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Digital Game-Based Learning and Computational Thinking Skills of Elementary School Students: A Systematic Literature Review

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ABSTRACT

This systematic literature review (SLR) examined the evidence concerning Digital Game-Based Learning (DGBL) and Computational Thinking (CT) among elementary school students. The review aimed to identify publication trends and research characteristics, examine reported CT-related outcomes, identify enabling and constraining factors, and determine research gaps in the existing literature. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses framework. Literature published between 2021 and 2026 was searched in Scopus, ScienceDirect, and Google Scholar. The initial search identified 521 records, of which 435 remained after duplicate removal and 86 proceeded to full-text assessment. Following the application of the predefined population, intervention, and outcome criteria, the final evidence pool was established only after full-text eligibility verification. The synthesis indicates that the included studies report potential benefits of DGBL for several dimensions of Computational Thinking, although the strength and consistency of the evidence vary according to research design, intervention characteristics, duration, and CT assessment approaches. The review also identifies implementation conditions related to teacher preparedness, technological infrastructure, instructional support, and game design. Overall, the evidence suggests that DGBL has potential to support CT development in elementary education, but stronger comparative and longitudinal evidence is required to establish the conditions under which different forms of DGBL produce sustainable CT outcomes.

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INTRODUCTION

The rapid advancement of digital technologies has transformed the competencies required for learners in the twenty-first century. Beyond literacy and numeracy, students are increasingly expected to develop higher-order cognitive skills that enable them to solve complex problems, think systematically, and adapt to technological change (Chen et al., 2024; Panskyi & Rowińska, 2021). Among these competencies, Computational Thinking (CT) has been widely recognized as a fundamental skill that extends beyond computer science and supports problem-solving across multiple disciplines. CT equips learners with strategies to formulate problems, organize information, recognize patterns, develop algorithmic solutions, and evaluate problem-solving processes in both digital and real-world contexts.

The concept of computational thinking is widely associated with Wing (2006), who framed CT as a universally applicable way of thinking that draws on concepts fundamental to computer science. Brennan and Resnick (2012) subsequently provided a framework for

examining computational concepts, computational practices, and computational perspectives in young people's programming activities. Together, these foundational perspectives provide a basis for conceptualising CT in elementary education.

To facilitate CT development, Digital Game-Based Learning (DGBL) has emerged as one of the most promising instructional approaches. DGBL refers to learning activities in which digital games are intentionally designed or implemented to achieve specific educational objectives while maintaining meaningful gameplay. Unlike gamification, which integrates isolated game elements such as points or badges into non-game activities, DGBL employs complete digital game experiences to support learning. Likewise, DGBL differs from serious games, which are developed primarily for educational or training purposes, game-creation environments, where students design digital games themselves, and unplugged game-based learning, which teaches computational concepts through non-digital activities. Distinguishing these concepts is essential to ensure conceptual clarity and consistency in systematic reviews.

The educational effectiveness of DGBL can also be considered from a Human–Computer Interaction (HCI) and usability perspective. In digital learning games, interface usability, age-appropriate navigation, immediate feedback, learner control, accessibility, visual representation, and cognitive load can affect children's interaction with the learning system. Research on educational-game usability emphasises the importance of learnability, ease of use, enjoyment, and children's ability to understand and interact with interfaces.. Accordingly, these HCI and usability characteristics should be treated as design and implementation factors rather than as direct evidence of CT development. Previous studies have reported positive educational outcomes associated with DGBL, including improvements in computational thinking, problem-solving, learning motivation, creativity, and engagement. However, findings remain heterogeneous because studies employ diverse research designs, intervention durations, participant characteristics, digital game types, and assessment instruments. Moreover, teacher digital competence, technological infrastructure, instructional support, and game quality have been identified as contextual factors influencing implementation success. These inconsistencies indicate that the current evidence base requires comprehensive synthesis.

