Metacognition in school Physical Education: a systematic review of strategies, instruments, and contextual challenges

Metacognición en Educación Física: revisión sistemática de estrategias, instrumentos y retos contextuales

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Abstract

Introduction: Metacognition and metacognitively oriented self-regulated learning are increasingly relevant to Physical Education because students must plan, monitor, evaluate, and adapt their learning during motor, tactical, and health-related tasks.
Objective: This systematic review examined how metacognition has been conceptualized, measured, and promoted in school Physical Education, mainly among adolescent students.
Methodology: The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines. Searches were conducted from database inception to July 1, 2026, in Scopus, Web of Science Core Collection, ERIC, PsycINFO, and SciELO. Quantitative, qualitative, mixed-methods, intervention, and instrument-development studies were included when they explicitly addressed metacognitive knowledge or regulation.
Results: Seventy-two records were identified, 21 duplicates were removed, and 51 records were screened. Sixteen reports representing 18 study samples met the inclusion criteria. The evidence was dominated by cross-sectional self-report studies. Mastery-oriented goals, incremental beliefs about ability, autonomy-supportive teaching, and task-involving motivational climates were associated with greater metacognitive and self-regulatory activity. Metacognition was also related to enjoyment, performance, learning engagement, motor-skill acquisition, and intentions to participate in physical activity.
Discussion: Interventions based on video modelling, explicit instruction, progressive self-regulated learning, and combined Teaching Games for Understanding and Sport Education approaches showed promising findings, but heterogeneity in designs, constructs, and measurement instruments limited comparisons and causal conclusions.
Conclusions: The evidence supports the relevance of metacognition in school Physical Education, but stronger longitudinal and controlled studies, task-specific and culturally validated instruments, and direct measures of metacognitive processes are still needed.

Keywords

Adolescents; metacognition; physical education; self-regulation; systematic review.

Resumen

Introducción: La metacognición es relevante en Educación Física porque permite planificar, monitorear y evaluar el aprendizaje durante tareas motrices, tácticas y relacionadas con la salud.
Objetivo: Esta revisión sistemática examinó cómo se ha conceptualizado, medido y promovido la metacognición en la Educación Física escolar, principalmente en estudiantes adolescentes.
Metodología: La revisión siguió PRISMA 2020. Se realizaron búsquedas hasta el 1 de julio de 2026 en Scopus, Web of Science Core Collection, ERIC, PsycINFO y SciELO. Se incluyeron estudios cuantitativos, cualitativos, mixtos, de intervención y de desarrollo instrumental que abordaran explícitamente procesos metacognitivos.
Resultados: Se identificaron 72 registros, se eliminaron 21 duplicados y se examinaron 51. Dieciséis informes, correspondientes a 18 muestras, cumplieron los criterios de inclusión. Predominaron los estudios transversales basados en autoinformes. Las metas de dominio, las creencias incrementales sobre la habilidad, el apoyo a la autonomía y los climas centrados en la tarea se asociaron con mayor actividad metacognitiva. También se observaron relaciones con disfrute, rendimiento, aprendizaje, habilidades motrices e intención de realizar actividad física.
Discusión: Las intervenciones basadas en modelado en video, enseñanza explícita, aprendizaje autorregulado y enfoques combinados de Teaching Games for Understanding y Sport Education mostraron resultados prometedores, aunque la heterogeneidad metodológica limitó las comparaciones y las inferencias causales.
Conclusiones: La evidencia respalda la relevancia de la metacognición en Educación Física escolar, pero se requieren estudios longitudinales y controlados, instrumentos específicos y culturalmente validados, y medidas directas de estos procesos.

Palabras clave

Adolescentes; autorregulación; educación física; metacognición; revisión sistemática.

Introduction

Secondary education requires students not only to acquire disciplinary knowledge but also to regulate how they learn. In Physical Education (PE), this involves setting goals, selecting strategies, monitoring performance, interpreting errors, and evaluating the effectiveness of actions within embodied and socially situated tasks (Bailey, 2006; Chatzipanteli et al., 2016; Tolgfors, 2018). These processes make metacognition particularly relevant to PE because students must frequently adapt decisions and actions while learning motor, tactical, and health-related content.

Metacognition is commonly defined as knowledge about and regulation of one's own cognitive processes (Flavell, 1979; Schraw & Moshman, 1995). Knowledge about cognition includes declarative, procedural, and conditional knowledge, whereas regulation of cognition involves processes such as planning, monitoring, strategy selection, and evaluation (Brown, 1987; Veenman et al., 2006). Metacognition is closely related to, but distinct from, self-regulated learning. Self-regulated learning is a broader construct that also incorporates motivational, affective, behavioural, and contextual regulation in the pursuit of learning goals (Pintrich, 2004; Zimmerman, 2002). This distinction is important because studies in PE often use self-regulation frameworks or instruments that combine metacognitive processes with effort, motivation, self-efficacy, or other dimensions.

The PE context poses demands for metacognitive regulation. Decisions and adjustments often occur while movement is unfolding and under changing task conditions. Students may need to anticipate a response, monitor execution, compare performance with an intended outcome, and modify strategies across successive attempts. Accordingly, pedagogical environments that provide opportunities for decision-making, feedback, self-assessment, and reflection may support metacognitive engagement. However, such opportunities do not necessarily produce metacognitive development by themselves; their contribution depends on how they are integrated with task demands, teacher guidance, and opportunities for students to assume responsibility for learning (Chatzipanteli et al., 2016; Morales-Belando et al., 2022).

Measurement presents a related challenge. Self-report questionnaires provide efficient information about students' perceived strategy use but may not capture regulation as it occurs during specific motor or tactical tasks (Jacobse & Harskamp, 2012; Veenman et al., 2006). This issue is especially relevant in PE, where metacognitive activity can be task-specific and time-sensitive. Context-adapted questionnaires, observation, interviews, think-aloud procedures, learning journals, and video-supported reflection may therefore provide complementary evidence. Nevertheless, it remains unclear how metacognition has been operationalized across PE studies and whether available instruments adequately represent the embodied nature of learning.

This question is also relevant to the transferability of the evidence. Research and curricular analyses in Latin America emphasize broader educational purposes for PE, including autonomy and integral development, while also identifying challenges in translating these principles into pedagogical practice (Barcelos et al., 2022; Castillo-Retamal et al., 2024). Yet it remains unclear how geographically diverse the empirical evidence on metacognition in PE is, or whether available instruments and pedagogical approaches have been validated in Latin American school contexts.

