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The relationship between computational thinking and executive functions in preschool and primary school children: A systematic review of empirical and observational studies

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ADMINISTRATIVE INFORMATION

Support - No support.

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 2 September 2026 and was last updated on 2 September 2026.

INTRODUCTION

Review question / Objective The review question and objectives were defined using the PICOS framework. This systematic review aims to: (1) synthesize experimental and quasi-experimental studies examining the effects of computational thinking (CT) interventions on executive functions (EFs) in preschool and primary school children (K–6); and (2) synthesize observational studies examining associations between CT skills and EFs in this population.

P (Population): Preschool and primary school children (K–6).
I (Intervention/Exposure): CT or coding-learning interventions; CT skill level as the exposure/predictor in observational studies.
C (Comparator): Active or passive control groups in experimental studies; not applicable to observational studies.
O (Outcomes): Standardized or validated measures of EFs, including working memory, inhibitory control, cognitive flexibility, and planning.
S (Study designs): Randomized and quasi-experimental controlled trials and correlational/observational studies.

Rationale The growing interest in developing computational thinking (CT) in early childhood and primary education has driven multiple educational initiatives incorporating CT from an early age. In parallel, a number of observational studies have begun to suggest a relationship between CT and the strengthening of executive functions (EFs) — a set of higher-order cognitive control processes involved in self-regulated learning and problem solving. However, no systematic synthesis currently integrates the empirical and observational evidence exploring this relationship in preschool and primary education contexts. This review is therefore both timely and necessary, not only to consolidate the available evidence, but also to inform the design of CT-based educational interventions with positive effects on early cognitive development. By compiling both experimental and correlational studies, this review aims to provide a comprehensive overview to

guide future research, pedagogical practice, and educational policy decisions.

Condition being studied This review focuses on executive functions (EFs), a set of higher-order cognitive processes essential for goal-directed behavior, learning, and self-regulation. Specifically, it examines working memory, inhibitory control, cognitive flexibility, and planning in preschool and primary school children (K–6), developmental periods characterized by substantial growth in these cognitive abilities. The review investigates EFs in relation to computational thinking (CT), considering both the potential effects of CT- or coding-based educational interventions on EFs and the associations between children's CT skills and their executive functioning.

METHODS

Search strategy The search string used was: [("computational thinking" OR "coding learning" OR "programming learning") AND ("executive function*" OR "working memory" OR "inhibitory control" OR "cognitive flexibility")], with database-specific syntax adaptations as required. Boolean operators "AND" and "OR" were used to combine descriptors. Records retrieved from all databases will be exported to Mendeley for reference management, and duplicates will be removed. Title and abstract screening will be conducted independently by Reviewer 1, with a second reviewer confirming eligibility against the inclusion criteria. Full-text screening will then be performed independently by two reviewers, followed by a plenary session with all three reviewers to resolve discrepancies. Disagreements that cannot be resolved by consensus will be referred to external arbitration.

Participant or population Children enrolled in preschool or primary education (K–6), including both typically developing children and, where reported, children with special educational needs, provided executive function outcomes were directly assessed.

Intervention Structured educational interventions or programs designed to teach computational thinking or coding, delivered through plugged (e.g., block-based programming, educational robotics) or unplugged formats, or a combination of both.

Comparator For experimental and quasi-experimental studies: active control groups (e.g., treatment-as-usual, alternative curriculum) or passive/waitlist control groups. Not applicable for observational/correlational studies, which will be synthesized separately.

Study designs to be included The review will include empirical studies using the following designs: (1) experimental studies, including randomized and non-randomized controlled trials; (2) quasi-experimental studies with a comparison or control group; and (3) observational studies, including correlational studies examining associations between computational thinking skills and executive functions.