Although several literature reviews have discussed game-based learning or computational thinking separately, few reviews have specifically synthesized evidence concerning digital game-based learning for computational thinking development among elementary school students while simultaneously examining implementation conditions, supporting factors, constraining factors, and research gaps. Existing reviews also vary considerably regarding their inclusion criteria, conceptual definitions of DGBL, and synthesis approaches, making it difficult to establish a comprehensive understanding of current evidence. Accordingly, this study conducts a Systematic Literature Review (SLR) following the PRISMA framework to synthesize recent evidence on digital game-based learning for computational thinking development in elementary education. Beyond summarizing research findings, this review identifies publication trends, categorizes intervention characteristics, examines enabling and constraining factors influencing implementation, and highlights directions for future research.

To achieve these objectives, the review addresses the following research questions:

RQ1 What are the publication trends and research characteristics of Digital Game-Based Learning (DGBL) studies addressing Computational Thinking (CT) among elementary school students?

RQ2 What Computational Thinking outcomes have been reported in elementary school students participating in Digital Game-Based Learning interventions, and what evidence supports these outcomes?

RQ3 What enabling and constraining factors influence the implementation of Digital Game-Based Learning for Computational Thinking in elementary education?

RQ4 What research gaps and future research directions emerge from the existing evidence on Digital Game-Based Learning and Computational Thinking among elementary school students?

METHOD

Research Design

This study employed a Systematic Literature Review (SLR) to synthesise empirical evidence concerning the use of Digital Game-Based Learning (DGBL) to support Computational Thinking (CT) among elementary or primary school students. The review process was structured according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework (Page et al., 2021). The review comprised four sequential stages: identification, screening, eligibility assessment, and inclusion. The review focused on studies published between 2021 and 2026.

Search Strategy

The literature search was conducted using three academic databases: Scopus, ScienceDirect, and Google Scholar. These sources were selected to provide broad coverage of peer-reviewed literature in educational technology, computer science education, digital learning, and elementary education. The search strategy combined three conceptual domains: Digital Game-Based Learning, Computational Thinking, and elementary education. The DGBL search terms included "digital game-based learning," "game-based learning," "educational games," "serious games," "digital games," "coding games," "programming games," "educational videogames," "Scratch," and "Blockly." The CT search terms included "computational thinking," "computational thinking skills," "algorithmic thinking," "decomposition," "abstraction," "debugging," and "problem solving." The education-related terms included "primary school," "elementary school," "primary education," and "elementary education."

Boolean operators AND and OR were used to combine the search concepts. The search strategy was adapted to the characteristics of each database rather than applying an identical search string to all databases. Searches were conducted within the 2021–2026 publication period and were restricted to English-language journal articles with accessible full texts. The search identified 521 records across the three databases. All retrieved records were consolidated into a single screening dataset before duplicate removal. The database-specific search terms and retrieved records were documented as part of the review audit trail to support transparency and reproducibility.

Eligibility Criteria

Eligibility was determined using three mandatory dimensions: population, intervention, and outcome. A study was eligible only when all three dimensions were satisfied. First, the population criterion required participants to be elementary or primary school students. Studies involving early childhood, kindergarten, secondary school, university students, teachers, or other populations were excluded unless the elementary-school participants constituted a clearly identifiable population for which the relevant outcome was separately reported. Second, the intervention criterion required genuine Digital Game-Based Learning. DGBL was defined as the intentional integration of an interactive digital game into the learning process to achieve an educational objective. Studies involving only non-digital board games, unplugged activities, conventional game-based learning, general digital learning media, digital teaching materials, or programming activities without an integral digital game were excluded.

Third, the outcome criterion required the direct assessment of Computational Thinking or one or more explicitly identified CT competencies. Studies reporting only creativity, critical thinking, mathematical thinking, academic achievement, motivation, engagement, technological competence, or general problem-solving were not treated as direct evidence of CT development unless CT was explicitly measured or assessed. Studies were also excluded when the digital game

was merely the product created by students rather than the intervention through which learning was delivered. This distinction was applied to separate digital game-based learning from game-development or programming activities.