Previous reviews have addressed related but narrower questions. Álvarez-Bueno et al. (2017) synthesized the effects of physical activity interventions on cognition and metacognition, whereas Cañadas (2022) examined self- and peer-assessment practices in Physical Education. More recently, Bujosa-Quetglas et al. (2023) systematically reviewed Physical Education interventions targeting metacognitive and motivational components of self-regulated learning in adolescents, with particular emphasis on the promotion of leisure-time physical activity. However, that review was restricted to intervention studies and did not jointly examine the broader theoretical conceptualization of metacognition, observational evidence, measurement approaches, or the measurement properties of PE-specific instruments. The present review therefore extends previous syntheses by integrating observational, correlational, intervention, mixed-methods, and measurement studies to examine how metacognition is conceptualized, pedagogically promoted, and assessed in curricular school PE. Accordingly, this systematic review examines metacognition among predominantly adolescent students enrolled in middle or secondary education and addresses four questions: (1) how metacognition is conceptualized and which theoretical frameworks are used; (2) which pedagogical strategies and learning environments target metacognitive

processes and under what implementation conditions; (3) which instruments and procedures are used and what evidence supports their measurement properties and contextual adequacy; and (4) which educational, motivational, affective, and performance-related outcomes are reported, and what methodological limitations constrain their interpretation.

Method

Protocol and reporting

This systematic review was reported in accordance with the PRISMA 2020 statement (Page et al., 2021). An initial protocol guided the review; however, methodological amendments were introduced after the initial search and before the definitive study-selection process. These amendments clarified the operational definition of metacognition, broadened the population criterion from a strict age range to predominantly adolescent students enrolled in middle or secondary education, removed the lower publication-date limit, extended the search end date to July 2026, and required a complete rerun of the search and selection process. The review was not prospectively registered. The amendments and their rationale were documented before the definitive full-text eligibility assessment.

Eligibility criteria

Eligibility criteria were defined using a PICOS-informed framework. We included peer-reviewed empirical studies employing quantitative, qualitative, or mixed-methods designs. Eligible participants were adolescents or students enrolled in middle or secondary education and participating in curricular school-based Physical Education (PE).

Studies with slightly broader age ranges were retained when participants were recruited from middle or secondary schools and the sample was predominantly adolescent. Studies involving mixed elementary- and secondary-school samples were also eligible when secondary-school students constituted a substantial proportion of the sample and the study directly examined curricular PE and explicit metacognitive processes. Such studies were retained when findings for secondary-school students were either reported separately, compared across educational levels, or could be meaningfully interpreted in relation to the target population. Findings based on the full mixed-age sample were identified as such and interpreted cautiously rather than treated as estimates exclusively representing secondary-school students.

Eligible studies had to explicitly examine metacognition as a theoretical construct, measured variable, pedagogical objective, intervention component, learning process, or study outcome. Metacognition was operationalized as knowledge about cognition and regulation of cognition, including declarative, procedural, and conditional knowledge, as well as planning, monitoring, strategy selection, evaluation, and reflection.

Studies framed in terms of self-regulated learning were eligible only when they explicitly incorporated or measured one or more metacognitive processes. General self-regulation, motivation, executive functions, emotional intelligence, emotional metacognition, physical literacy, or critical thinking were not considered sufficient in the absence of an explicit metacognitive construct or component.

No specific instructional model, intervention, or comparator was required. Eligible studies could examine pedagogical interventions, motivational climates, achievement goals, teaching practices, learning environments, self-regulated learning, metacognitive processes, or the development and validation of metacognition-related instruments in curricular PE. Comparator conditions could include usual practice, an alternative pedagogy, another instructional condition, or within-group pre–post comparisons, but a comparator was not required for observational, correlational, qualitative, or instrument-development studies.

Primary outcomes included metacognitive knowledge, metacognitive regulation, planning, monitoring, evaluation, reflection, and related metacognitive strategies. These outcomes could be assessed using questionnaires, interviews, observation protocols, learning journals, think-aloud procedures, microanalytic interviews, task-embedded indicators, or other explicitly metacognitive measures. Related out-

comes such as motivation, emotional regulation, physical activity, enjoyment, boredom, decision-making, motor performance, or academic achievement were extracted only when the study also fulfilled the explicit metacognition criterion.

Studies published in English, Spanish, or Portuguese up to July 1, 2026, were eligible. No lower publication-date limit was applied. Reviews, conceptual papers, editorials, commentaries, dissertations, conference abstracts without an available full paper, and studies without an explicit metacognition construct or component were excluded.

Information sources and search strategy

The main database searches were conducted on July 1, 2026, in Scopus, Web of Science Core Collection, ERIC through ProQuest, APA PsycINFO through EBSCOhost, and SciELO. Searches covered all records available in each information source from database inception to July 2026. No lower publication-date filter was applied.

The same predefined three-block Boolean structure was used across all sources: (metacogn* OR "metacognitive knowledge" OR "metacognitive regulation" OR "metacognitive awareness" OR "metacognitive strateg*") AND ("physical education" OR "school physical education" OR "physical education class*" OR "physical education lesson*") AND (adolescen* OR "secondary school*" OR "middle school*" OR "high school*" OR "grades 7-12").

The conceptual content of the search strategy was maintained across sources. Only database-specific field tags, truncation functions, quotation marks, and interface requirements were adapted. No additional controlled vocabulary, translated terms, broader related constructs, or database-specific synonyms were added. Following peer review, a supplementary journal-specific search was conducted in Retos: Nuevas Tendencias en Educación Física, Deporte y Recreación using the journal's internal search engine with metacognition-related search terms. All records retrieved through this supplementary search were screened using the same population, context, construct, study-design, and publication-type eligibility criteria applied in the main database search. The search identified several publications addressing metacognition, self-regulated learning, learning strategies, autonomy, and related constructs; however, no additional eligible primary study was identified. Most records involved university students or preservice teachers, addressed related but distinct constructs, or were review articles rather than primary empirical studies. Relevant review and contextual publications were used to refine the theoretical background and discussion but were not added to the primary-study corpus. Consequently, the final evidence base remained unchanged at 16 reports representing 18 study samples.

Record management and deduplication

All retrieved records were exported in CSV or equivalent bibliographic formats and consolidated into a structured database while retaining information on their source of identification. The searches produced 72 records before deduplication.

Duplicates were identified using normalized DOI values and exact or near-exact normalized title matching. Records with conflicting bibliographic information were reviewed manually. Twenty-one duplicate records were removed, leaving 51 unique records for title and abstract screening.

Study selection

Study selection was conducted in two stages: title and abstract screening followed by full-text eligibility assessment. Artificial-intelligence-assisted procedures were used to organize the bibliographic records, identify potential duplicates, and support the initial application of the eligibility criteria. All final inclusion decisions at the full-text stage were made by the lead human reviewer. The 51 unique records were assessed at the title and abstract stage. Sixteen records were retained for full-text assessment, and 35 were excluded. The full texts of the 16 potentially eligible reports were examined against the predefined population, context, construct, publication-type, and design criteria. All 16 reports met the revised eligibility criteria and were retained for synthesis.

