objective of physical education lies in nurturing individuals who are physically literate, equipped with the knowledge, competencies, and confidence to engage in lifelong healthy physical activities (American Alliance for Health, Physical Education, Recreation, and Dance, 2013, p.1). Siedentop et al. advocate for SEM instruction, emphasizing the acquisition of essential skills for active sports participation through comprehension and application of strategies. They also stress the importance of fostering an understanding and respect for sports' regulations, customs, and traditions, along with the ability to discern appropriate sports conduct (Siedentop et al., 2019).

Our meta-analysis revealed a moderate (ES = 0.70) indicating SEM's significant impact on enhancing content knowledge compared to control groups. Notably, content knowledge was a primary focus in the majority of studies (8 out of 10) analysed. These findings align with Bessa et al.'s observations, emphasizing SEM's structured teaching approach in bolstering both motor and cognitive development. This highlights the importance of fostering meaningful learning experiences, potentially driven by heightened cognitive engagement facilitated by SEM

(Bessa et al., 2021).

During full-text screening, Mahedero et al. (2015) categorized students by skill level in Mini-volleyball instruction using SEM, finding significant differences in knowledge acquisition among skill groups. Intermediate-level students showed the most significant improvement. However, without a control group, comparisons were limited. Pereira et al. (2016) classified students by skill level in track and field instruction, revealing superior knowledge gains in low-skilled students compared to controls, highlighting potential differences in knowledge development across skill levels in SEM instruction for various sports.

Six years later, Mahedero et al. (2022) extended their SEM instruction research to floorball and basketball, examining students' knowledge improvement across different skill levels. The study found no significant impact of SEM instruction on knowledge enhancement for either high or low-skill students, consistent with their earlier Mini-volleyball study. While shedding light on SEM's varied effects across skill levels and sports, the limited evidence necessitates caution in endorsing these findings unequivocally. Future research should further explore the influence of student skill levels and compare SEM's efficacy across different sports disciplines.

**The Effect of SEM on Technical Skill**

Physical education instruction plays a pivotal role in fostering technical skills essential for students' lifelong engagement in physical activities (Hastie et al., 2009; Layne et al., 2015). Proficiency in technical skills significantly influences sports performance and is consistent across various teaching approaches (Hopper & Kruisselbrink, 2001; Turner & Martinek, 1999). SEM instruction, as proposed by Siedentop et al., aims to equip students with the skills needed for active participation and organization of competitions (Siedentop et al., 2019).

Our meta-analysis revealed a modest enhancement (ES = 0.36) in technical skill measures associated with SEM compared to control conditions. This finding resonates with the research of Hastie et al. (2009), who, in their examination of SEM's impact on badminton technical skills, emphasized the ample practice opportunities afforded by SEM's extended seasons (Hastie et al., 2009). Additionally, students naturally refine their game understanding over the course of a SEM season characterized by its unique large-unit teaching approach, often with minimal teacher intervention. SEM's emphasis on extended gameplay provides a platform for technical skill development, a facet less emphasized in traditional teaching methodologies (Bessa et al., 2021). Moreover, students actively engage in observational roles during SEM seasons, occasionally serving as referees or officials. This role promotes heightened awareness of technical skills as they closely observe their peers (Hastie et al., 2009).

Nonetheless, akin to discussions regarding content knowledge, research findings exploring the differentiation of students' skill levels often present ambiguous outcomes. While some scholars argue that students with lower initial skill levels have more room for improvement compared to their higher-skilled counterparts, who may encounter ceiling effects limiting their progress (Mesquita et al., 2005). Hence, further research is necessary to elucidate this matter conclusively.

**The Effect of SEM on Game Performance**

The proficiency level of students' knowledge and skills significantly influences their game performance (Mitchell et al., 1997). Hastie (1998) conducted the pioneering empirical study within the SE model, revealing notable improvements in game performance throughout a 30-lesson Ultimate Frisbee season. Subsequent research, such as that by Pritchard et al. (2014), demonstrated enhancements in game performance, particularly in decision-making and skill execution, during 3-on-3 basketball games over 18 days. Similarly, Guijarro et al. (2021) contrasted SE with Teaching Games for Understanding, illustrating SEM's capacity to enhance game performance across various aspects, including decision-making, skill execution, and game involvement, consistent with the findings of this review (ES = 0.92).