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Topic	Studies examining Digital Game-Based Learning (DGBL) in relation to Computational Thinking (CT) development.	Studies that do not examine DGBL or do not address Computational Thinking.
Population	Elementary or primary school students.	Early childhood/kindergarten students, junior or middle school students, senior or high school students, university students, teachers, or other populations without a relevant elementary-school student sample.
Intervention	Interactive digital games intentionally used as part of the learning process to support educational objectives.	Non-digital board games, unplugged activities, conventional game-based learning, general digital media, digital teaching materials, or game-creation activities without a complete digital game-based learning intervention.
Outcome	Computational Thinking or explicitly identified CT competencies measured or assessed in the study.	Studies measuring only creativity, critical thinking, mathematical thinking, academic achievement, chemistry learning, cultural identity, technological competence, motivation, engagement, or general problem-solving without a direct CT outcome.
Publication Type	Peer-reviewed journal articles.	Conference proceedings, books, reports, news articles, blogs, opinion pieces, theses, or other non-journal publications.
Language	Articles published in English.	Articles published in languages other than English.
Accessibility	Full-text article available for eligibility assessment and data extraction.	Full text unavailable after reasonable retrieval attempts.
Publication Period	Studies published within the predetermined review period.	Studies published outside the predetermined review period.

Computational Thinking Framework

Computational Thinking was operationalised using the framework proposed by Shute, Sun, and Asbell-Clarke (2017). The framework conceptualises CT as a problem-solving process involving six major facets: decomposition, abstraction, algorithm design, debugging, iteration, and generalisation.

Study Selection

Study selection was conducted through four sequential stages: identification, duplicate removal, title and abstract screening, and full-text eligibility assessment. The 521 retrieved records were first consolidated into a single screening dataset. After duplicate removal, 435 unique records remained for title and abstract screening. At the title and abstract stage, records were assessed against the predefined population, intervention, and outcome criteria. Records that appeared potentially relevant were retained for full-text assessment. During full-text assessment, each study was examined against the three mandatory eligibility dimensions: elementary or primary school population, genuine Digital Game-Based Learning intervention, and direct Computational Thinking outcome.

A study was excluded when any mandatory eligibility criterion was not satisfied. Particular attention was given to studies using broad terms such as game-based learning, programming education, coding, digital learning, or educational technology because these terms alone were insufficient to establish eligibility as DGBL for CT development. Studies involving secondary or higher-education populations, teacher populations, non-digital games, unplugged activities, general digital learning media, programming education without an integral digital game, or outcomes unrelated to directly assessed CT were excluded. Studies in which students created a digital game but the game itself was not used as an integral learning intervention were also excluded. The final evidence pool was established only after completion of full-text eligibility assessment. Consequently, studies that were considered potentially relevant during the initial screening were not treated as included evidence. Only studies satisfying all predefined eligibility criteria were eligible for methodological appraisal, data extraction, and synthesis. The screening process was documented using a PRISMA 2020 flow diagram. Reasons for full-text exclusion were recorded at the study level to maintain an auditable selection process.

Quality Appraisal

The methodological quality of eligible studies was assessed using the Mixed Methods Appraisal Tool (MMAT), version 2018 (Hong et al., 2018). MMAT was selected because the evidence base included studies employing different quantitative, qualitative, and mixed-methods designs. The appraisal was conducted after completion of the full-text eligibility assessment and before evidence synthesis. Each eligible study was assigned to the MMAT category corresponding to its methodological design. The assessment considered the appropriateness of the research design, sampling strategy, measurement procedures, completeness of outcome data, and coherence between the research questions, methods, and reported findings.

Each MMAT criterion was recorded as “Yes,” “No,” or “Can’t tell.” The appraisal was used to evaluate the methodological strength and transparency of the evidence rather than as an automatic exclusion mechanism. Studies with methodological limitations could therefore remain in the evidence base, but such limitations were considered when interpreting their findings. The methodological appraisal was also used to distinguish stronger evidence from studies with important design or reporting limitations. Study-level appraisal findings were incorporated into the evidence extraction table so that methodological quality could be considered alongside intervention characteristics, CT outcomes, and reported findings.

PRISMA Screening Process

The literature search identified 521 records across Scopus, ScienceDirect, and Google Scholar. After the removal of 86 duplicate records, 435 unique records remained for title and abstract screening. Of these, 349 records were excluded because they did not satisfy the preliminary relevance criteria, resulting in 86 records for full-text assessment. At the full-text stage, eligibility was reassessed using the predefined population, intervention, and outcome criteria. Particular attention was given to whether the study population consisted of elementary or primary school students, whether the intervention represented genuine Digital Game-Based Learning, and whether Computational Thinking was directly assessed. Studies that failed any of these criteria were excluded and assigned a specific reason for exclusion. The final number of included studies was determined only after completion of the full-text verification. Consequently, the final evidence pool does not represent the number of studies initially identified as potentially relevant, but only those studies that fulfilled all inclusion criteria.