Reasons for exclusion at the title and abstract stage were recorded using standardized categories, including wrong population, non-school setting, absence of an explicit metacognition construct, emotional metacognition or emotional intelligence rather than learning-related metacognition, wrong publication type, and non-curricular physical activity or sport context. Because some reports contained more than

one empirical study and different reports could potentially draw on overlapping samples, included reports were assigned separate report-level and study-level identifiers during data extraction.

Data extraction

A standardized data-extraction form was developed to capture information at both the report and study levels. Extracted information included bibliographic data; country and educational context; study design; number of studies or samples reported; sample size; participant age, grade, and gender; PE setting and content; theoretical and operational definition of metacognition; metacognitive dimensions examined; instructional model or learning environment; intervention characteristics, when applicable; comparator condition; measurement instruments; available evidence of validity and reliability; metacognitive and related outcomes; implementation features; quantitative findings; qualitative themes; and authors' reported limitations.

Reports containing multiple empirical studies were disaggregated during extraction. Reports using potentially overlapping samples were linked to avoid double counting participants or findings.

Methodological quality appraisal

Methodological quality was appraised using the 2018 Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018). Each study sample was classified according to its design and judged against the five applicable design-specific criteria as Yes, No, or Can't tell. Cross-sectional questionnaire and instrument-development studies were appraised using the quantitative descriptive criteria; the randomized comparison was appraised using the randomized controlled trial criteria; and mixed-methods studies were appraised using the mixed-methods criteria, with explicit consideration of the quality of their qualitative and quantitative components. Judgments were made from the information reported in the full texts. No overall numerical MMAT score was calculated, because criterion-level reporting preserves the specific methodological strengths and limitations of each study.

Appraisal of measurement properties

For studies whose primary objective was the development, adaptation, or validation of an instrument assessing metacognition or metacognitively oriented self-regulated learning, measurement properties were appraised using relevant COSMIN standards as a methodological framework (Prinsen et al., 2018). Because COSMIN was originally developed for systematic reviews of patient-reported outcome measures and the present review did not conduct an exhaustive instrument-specific search for all validation studies, the assessment was treated as COSMIN-informed rather than as a full COSMIN systematic review. The appraisal considered instrument development and content validity, structural validity, internal consistency, reliability, measurement error, cross-cultural validity or measurement invariance, criterion validity, construct validity through hypothesis testing, and responsiveness, when reported. COSMIN was not applied to observational or intervention studies solely because they used a questionnaire.

Synthesis methods

Owing to heterogeneity in study designs, theoretical frameworks, metacognitive constructs, measurement instruments, PE content, and outcomes, a structured narrative synthesis was conducted.

Included reports were grouped according to:

1. study design: observational, correlational, intervention, mixed-methods, or instrument-development;
2. role of metacognition: primary construct, component of self-regulated learning, intervention target, measured outcome, or secondary validation variable;
3. metacognitive dimension: knowledge of cognition, planning, monitoring, regulation, evaluation, or reflection;
4. pedagogical or motivational context;
5. type of measurement instrument;
6. educational level and PE content.

Quantitative findings were summarized using the effect estimates reported by the original studies. Standardized effect sizes were extracted or calculated only when sufficient and comparable information was available. Qualitative findings were integrated thematically to identify pedagogical mechanisms, student experiences, implementation conditions, and contextual explanations.

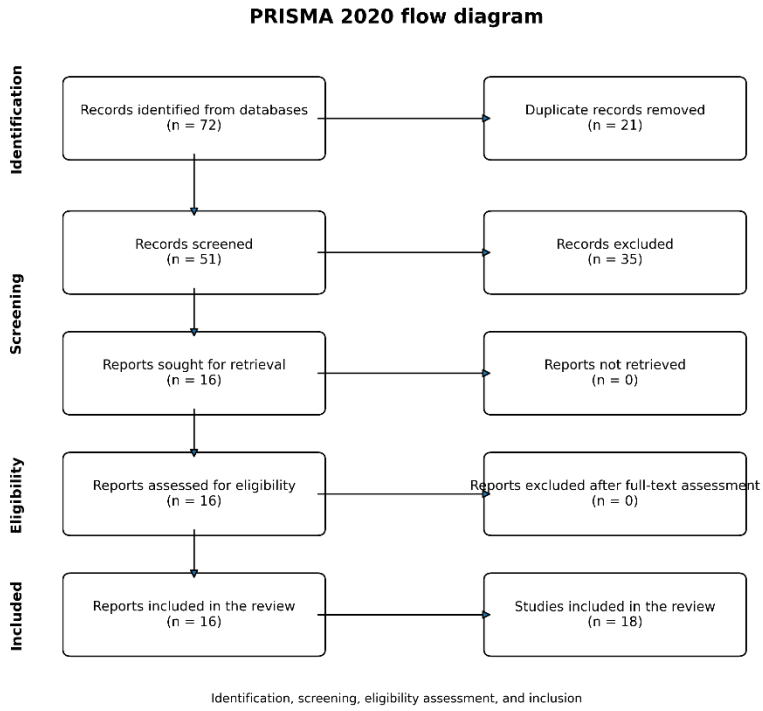
Intervention, observational, and instrument-development studies were synthesized separately before examining convergences across designs. No sufficiently homogeneous subset of studies meeting these criteria was identified; therefore, quantitative pooling was not undertaken.

Results

Search results and study inclusion

The database searches identified 72 records. After removing 21 duplicates, 51 unique records were screened by title and abstract. Thirty-five records were excluded at this stage, and 16 reports were retrieved and assessed in full text. All 16 reports met the revised eligibility criteria and were included in the review. One report contained three separate empirical studies; therefore, the final evidence base comprised 16 reports describing 18 study samples. The study-selection process is presented in Figure 1.

Figure 1. PRISMA 2020 flow diagram of record identification, deduplication, screening, full-text eligibility assessment, and inclusion.



Source: Authors' own elaboration.

Characteristics of the included evidence

The included reports were published between 2003 and 2026 and represented seven countries (see Table 1). Thirteen of the 16 reports were conducted in Europe: Spain contributed five reports, Greece four, Norway three, and Italy one. The remaining studies were conducted in Tunisia, the United States, and Iran.

Across the 18 reported study samples, the nominal combined sample was 10,441 participants, with individual sample sizes ranging from 56 to 2,439. This total should not be interpreted as an exact count of

unique eligible participants because two reports included mixed elementary- and secondary-school samples, and the information provided did not permit verification of potential participant overlap among reports conducted by related research teams.

At report level, ten articles employed cross-sectional observational or explanatory designs, three focused primarily on instrument development or validation, and three evaluated pedagogical interventions. Because one report contained three separate cross-sectional studies, the evidence base comprised 12 observational study samples, three measurement studies, and three intervention studies. Most studies involved coeducational curricular PE classes. The interventions addressed gymnastics, football, and muscular-strengthening activities.