Eligibility criteria

Inclusion criteria

Studies reporting empirical results on the effect of a CT intervention on EF outcomes

Studies reporting observational/correlational results on the relationship between CT and EF

Samples of preschool or primary school students (K–6)

Published in peer-reviewed journals

Exclusion criteria

Conference abstracts or proceedings without full peer-reviewed text

Review articles, theoretical papers, or commentaries

Studies that do not directly assess EF using a validated instrument

Studies in which CT is assessed only as an academic outcome, without any EF measure.

Information sources The information sources will include the following electronic databases and academic publishing platforms: Web of Science, ProQuest, ScienceDirect, SpringerLink, Taylor & Francis Online, SAGE Journals, and Wiley Online Library. In addition, the reference lists of all included studies and relevant previous systematic reviews will be manually screened to identify additional potentially eligible studies. No contact with study authors or searches of trial registries are planned at this stage.

Main outcome(s) The main outcomes will be the effects of computational thinking (CT) interventions on executive functions (EFs), including working memory, inhibitory control, cognitive flexibility, and planning, as well as the associations between CT skills and EFs reported in observational studies. Effect estimates (e.g., between-group differences, standardized effect sizes, and correlation coefficients) will be extracted when available. Secondary outcomes will include effects on other cognitive processes or abilities beyond EFs, as well as the effects of relevant covariates or moderators. The main outcomes will be the effects of computational thinking (CT) interventions on

executive functions (EFs), including working memory, inhibitory control, cognitive flexibility, and planning, as well as the associations between CT skills and EFs reported in observational studies. Effect estimates (e.g., between-group differences, standardized effect sizes, and correlation coefficients) will be extracted when available. Secondary outcomes will include the effects of relevant covariates or moderators. For contextual and methodological characterization, data will also be extracted on population and sample characteristics, study design, CT and EF measurement instruments (including type, items/tasks, and platform or device, where applicable).

Additional outcome(s) Additional information will include population and sample characteristics, study design, CT and EF measurement instruments (including type, items/tasks, and platform or device, where applicable), and journal quality indicators (e.g., indexing and impact factor).

Data management A structured data-extraction matrix will be used to record: author(s), title, year of publication, country, sample description (size, age, educational level), study objectives, measurement instrument characteristics (type of measure, item format, device/platform, instrument type), CT component assessed, and results (statistical significance, effect sizes, post hoc comparisons, correlationcoefficients).

Quality assessment / Risk of bias analysis Risk of bias in randomized and quasi-experimental studies will be assessed using the Cochrane Risk of Bias tool (RoB 2), evaluating selection, performance, detection, attrition, and reporting bias, consistent with CONSORT reporting standards. Risk of bias in observational/correlational studies will be assessed using the Newcastle-Ottawa Scale (NOS), adapted for cross-sectional designs. Two reviewers will independently assess risk of bias, with disagreements resolved through discussion or third-reviewer arbitration.

Strategy of data synthesis Given the anticipated heterogeneity in study designs, measurement instruments, and outcome metrics, findings will be synthesized narratively, organized by executive function domain (working memory, inhibitory control, cognitive flexibility, planning) and by study design (experimental vs. observational). Where a sufficient number of methodologically comparable studies is identified (e.g., ≥5 studies reporting compatible effect sizes for the same EF domain), a meta-analysis will be considered as a post hoc addition; this decision will be documented transparently in the final review.

Subgroup analysis If data allows it, we will conduct subgroup analyses using educational level (preschool vs. primary), intervention modality (plugged vs. unplugged vs. combined), and geographic region as grouping variables.

Sensitivity analysis None.

Language restriction English and Spanish.

Country(ies) involved Colombia.

Other relevant information None

Keywords Computational thinking; coding learning; programming; executive functions; preschool education; primary education.

Dissemination plans Results will be submitted for publication in a peer-reviewed, high-impact journal in the fields of developmental psychology or educational technology.

Contributions of each author

Author 1 - Carolina Robledo-Castro - Formulation of search strategy, execution of search chain, retrieval of articles, first filter in data extraction.
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