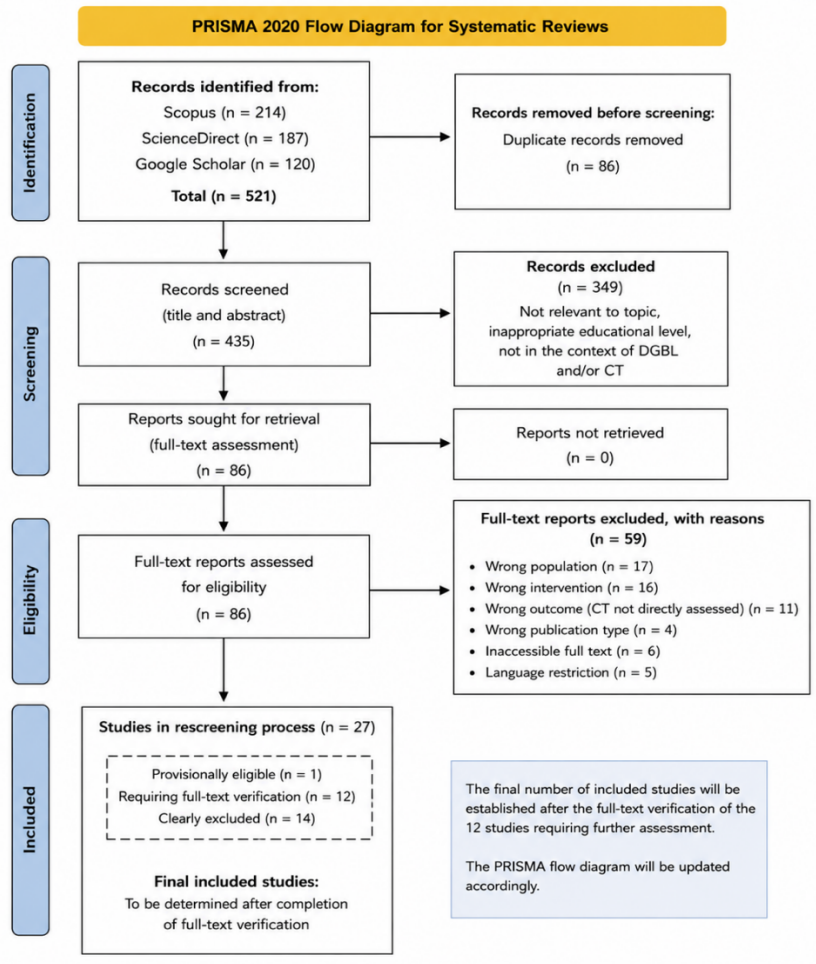


Figure 1. PRISMA Flow Diagram

Data Extraction

Data were systematically extracted from each study that satisfied the final eligibility criteria. The extraction variables included author and publication year, country, educational level, participant characteristics, sample size, research design, type of digital game, digital platform, intervention duration, comparison condition, CT construct or competency, CT assessment instrument, principal findings, statistical significance or effect size when available, methodological quality, and study limitations. The extraction process also distinguished direct CT outcomes from related educational outcomes. Motivation, engagement, usability, feasibility, teacher competence, implementation experience, and general academic achievement were recorded when reported but were not classified as direct evidence of CT development.

Data Synthesis

Because substantial methodological and intervention heterogeneity was anticipated, the evidence was synthesised thematically rather than through statistical meta-analysis. The synthesis proceeded through four stages. First, the characteristics and findings of each eligible study were summarised. Second, recurring concepts were coded according to the research questions and CT framework. Third, related codes were grouped into descriptive themes. Finally, the themes were interpreted to identify broader patterns concerning DGBL implementation, CT development, supporting conditions, constraints, and research gaps. Direct CT evidence was synthesised separately from indirect outcomes. Findings related to motivation, engagement, usability, feasibility, teacher experience, or implementation were not interpreted as evidence of CT effectiveness unless the corresponding study also directly assessed CT. The synthesis also

considered differences in intervention design, game type, duration, instructional integration, participant characteristics, CT constructs, assessment instruments, and research design. Therefore, findings were interpreted comparatively rather than assuming that all DGBL interventions produced equivalent outcomes.