Table 1. Characteristics of the included reports

Report	Country and design	Participants and educational context	Theoretical framework	Role of metacognition	PE content
Ommundsen (2003)	Norway; cross-sectional correlational	N = 343; 13–14 years; secondary-school PE	Implicit theories of ability; self-regulated learning	Measured outcome: metacognitive/elaboration strategies as part of students' self-regulation	General curricular secondary-school PE; specific content not reported
Ommundsen (2006)	Norway; cross-sectional mediation/moderation analysis	N = 273; 15–16 years; Grade 10 PE	Achievement goal theory; motivational climate; self-regulated learning	Measured outcome: metacognitive self-regulation examined in relation to motivational climate and achievement goals	General Grade 10 curricular PE; specific content not reported
Theodosiou and Papaioannou (2006)	Greece; cross-sectional	N = 782; elementary n = 182, junior high n = 365, senior high n = 235	Achievement goal theory; mastery motivational climate; knowledge and regulation of cognition	Primary construct and statistical mediator: metacognition linked mastery-related variables with out-of-school exercise	Sport-related curricular PE; specific activity/unit not reported
Theodosiou et al. (2008)	Greece; cross-sectional age-group comparison	N = 510; elementary n = 109, junior high n = 229, senior high n = 172	Goal perspectives theory; self-regulated/constructivist learning; threshold-of-problematicity perspective	Primary outcome: metacognitive knowledge and regulation compared across educational levels	General curricular PE; specific content not reported
Papaioannou et al. (2009)	Greece; three cross-sectional studies	Study 1: n = 351; Study 2: n = 580; Study 3: n = 658; coeducational PE	Achievement goal theory across contextual and global levels; self-regulation theory	Measured outcome: PE-specific metacognitive/self-regulatory activity related to contextual and global goals	General coeducational curricular PE; specific content not reported
Settanni et al. (2012)	Italy; instrument development and validation	N = 320; 11–15 years; Grades 6–8; curricular PE	Metacognition applied to physical/motor activity; knowledge and regulation of cognition	Measurement target: metacognition operationalized as the construct underlying MAPAS	General physical activity and curricular PE rather than a specific motor task
Karagiannidis et al. (2015)	Greece; cross-sectional regression and mediation	N = 630; M age = 14.06; two junior high schools	Self-determination theory; autonomy-supportive motivational climate; metacognition	Mediator and predictor: metacognition linked autonomy support with physical-activity intentions and was related to enjoyment	General junior-high PE lessons; specific activity not reported
Trigueros et al. (2019)	Spain; cross-sectional structural equation modelling	Reported N = 1,602; 13–19 years; secondary education	Self-determination theory, particularly its "dark side" and psychological-need frustration	Downstream cognitive outcome: metacognitive strategies examined in relation to need frustration and emotional intelligence	General secondary-school PE; specific content not reported
Trigueros and Navarro (2019)	Spain; cross-sectional structural equation modelling	N = 545; 13–19 years; secondary-school PE	Self-determination theory; autonomy support/controlling teaching; deep-learning strategies	Intermediate learning process: motivation → metacognitive strategies/critical thinking → reported PE achievement	General secondary-school PE; specific content not reported
Trabelsi et al. (2022)	Tunisia; one-group mixed-methods pre–post intervention	N = 56; M age = 16.6; secondary-school gymnastics	Social cognitive theory; cognitive apprenticeship; Zimmerman's self-regulated learning; observational learning	Learning mechanism: repeated viewing/interpretation, self-talk, and mental rehearsal emerged as metacognitive strategies	Gymnastics; floor-exercise motor skills and associated knowledge

Fernandez-Ortega et al. (2022)	Spain; cross-sectional structural equation modelling	N = 2,439; 12–18 years; compulsory and post-compulsory secondary education	Learning-strategy and engagement framework; MSLQ-based metacognitive regulation	Intermediate/predictive variable: metacognitive strategies linked perceptions of teaching and learning with activity intentions	General secondary-school PE; specific unit not reported
Jørgensen Olsen and Mehus (2022)	Norway; cross-sectional structural equation modelling	N = 571; Grades 11–13; upper-secondary PE	2 × 2 achievement goal framework and cyclical model of self-regulated learning	Component of SRL and mediator: self-regulated learning linked achievement goals with PE performance	General upper-secondary PE curriculum; specific unit not reported
Simonton et al. (2023)	United States; instrument expansion and criterion-validity study	N = 495; M age = 11.96; Grades 6–8; compulsory PE	Control-Value Theory of Achievement Emotions (CVTAE)	Criterion outcome: declarative, procedural, and conditional metacognitive knowledge used to examine predictive validity of DEPES	Compulsory middle-school PE; specific activity not reported
Bujosa-Quetglas et al. (2024)	Spain; instrument development and validation	N = 153; 13–17 years; secondary education	Zimmerman's cyclical self-regulated learning model; social cognitive theory	Components of broader SRL: planning, self-monitoring, evaluation, and reflection	Muscular-resistance exercises in PE
Nazari et al. (2025)	Iran; randomized pre–post comparison	N = 72; Grade 9; M age = 14.82	Constructivist/game-based learning; hybrid TGfU + Sport Education pedagogical model	Intervention outcome: general metacognitive beliefs assessed alongside emotional and psychomotor outcomes	Football
Bujosa-Quetglas et al. (2026)	Spain; mixed-methods interrupted time series	N = 61; M age = 15.75; ten PE sessions	Explicit teaching; Zimmerman and Moylan's (2009) cyclical SRL model; sequential development of self-regulation	Explicit intervention target and outcome: planning, monitoring, evaluation/reflection and broader SRL	Muscular-strengthening/resistance exercises

Two reports included mixed elementary- and secondary-school samples (Theodosiou & Papaioannou, 2006; Theodosiou et al., 2008). These reports were retained because secondary-school students constituted the majority of the samples and metacognition was assessed specifically within curricular PE. In Theodosiou et al. (2008), educational-level comparisons were explicitly reported. In Theodosiou and Papaioannou (2006), the principal regression and mediation analyses were based on the complete Grade 5–12 sample; consequently, these estimates were interpreted as mixed-age evidence rather than as effects specific to secondary-school students.

The theoretical foundations of the included evidence clustered around several related but distinguishable traditions. Achievement goal and motivational-climate frameworks predominated in the earlier observational literature, where metacognition was generally examined as an outcome of students' beliefs, goals, and perceptions of the learning environment (Ommundsen, 2003, 2006; Papaioannou et al., 2009; Theodosiou & Papaioannou, 2006; Theodosiou et al., 2008). Self-determination theory subsequently provided the main framework for studies connecting autonomy-supportive or controlling teaching with motivation, emotional processes, and metacognitive strategy use (Karagiannidis et al., 2015; Trigueros et al., 2019; Trigueros & Navarro, 2019). Other reports drew explicitly on cyclical models of self-regulated learning (Bujosa-Quetglas et al., 2024, 2026; Jørgensen Olsen & Mehus, 2022; Trabelsi et al., 2022), whereas Simonton et al. (2023) positioned metacognitive knowledge within the Control-Value Theory of Achievement Emotions. Metacognition therefore functioned more frequently as a measured outcome, mediator, or component of broader self-regulation than as an explicit instructional target. Only the intervention studies directly manipulated pedagogical conditions intended to activate metacognitive or self-regulatory processes. These interventions were also the only reports to provide detailed information on PE content and implementation: gymnastics with video modelling, football through a hybrid TGfU–Sport Education model, and muscular-strengthening activities combining explicit instruction with progressive self-regulation (Bujosa-Quetglas et al., 2026; Nazari et al., 2025; Trabelsi et al., 2022).