Numerous researchers have explored the foundational mechanisms contributing to SEM's efficacy in enhancing students' game performance (Pritchard et al., 2014). Initially, studies have indicated that SEM fosters heightened autonomy in gameplay (Mahedero et al., 2015), skill execution (Mahedero et al., 2015), and game involvement (Wallhead et al., 2013). Moreover, recent large-scale empirical inquiries have validated that student participation in a yearlong physical education curriculum positively influences their intentions to engage in extracurricular sports in the future (Pritchard et al., 2014). Furthermore, it can contribute to restructuring unequal power dynamics to establish a more equitable learning atmosphere (Farias et al., 2017).

However, not all studies uniformly demonstrate SEM's significant benefits across all aspects of game involvement indicators. For instance, Pritchard et al. (2008) found no notable divergence in post-test data between the experimental and control groups concerning game involvement (Pritchard et al., 2008). Given the limited literature available and the absence of comprehensive data on each facet of game performance metrics in certain studies (Layne et al., 2015; Li et al., 2022; Liu et al., 2022), this perspective remains somewhat uncertain. Hence, further research can delve deeper into SEM's effects on various game performance indicators to elucidate the specific advantages it offers in enhancing students' game performance.

**Subgroup Analysis**

This study conducted a subgroup analysis to explore whether variables such as intervention frequency, cycle duration, and students' educational stages exerted an influence on the effect of SEM on students' knowledge acquisition. However, our findings suggest that there were no significant disparities between subgroups based on the frequency of SEM interventions and the duration of intervention cycles. Nonetheless, notable distinctions were observed among subgroups concerning the duration of each intervention and the students' educational stages (elementary, secondary, and university).

We conducted a subgroup analysis on various game performance metrics, revealing significant differences. However, caution is warranted due to the lack of meta-analyses in the literature and the need for further investigation. Additionally, the examination of SEM moderators on game performance may be limited by the scarcity of studies and the absence of control groups in some cases.

As a result, we cannot currently offer definitive guidance on the optimal course design for enhancing content knowledge, technical skill, and game performance through SEM. Future research should aim to explore SEM effects more comprehensively to determine the most effective implementation strategies under various course designs.

## Limitations

This systematic review is constrained by several noteworthy limitations warranting attention. Firstly, the limited number of included studies results in incomplete coverage of sports items, hindering comprehensive outcome analysis for certain indicators. Secondly, gender disparity among participants may compromise result generalizability. Thirdly, potential bias may arise from the measurement of some indicators within the same article. Fourthly, binary classification of continuous data using a median segmentation strategy (e.g., ≤8 weeks vs. > 8 weeks) may introduce residual confusion and reduce statistical power.

## Conclusion

Our results illustrate the considerable efficacy of SEM in improving students' content knowledge, technical skill, and game performance. Subgroup analysis indicated no noteworthy differences in intervention frequency and cycle duration. However, intervention duration varied significantly based on students' learning stages. Moreover, notable divergences were observed among game performance indicators. To thoroughly assess SEM's effectiveness in enhancing students' content knowledge, technical skill, and game performance, further high-quality research across a wider range of physical activities is warranted.

## Practical Applications

The review underscores the practical significance of SEM for PE educators, pre-service teachers, and students, highlighting its efficacy in enhancing content knowledge, technical skill, and game performance. A recommended teaching structure entails 50–90-minute sessions, twice weekly, spanning 10 weeks, consistent with Siedentop et al.'s proposal and prevalent intervention frequencies. Nonetheless, further research is needed to refine teaching frameworks and consider educational contexts' impact on student outcomes.

**Supplementary Materials**

S1 Table: Detailed search strategy.
S2 Table: Data used for meta-analysis.
S3 Table: PRISMA 2020 checklist.

**Author Contributions**

Conceptualization, J.Z.and H.M.; methodology, J.Z., S.Z., and H.M.; formal analysis, J.Z.; investigation, J.Z., S.Z., and H.M.; data curation, J.Z.; writing—original draft preparation, J.Z. and H.M.; writing—review and editing, H.M. and J.Z. All authors have read and agreed to the published version of the manuscript.

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**Data Availability Statement**

The references for all cited data and materials are exhaustively documented in the bibliography section of this manuscript. For additional inquiries pertaining to the data sources and materials referenced in this review, readers are encouraged to refer to the original publications or establish contact with the corresponding authors of said works. The authors of this current review are also accessible for correspondence, should further elucidation or supplementary insights be required.

**Conflicts of Interest**

The authors declare no conflict of interest.

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