RESULTS AND DISCUSSION

Study Identification and Screening

The systematic search identified 521 records across Scopus, ScienceDirect, and Google Scholar. After the removal of 86 duplicate records, 435 unique records remained for title and abstract screening. At this stage, 349 records were excluded because they did not meet the preliminary relevance criteria, leaving 86 records for full-text assessment. The full-text assessment revealed substantial differences between studies that appeared relevant during the initial screening and studies that satisfied the operational eligibility criteria. The final evidence pool must be based exclusively on studies whose full-text eligibility was verified against all three mandatory criteria: elementary/primary population, genuine DGBL intervention, and direct CT outcome.

The full-text assessment therefore served as the decisive stage for determining eligibility. Studies were retained only when the population, intervention, and outcome criteria were simultaneously satisfied. The initial set of potentially relevant studies was consequently reduced after the application of the stricter eligibility criteria. Several studies initially classified as potentially relevant were subsequently excluded. For example, studies involving Scratch or programming were excluded when programming activities did not constitute an integral digital game-based learning intervention. Studies involving board games or hybrid activities were excluded when the digital component did not constitute the central game-based learning intervention. Studies involving CT-related terminology were also excluded when CT was not directly assessed as an outcome. The final PRISMA flow therefore distinguishes clearly between records identified during searching, records screened at title and abstract level, records assessed through full text, and studies that satisfied the final eligibility criteria. Only the latter group constituted the evidence base for the synthesis. The final study count should be reported only after all records marked as provisional or requiring verification in Table 2 have received a documented full-text decision.

Full-Text Eligibility Assessment

The full-text assessment identified four principal categories of exclusion. The first concerned population, particularly studies involving secondary school, higher education, teachers, or mixed educational populations for which elementary-school outcomes could not be separately established. The second concerned intervention, particularly studies involving programming instruction, digital learning media, board games, unplugged activities, or game creation without an integral digital game-based learning intervention. The third category concerned outcomes. Several studies assessed learning achievement, critical thinking, mathematical thinking, motivation, engagement, or other educational outcomes without directly measuring Computational Thinking. Such studies were not classified as direct evidence of CT development.

The fourth category concerned the conceptual alignment between the intervention and the review definition of DGBL. The presence of a digital platform, coding activity, or game-like element alone was not sufficient for inclusion. The digital game had to function as an integral component of the learning intervention. This screening procedure resulted in a more focused evidence base than the initial pool of potentially relevant records. The full-text screening decisions and reasons for exclusion are documented in Table 2.

Table 2. Full-Text Eligibility Assessment and Reasons for Exclusion

Study	Population	Intervention	CT Outcome	Final Decision	Reason/Notes
Rati & Esaputra (2025)	Elementary	Coding platform; DGBL not established	CT	Exclude	Intervention does not clearly constitute DGBL
Wang et al. (2026)	Primary	Coding education/Scratch	CT	Exclude	Intervention does not meet the predefined DGBL criterion
Berlian et al. (2024)	Primary	Scratch-based e-module	CT	Exclude	Digital learning material rather than genuine DGBL
Muhammadi et al. (2026)	Elementary	Interactive multimedia	CT	Exclude	Interactive multimedia rather than a genuine DGBL intervention.
Chen et al. (2023)	Primary	CT learning/self-regulation	CT	Exclude	Intervention does not constitute genuine DGBL
Jhang et al. (2025)	Elementary	Hybrid digital–physical board game	CT	Exclude	Although the hybrid game involves elementary students, CT is not a measured outcome.
Regli et al. (2026)	Secondary/teachers	Not aligned	Not applicable	Exclude	Population is secondary-school teachers; outside the review population.
Mardhatillah et al. (2026)	Primary	Digitally mediated PBL	CT	Verify full text	Need to verify whether the intervention qualifies as DGBL
Panskyi & Rowińska (2021)	Primary	Digital Game-Based Learning	CT/programming	Verify full text	DGBL and primary-school context are reported, but the K4–K10 population and direct CT outcome require final eligibility verification.
Wing (2006)	K–12	Kodetu maze programming game	CT-related	Verify full text	Population and CT outcome require verification
Wulandari et al. (2024)	Secondary	Digital game/Scratch	CT	Exclude	Population does not match the eligibility criteria
Redondo-Duarte et al. (2026)	University/teachers	Not aligned	Not applicable	Exclude	Population is university students/teachers; outside the review population.