Conceptualization and measurement of metacognition

Substantial conceptual and measurement heterogeneity was observed across the included reports (see Table 2). The earlier Greek studies primarily adopted Brown's (1987) distinction between knowledge

of cognition and regulation of cognition. Their measures included declarative, procedural, and conditional knowledge, together with information management, planning, mental imagery, self-monitoring, problem-solving or debugging strategies, and evaluation (Karagiannidis et al., 2015; Papaioannou et al., 2009; Theodosiou & Papaioannou, 2006; Theodosiou et al., 2008).

A second group operationalized metacognition as a component of self-regulated learning, frequently using adaptations or selected subscales of the Motivated Strategies for Learning Questionnaire (Pintrich et al., 1993). These studies typically assessed the planning, monitoring, control, and evaluation of learning, sometimes alongside effort regulation, help-seeking, critical thinking, motivation, and self-reflection (Fernandez-Ortega et al., 2022; Jørgensen Olsen & Mehus, 2022; Ommundsen, 2003, 2006; Trigueros et al., 2019; Trigueros & Navarro, 2019).

Three reports developed or evaluated context-specific measures. Settanni et al. (2012) developed the Metacognition Applied to Physical Activity Scale, Bujosa-Quetglas et al. (2024) developed a self-regulated learning questionnaire for muscular-resistance exercises, and Simonton et al. (2023) used declarative, procedural, and conditional metacognitive knowledge as criterion variables when extending a measure of discrete emotions in PE.

The intervention conducted by Trabelsi et al. (2022) identified repeated viewing and interpretation, instructional self-talk, and mental rehearsal through retrospective interviews rather than through a standardized pre–post measure of metacognition. Consequently, the study provided evidence of the metacognitive strategies activated during learning but did not directly quantify changes in metacognition over the intervention.

Nazari et al. (2025) used the 30-item Metacognitions Questionnaire, which assesses general metacognitive beliefs concerning thoughts, worry, confidence in memory, and cognitive control rather than PE-specific knowledge and regulation of motor learning. Its findings were therefore interpreted separately from those of studies employing measures specifically focused on learning-related metacognition in PE.

Table 2. Operationalization of metacognition and principal findings

Report	Metacognitive construct or measure	Principal findings
Ommundsen (2003)	Metacognitive/elaboration strategies, effort regulation, adaptive help-seeking	Incremental beliefs positively predicted metacognitive/elaboration strategies, β = .47, whereas stable ability beliefs predicted them negatively, β = –.16. Ability beliefs explained 12–28% of variance across self-regulation outcomes.
Ommundsen (2006)	Metacognitive self-regulation, effort regulation, help-seeking	Mastery climate had positive direct and goal-mediated relationships with metacognitive strategy use. Performance-avoidance goals were associated with less adaptive regulation and greater self-handicapping.
Theodosiou and Papaioannou (2006)	Knowledge and regulation of cognition in the MPIPEQ	Task orientation and mastery climate jointly explained approximately 45% of the variance in total metacognition. Metacognition statistically mediated relationships between mastery-related variables and out-of-school exercise frequency.
Theodosiou et al. (2008)	Declarative, conditional, and procedural knowledge; planning, monitoring, problem-solving and evaluation	Younger pupils reported more frequent metacognitive activity. Task orientation and task-involving climate accounted for part of the differences between educational levels.
Papaioannou et al. (2009)	Eight PE-specific knowledge and regulation dimensions	Mastery orientation in PE positively predicted metacognition. A global personal-improvement goal also contributed positively after PE-specific goals were considered.
Settanni et al. (2012)	Ten-item unidimensional MAPAS	EFA: CFI = .98, RMSEA = .065, SRMR = .048; CFA: CFI = .97, RMSEA = .061. Scores were higher among girls, younger grades, extracurricular sport participants, and students reporting more weekly activity.
Karagiannidis et al. (2015)	Modified MPIPEQ: knowledge and regulation of cognition	Metacognition predicted leisure-time physical-activity intentions, β = .29, and enjoyment, β = .10, but not boredom. Metacognition significantly mediated the relationship between autonomy support and activity intentions.
Trigueros et al. (2019)	Twelve-item MSLQ metacognitive-strategies subscale	Emotional intelligence positively predicted metacognitive strategies, β = .60. Psychological-need frustration was negatively associated with emotional intelligence.
Trigueros and Navarro (2019)	Twelve MSLQ metacognition items	Self-determined motivation predicted metacognitive strategies, β = .61; metacognitive strategies predicted reported PE achievement, β = .82.
Trabelsi et al. (2022)	Retrospective interviews on self-regulatory and metacognitive strategies	Motor-skill and knowledge performance improved significantly after video-modelling instruction. Interviews identified repeated viewing and interpretation, instructional self-talk, and mental rehearsal.
Fernandez-Ortega et al. (2022)	Twelve-item MSLQ metacognition subscale	Teaching, cognitive development, and mastery experiences predicted metacognitive strategies, β = .41, .32, and .48. Metacognition predicted intention to be active, β = .17; the path to Mediterranean-diet adherence was β = .18 with p = .06 and was not conventionally significant.

Jørgensen Olsen and Mehus (2022)	Nine-item self-regulated learning measure covering forethought, performance, and reflection	Mastery-approach and mastery-avoidance goals positively predicted SRL, β = .47 and .14; performance-avoidance predicted it negatively, β = –.27. SRL predicted PE performance, β = .16.
Simonton et al. (2023)	Declarative, procedural, and conditional knowledge subscales	Discrete emotions explained 40%, 52%, and 57% of the variance in declarative, conditional, and procedural knowledge. Pride was consistently positive, whereas anger and boredom showed negative associations with selected knowledge dimensions.
Bujosa-Quetglas et al. (2024)	Planning, self-monitoring, evaluation, reflection, effort, and self-efficacy	The final instrument contained 40 items in six dimensions. Internal consistency ranged from α = .758 to .926. CFA fit was acceptable for forethought, mixed for reflection, and below conventional standards for the execution phase.
Nazari et al. (2025)	MCQ-30 general metacognitive beliefs	The intervention group increased from M = 65.58 to 75.66, whereas controls remained almost unchanged. The time-by-group interaction was F = 16.12, partial η^2 = .31. The instrument did not measure PE-specific learning regulation.
Bujosa-Quetglas et al. (2026)	CAAERMEF total self-regulation; microanalytic interviews	Total self-regulation increased across measurement points, F = 3.87, p = .005, especially in initially inactive or insufficiently active groups. Most qualitative subprocess frequencies did not change significantly.

Motivational climates, achievement beliefs, and metacognition

The most consistent pattern across the observational evidence concerned mastery-oriented beliefs and learning environments. Incremental beliefs about ability, task-oriented goals, mastery-approach goals, and perceptions of a mastery climate were positively associated with students' reported use of metacognitive and self-regulatory strategies. Conversely, stable beliefs about ability and performance-avoidance goals were generally associated with lower self-regulation or less adaptive learning patterns (Jørgensen Olsen & Mehus, 2022; Ommundsen, 2003, 2006; Papaioannou et al., 2009; Theodosiou & Papaioannou, 2006; Theodosiou et al., 2008).

Ommundsen (2003) found that endorsing an incremental or learning-induced theory of ability positively predicted students' use of metacognitive and elaboration strategies, whereas perceiving ability as stable was negatively associated with their use. These findings suggest that students who viewed competence as modifiable through effort and learning were more likely to plan, monitor, and regulate their cognition during PE activities. In a subsequent study, Ommundsen (2006) found that perceptions of a mastery-oriented climate were related both directly and indirectly, through students' achievement goals, to metacognitive self-regulation and effort regulation.

Evidence from Greece showed a similar pattern. In their mixed elementary- and secondary-school sample, Theodosiou and Papaioannou (2006) found that task orientation and perceptions of a mastery climate made independent contributions to students' reported metacognitive activity. Together, these variables explained approximately 45% of the variance in total metacognition. Their statistical model also indicated that metacognition partially mediated the relationship between mastery-related motivational characteristics and students' frequency of sport and exercise involvement outside school. Theodosiou et al. (2008) subsequently found that younger students reported more frequent use of metacognitive processes than students in higher educational levels. However, task orientation and perceptions of a task-involving motivational climate accounted for part of these age-group differences. Papaioannou et al. (2009) similarly found that mastery goals within PE made a unique positive contribution to the explanation of metacognitive activity. In addition, a general orientation toward personal improvement contributed to metacognition after PE-specific achievement goals had been considered, suggesting that both contextual and broader motivational orientations may be relevant to students' regulation of learning.

More recent evidence from Norway was consistent with these findings. Jørgensen Olsen and Mehus (2022) reported that mastery-approach goals showed the strongest positive association with self-regulated learning, whereas performance-avoidance goals were negatively associated with it. Self-regulated learning was also positively related to students' self-reported PE performance and statistically mediated some of the relationships between achievement goals and performance.

Teacher-created learning environments, motivation, and emotional processes

Autonomy-supportive teaching and positive perceptions of the instructional environment were consistently associated with greater use of metacognitive strategies. However, the studies examining these relationships employed cross-sectional designs, meaning that the observed associations cannot establish

temporal or causal direction (Fernandez-Ortega et al., 2022; Karagiannidis et al., 2015; Trigueros et al., 2019; Trigueros & Navarro, 2019).

Karagiannidis et al. (2015) found that students' metacognition positively predicted enjoyment during PE and intentions to participate in leisure-time physical activity. Metacognition also statistically mediated the relationship between perceptions of autonomy-supportive teaching and intentions to be physically active. Nevertheless, metacognition did not independently predict boredom after the other motivational variables were entered into the final regression model.

The two Spanish studies published in 2019 connected metacognition with teacher behaviour, motivation, and emotional processes. Trigueros et al. (2019) found that frustration of students' psychological needs was negatively associated with emotional intelligence, while emotional intelligence positively predicted the use of metacognitive strategies. Trigueros and Navarro (2019) reported that self-determined motivation positively predicted students' use of metacognitive strategies and critical thinking. Both variables were subsequently associated with higher reported achievement in PE. Fernandez-Ortega et al. (2022) found that students' satisfaction with teaching quality, perceived cognitive development, and mastery of PE content each contributed positively to metacognitive strategies. Metacognition was also positively, although relatively weakly, associated with intentions to engage in physical activity. In contrast, the reported relationship between metacognition and adherence to the Mediterranean diet did not reach the conventional level of statistical significance.

Intervention findings

All three intervention reports described improvements in their principal metacognitive, self-regulatory, or learning-related outcomes. Nevertheless, the interventions differed substantially in pedagogical approach, duration, study design, measurement, and PE content, limiting direct comparison across studies (Bujosa-Quetglas et al., 2026; Nazari et al., 2025; Trabelsi et al., 2022).

Trabelsi et al. (2022) implemented a video-modelling intervention during a secondary-school gymnastics unit. Students showed significant improvements in motor-skill performance and gymnastics-related knowledge following the intervention. The qualitative findings indicated that students regulated their learning through repeated viewing and interpretation of the video models, instructional self-talk, and mental rehearsal. Because metacognition was identified retrospectively through interviews rather than measured using a standardized pre–post instrument, the study provided evidence of metacognitive strategy use but did not directly quantify change in metacognitive ability.

Nazari et al. (2025) found significant time-by-group effects favouring an intervention that combined Teaching Games for Understanding and Sport Education. Students in the intervention condition improved in metacognition, emotion regulation, intrapersonal intelligence, and psychomotor skills compared with those receiving regular PE instruction. However, the study assessed metacognition using the Metacognitions Questionnaire-30, which measures general beliefs about thoughts and cognitive control rather than task-specific planning, monitoring, and evaluation during PE learning. The findings should therefore not be treated as directly equivalent to those obtained with PE-specific measures of metacognitive regulation.

Bujosa-Quetglas et al. (2026) implemented ten PE sessions combining explicit teaching with a progressive model of self-regulated learning in muscular-strengthening activities. Overall self-regulation improved across the intervention, with the largest changes observed among students who reported no or little muscular-strengthening activity at baseline. Nevertheless, most of the interview-based indicators of goal setting, strategic planning, monitoring, causal attribution, and adaptive inference did not show statistically significant changes. The discrepancy between the questionnaire and qualitative results suggests that improvements in global self-reported self-regulation may not necessarily reflect consistent changes in all task-specific metacognitive subprocesses.

Measurement studies

The three measurement-oriented reports provided preliminary evidence supporting the assessment of metacognitive constructs in Physical Education (PE). However, none provided definitive evidence based on independent validation samples, longitudinal stability, or cross-cultural replication (Bujosa-Quetglas et al., 2024; Settanni et al., 2012; Simonton et al., 2023).