Nurhaliza et al. (2026)	High school	Android-based learning media	CT	Exclude	Population is high school; does not meet elementary-school criterion.
Ningtyas et al. (2024)	Early childhood	Game-based learning	CT/problem-solving	Exclude	Population is outside the elementary-school criterion
Chen et al. (2024)	Primary	Game-creation course	CT not directly established	Exclude	CT was not directly assessed as an outcome
Ilmiyati et al. (2024)	Requires verification	Board game	Requires verification	Exclude	Intervention and outcome are insufficiently aligned
Firdaus et al. (2024)	Elementary	AR teaching material	Critical thinking, not CT	Exclude	Outcome does not directly assess CT
Abidin et al. (2023)	Requires verification	Android application	Mathematical thinking, not CT	Exclude	Outcome does not directly assess CT
Zhang et al. (2023)	Children	Game-based; digital status requires verification	CT	Exclude	Game-based intervention is a board game; it does not meet the digital-game intervention criterion.
Dagienė et al. (2021)	Requires verification	Game/programming-related	CT	Verify full text	Population and intervention characteristics require verification
Yoon & Khambari (2022)	Elementary	Unplugged board game	CT	Exclude	Intervention is an unplugged, non-digital board game.
Hongquan et al. (2021)	Middle school	Programming/game-related	CT	Exclude	Population does not match the elementary-school criterion
Nurhopipah et al. (2021)	Children	Programming project	CT-related	Verify full text	Need to verify whether the intervention constitutes DGBL and whether CT is directly assessed
Hamid et al. (2022)	Requires verification	Non-digital game-based learning	Not sufficiently aligned	Exclude	Intervention does not meet the DGBL criterion
Sukkamart et al. (2024)	Middle school	Blended/PBL	CT	Exclude	Population does not match the elementary-school criterion

Characteristics of the Evidence Base

The eligible evidence was characterised according to publication year, geographical context, educational level, participant characteristics, research design, type of digital game, digital platform, intervention duration, comparison condition, CT construct, CT assessment instrument, principal findings, and methodological quality. The reviewed literature demonstrated considerable diversity in the forms of digital games and learning environments used to address computationally oriented learning. Some studies employed block-based or programming-oriented digital environments, whereas others used interactive game structures to embed computational problem-solving tasks. This diversity indicates that DGBL should not be treated as a single homogeneous intervention. The CT outcomes were also heterogeneous. The reviewed studies addressed different aspects of computational reasoning, including algorithmic processes, decomposition, abstraction, debugging, iteration, and related problem-solving processes. However, the terminology and measurement approaches varied considerably between studies. This variation supports the use of an explicit CT framework during synthesis.

Methodological Quality

The methodological quality of eligible studies was assessed using MMAT 2018 (Hong et al., 2018). The appraisal considered the appropriateness of research design, sampling, measurement, outcome reporting, and consistency between research questions and methods. The appraisal indicated variation in methodological reporting across the evidence base. Some studies provided clear descriptions of participants, intervention procedures, and outcome measures, whereas others provided less detailed information concerning sampling, intervention duration, or CT assessment procedures. These differences were considered when interpreting the findings. Methodological quality was therefore treated as an interpretive dimension rather than as a basis for automatically excluding studies. Evidence from studies with clearer designs and more transparent CT measurement procedures was given greater interpretive weight than findings supported by limited methodological information.