Settanni et al. (2012) developed the Metacognition Applied to Physical Activity Scale (MAPAS). After expert assessment of an initial pool of 40 items, the final instrument comprised 10 items with a unidimensional structure. Both the exploratory factor analysis, CFI = .98, RMSEA = .065, SRMR = .048, and the confirmatory factor analysis, CFI = .97, RMSEA = .061, supported the one-factor solution. MAPAS scores were significantly higher among girls, students in lower grades, students participating in extracurricular sport, and those reporting more weekly hours of physical activity. Mastery-approach goals also showed the strongest positive association with metacognition applied to physical activity. Nevertheless, the authors acknowledged that the MAPAS provides a general measure across physical activities rather than a task-specific assessment and that its validation relied exclusively on self-report data (Settanni et al., 2012).

Bujosa-Quetglas et al. (2024) developed the Self-Regulated Learning Questionnaire for Muscular Resistance Exercises in Physical Education. The final 40-item instrument comprised six dimensions: planning, self-monitoring, evaluation, reflection, effort, and self-efficacy. The first four dimensions represented metacognitive processes, whereas effort and self-efficacy represented motivational components of self-regulated learning. Internal consistency estimates ranged from α = .758 for reflection to α = .926 for self-efficacy. Although the phase-specific analyses generally supported the proposed multidimensional organization, model fit varied across the forethought, execution, and reflection phases. Some indices for the execution-related model indicated weaker factorial fit than those obtained for the other phases. The authors also noted that the instrument did not capture all subprocesses included in Zimmerman's model and recommended further development and validation (Bujosa-Quetglas et al., 2024).

Measurement properties of metacognition-specific instruments

The COSMIN-informed appraisal of the metacognition-specific measurement instruments is presented in Supplementary Table S2. MAPAS showed sufficient structural validity for its proposed one-factor solution, although methodological limitations reduced confidence in the evidence. The same sample was used for exploratory and confirmatory analyses, the report contained an inconsistency in the sample size associated with the item-correlation table, and the Cronbach's alpha coefficient was not reported despite being described in the methods (Settanni et al., 2012). Content validity was considered indeterminate because expert review supported item relevance, but direct evidence from adolescents regarding comprehensiveness and comprehensibility was not reported. Evidence based on hypothesis testing was mixed because the expected age-related pattern was not supported.

For CAAERMEF, expert review and adolescent comprehensibility testing supported item relevance and wording (Bujosa-Quetglas et al., 2024). However, the authors acknowledged that several subprocesses derived from the theoretical model were not represented, limiting evidence for content comprehensiveness. Internal consistency was adequate across the six dimensions, with Cronbach's alpha coefficients ranging from .758 to .926. Although phase-specific factorial analyses provided some support for the proposed organization, confidence in structural validity was limited by the use of a single modest sample, the initial item-to-participant ratio, and the absence of a confirmatory model testing the complete six-dimension structure.

Neither MAPAS nor CAAERMEF provided evidence regarding test–retest reliability, measurement error, cross-cultural validity or measurement invariance, criterion validity, or responsiveness (Bujosa-Quetglas et al., 2024; Settanni et al., 2012). Accordingly, both instruments provide useful preliminary approaches for assessing metacognitive or self-regulatory processes in PE, but their measurement properties require further independent validation.

Methodological quality appraisal

The criterion-level MMAT appraisal is presented in Supplementary Table S1. Across the quantitative non-randomized studies, measurements and statistical analyses were generally appropriate, but representativeness and potential nonresponse bias were frequently unclear. Several reports relied on local or convenience samples, limiting the generalizability of their findings. More substantial analytical concerns were identified in selected reports. Fernandez-Ortega et al. (2022), for example, reported inconsistent sample sizes between the participant description and the structural equation model, whereas Bujosa-Quetglas et al. (2024) conducted exploratory and confirmatory factorial analyses using the same relatively modest sample.

Among intervention studies, Nazari et al. (2025) described random allocation, comparable baseline values, complete outcome data, and intervention completion; however, researcher awareness of group allocation meant that assessor blinding could not be demonstrated. The mixed-methods studies provided a clear rationale for combining quantitative and qualitative evidence and integrated both components in their interpretations (Bujosa-Quetglas et al., 2026; Trabelsi et al., 2022). Nevertheless, their one-group intervention designs limited control over confounding and alternative explanations for change. In addition, Trabelsi et al. (2022) provided limited information concerning independent qualitative coding and analytic reflexivity. Overall, methodological quality was therefore heterogeneous: the observational evidence was generally adequate for examining associations, but its predominantly cross-sectional nature precluded causal inference, while the intervention evidence remained promising but preliminary because of small samples, limited control conditions, and heterogeneous measurement approaches.

Discussion

This systematic review synthesized 16 reports representing 18 study samples on metacognition and metacognitively oriented self-regulated learning in school-based Physical Education (PE). Three main findings emerged. First, metacognitive activity was consistently associated with the motivational and pedagogical characteristics of PE lessons. Mastery-oriented goals, incremental beliefs about ability, autonomy-supportive teaching, and positive perceptions of instruction were related to greater planning, monitoring, evaluation, and strategic regulation (Jørgensen Olsen & Mehus, 2022; Ommundsen, 2003, 2006; Papaioannou et al., 2009; Theodosiou & Papaioannou, 2006). Second, metacognition was positively associated with enjoyment, PE performance, learning engagement, physical-activity intentions, and selected motor-learning outcomes (Fernandez-Ortega et al., 2022; Karagiannidis et al., 2015; Trabelsi et al., 2022; Trigueros & Navarro, 2019). Third, intervention studies suggested that explicit instruction, video modelling, game-based pedagogies, guided reflection, and progressive transfer of responsibility may support metacognitive or self-regulatory development (Bujosa-Quetglas et al., 2026; Nazari et al., 2025; Trabelsi et al., 2022).

Metacognition and the learning environment in Physical Education

The findings suggest that metacognition in PE is not simply an individual learner characteristic. Its activation appears to depend partly on the goals, instructional practices, and motivational climate that structure the learning experience. Students who perceived ability as modifiable and who focused on learning, effort, and personal improvement reported greater use of metacognitive and self-regulatory strategies. In contrast, fixed beliefs about ability and performance-avoidance goals were related to less adaptive learning processes (Jørgensen Olsen & Mehus, 2022; Ommundsen, 2003, 2006).

This pattern was also evident in studies examining mastery-oriented climates. Task orientation and perceptions of a mastery environment were positively associated with knowledge and regulation of cognition, including planning, monitoring, information management, and evaluation (Papaioannou et al., 2009; Theodosiou & Papaioannou, 2006; Theodosiou et al., 2008). These findings indicate that students may be more likely to reflect on how they learn when success is defined through progress, understanding, strategy use, and individual improvement rather than through comparison with classmates.

The pedagogical implication is that promoting metacognition requires more than asking students to reflect at the end of a lesson. Teachers must create conditions in which reflection is meaningful. Tasks should involve decisions, alternative strategies, observable criteria for success, and opportunities to revise performance. Errors should be treated as information for learning rather than solely as evidence of low ability.

However, most studies examining motivational climate and metacognition were cross-sectional. Consequently, the direction of the relationships cannot be established. Students with stronger metacognitive skills may perceive teaching more positively, while more motivated students may report both greater mastery orientation and more frequent strategy use. The evidence therefore supports associations, but not causal conclusions.

Metacognition, learning outcomes, and physical activity

Metacognition was associated with several educational and behavioural outcomes. Karagiannidis et al. (2015) found that metacognition was related to enjoyment and intentions to participate in leisure-time physical activity. Theodosiou and Papaioannou (2006) similarly reported that metacognition statistically mediated relationships between mastery-related motivational variables and out-of-school exercise participation. These findings suggest that planning, monitoring, and evaluating learning may contribute to students' capacity to transfer knowledge and strategies from PE to activity beyond school. Metacognitive and self-regulatory processes were also associated with PE performance. Jørgensen Olsen and Mehus (2022) found that mastery goals were positively related to self-regulated learning, which was subsequently associated with performance. Trigueros and Navarro (2019) similarly connected self-determined motivation, metacognitive strategies, critical thinking, and reported achievement.

These results reinforce the idea that PE is not limited to physical participation. Learning in PE involves the coordination of movement, knowledge, motivation, emotion, and strategic thinking. Nevertheless, most outcomes were based on self-reports, intentions, or grades reported by students. Evidence is still insufficient to determine whether metacognitive development produces sustained changes in objectively assessed physical activity or motor performance.

Pedagogical interventions

The intervention evidence was promising but limited. Trabelsi et al. (2022) showed that video modelling supported improvements in gymnastics performance and knowledge. Students reported using repeated viewing, self-talk, and mental rehearsal to regulate their learning. The intervention suggests that video may support metacognition when it enables students to control observation, compare their execution with a model, and revisit relevant information. The benefit should therefore not be attributed to technology alone, but to the learning processes that technology makes possible.

Nazari et al. (2025) reported improvements after combining Teaching Games for Understanding and Sport Education. These models may stimulate metacognition through problem-solving, tactical decision-making, collaborative roles, and reflection on game performance. However, the study employed a general measure of metacognitive beliefs rather than a PE-specific measure of planning, monitoring, and evaluation. Its metacognitive findings should therefore be interpreted cautiously.

Bujosa-Quetglas et al. (2026) found that explicit instruction combined with progressive self-regulated learning improved overall self-regulation and muscular-strengthening activity, particularly among students with lower initial participation. However, most interview-based metacognitive subprocesses did not change significantly. This discrepancy indicates that improvements in global questionnaire scores do not necessarily imply changes in all task-specific processes, such as goal setting, monitoring, causal attribution, and adaptive reflection.

Taken together, the interventions indicate that metacognitive development may be supported through explicit goal setting, strategic modelling, guided practice, self-assessment, feedback, and progressive learner autonomy. Nevertheless, the small number of interventions, their different designs, and the use of non-equivalent measures prevent identifying one pedagogical model as superior.

Conceptual and measurement issues

A central limitation of the field is the lack of a consistent operational definition of metacognition. Some studies distinguished knowledge of cognition from regulation of cognition and measured declarative, procedural, and conditional knowledge alongside planning, monitoring, and evaluation (Karagiannidis et al., 2015; Theodosiou & Papaioannou, 2006). Others treated metacognition as one component of the broader construct of self-regulated learning, together with effort, help-seeking, motivation, or self-efficacy (Bujosa-Quetglas et al., 2024; Jørgensen Olsen & Mehus, 2022; Ommundsen, 2006).

This distinction matters because self-regulated learning is broader than metacognition. Instruments combining metacognitive, motivational, emotional, and behavioural dimensions should not be interpreted as pure measures of metacognition. For example, the questionnaire developed by Bujosa-Quetglas et al. (2024) included planning, self-monitoring, evaluation, and reflection, but also effort and self-efficacy.

Measurement also varied in contextual specificity. Some instruments were designed for PE or physical activity, whereas others assessed general learning strategies or beliefs about thinking. Because metacognition is activated in relation to tasks, monitoring a gymnastics sequence, evaluating a tactical decision, and planning a strength-training routine may involve different forms of knowledge and regulation. Future studies should combine PE-specific questionnaires with task-sensitive methods such as think-aloud protocols, stimulated recall, observation, learning journals, and microanalytic interviews.

Strengths and limitations

This review applied an explicit definition of metacognition and distinguished it from emotional intelligence, general motivation, and other related constructs. The absence of a lower publication-date limit also allowed the inclusion of foundational studies that would otherwise have been excluded.

Several limitations must be acknowledged. The protocol was not prospectively registered and was amended after the initial search. The population criterion permitted predominantly adolescent samples with slightly broader age ranges and two mixed elementary–secondary samples. In these mixed-age studies, secondary-school students represented most participants, but not all reported estimates could be disaggregated by educational level. Their findings were therefore retained because of their direct relevance to curricular PE and explicit assessment of metacognition, but results based on the complete samples should not be interpreted as estimates specific to adolescents.

The evidence base itself was dominated by cross-sectional self-report studies. Consequently, statistical mediation and structural associations should not be interpreted as evidence of causal effects. Heterogeneity in designs, theoretical frameworks, instruments, PE content, and outcomes also precluded meta-analysis.

Because screening and eligibility decisions were made by a single lead reviewer with artificial-intelligence support rather than by two independent reviewers, inter-rater agreement could not be calculated and selection error cannot be ruled out.

Conclusions

The available evidence indicates that metacognition in school PE is closely connected to how learning is organized and experienced. Mastery-oriented goals, incremental beliefs about ability, autonomy-supportive teaching, and environments emphasizing understanding and personal improvement were consistently associated with greater metacognitive and self-regulatory activity (Jørgensen Olsen & Mehus, 2022; Ommundsen, 2003, 2006; Papaioannou et al., 2009; Theodosiou & Papaioannou, 2006).

Metacognition was also related to PE performance, enjoyment, learning engagement, motor-skill acquisition, and intentions to remain physically active (Fernandez-Ortega et al., 2022; Karagiannidis et al., 2015; Jørgensen Olsen & Mehus, 2022; Trabelsi et al., 2022; Trigueros & Navarro, 2019).

Interventions based on explicit instruction, video modelling, guided reflection, game-based learning, and progressive learner responsibility produced promising findings (Bujosa-Quetglas et al., 2026; Nazari et al., 2025; Trabelsi et al., 2022). However, the small number of intervention studies and their methodological and measurement heterogeneity prevent firm conclusions regarding effectiveness.

The principal challenge for the field is therefore no longer only to demonstrate that metacognition is relevant to PE, but to determine how it can be intentionally taught, directly observed, and reliably measured across different learning tasks, and how these processes contribute to sustained learning and physical activity beyond the PE lesson.

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