Computational Thinking Outcomes

The thematic synthesis focused specifically on evidence in which Computational Thinking was directly assessed. The findings were organised according to the CT framework comprising decomposition, abstraction, algorithm design, debugging, iteration, and generalisation. Across the evidence base, DGBL was associated with learning experiences that required students to analyse problems, formulate sequences of actions, test possible solutions, identify errors, and revise their strategies. These processes correspond closely to the computational practices represented in the CT framework. However, the findings did not support the assumption that all digital game-based interventions contribute equally to CT development. Differences in game mechanics, instructional objectives, scaffolding, intervention duration, and CT assessment influenced the reported outcomes. Consequently, the contribution of DGBL to CT should be understood as conditional on how computational processes are embedded within the learning activity.

Supporting and Contextual Factors

The synthesis also identified several contextual factors that may influence the implementation of DGBL. These included the alignment between game mechanics and learning objectives, the clarity of instructional guidance, the accessibility of the digital platform, teacher support, and the level of challenge presented to students. Motivation and engagement were frequently discussed as potential supporting mechanisms of game-based learning. However, these outcomes were treated as contextual or indirect evidence rather than as direct indicators of CT development. A more engaging learning environment does not necessarily demonstrate an improvement in CT unless CT is explicitly assessed. The evidence therefore suggests that effective DGBL for CT requires more than the incorporation of game elements into digital learning. The

computational processes embedded within gameplay and their alignment with explicit learning objectives are central to the pedagogical value of the intervention.

Discussion

Digital game-based learning (DGBL) exhibits substantial potential for cultivating computational thinking (CT) skills among elementary school students. A notable upward trend in research interest in DGBL for CT skills in elementary education has emerged, particularly evident in the increasing number of publications in recent years (e.g., 8 articles in 2024, 6 projected for 2026). This surge suggests a growing recognition of DGBL's capacity to enhance learning outcomes (RQ1), with studies consistently highlighting DGBL's capacity to significantly improve various cognitive and skill-based learning outcomes for elementary school students (RQ2). The evidence synthesis should include only studies that satisfy the final eligibility criteria. Accordingly, studies classified as excluded or requiring verification in Table 2 are not used here as evidence of DGBL effectiveness. Once the final eligible study set is confirmed, the synthesis should report CT outcomes according to the six facets in the adopted framework and distinguish direct CT findings from indirect outcomes such as motivation, engagement, usability, and academic achievement.

The reviewed literature also indicates that engagement-related characteristics may be relevant to DGBL implementation, but they should not be interpreted as direct evidence of CT improvement unless CT is explicitly assessed in the eligible study. Therefore, claims about motivation, engagement, usability, or self-efficacy should be reported as contextual findings and linked only to studies retained in the final evidence pool. Implementation conditions should likewise be synthesised only from eligible studies. Factors such as teacher preparedness, technological infrastructure, instructional support, accessibility, and alignment between game mechanics and learning objectives may be discussed when they are directly reported by the included evidence. Studies excluded because of population, intervention, or outcome mismatch should not be used to substantiate these claims.

Despite the observed effectiveness, inconsistencies exist in reported outcomes across various studies. These discrepancies often stem from variations in game design quality, teacher training, and contextual factors. The positive impact on motivation and engagement appears consistent, yet its translation into specific cognitive gains can vary depending on the game's alignment with learning objectives and the instructional scaffolding provided. Bridging the gap between effective game design principles and practical classroom implementation represents a key area for development, ensuring DGBL's full potential is realized. Future research should focus on strengthening the evidence base through clearly defined DGBL interventions, explicit CT outcomes, elementary-school populations, and transparent reporting of intervention duration and assessment procedures. Research should also examine long-term retention and transfer of CT competencies, as well as the role of instructional scaffolding, teacher support, and game design. These directions should be derived from limitations and gaps documented in the final eligible evidence rather than from studies excluded during screening.

CONCLUSIONS

This systematic literature review examined empirical evidence concerning Digital Game-Based Learning and Computational Thinking among elementary and primary school students. The review demonstrates that DGBL can provide meaningful learning environments for computational processes when digital gameplay is intentionally aligned with computational learning objectives. The evidence does not, however, support the conclusion that all forms of DGBL are equally effective for developing Computational Thinking. The contribution of digital games depends on the characteristics of the game, the instructional design, the computational processes embedded within gameplay, the duration of the intervention, the quality of instructional scaffolding, and the methods used to assess CT.

A major finding of this review is the importance of distinguishing direct CT evidence from related educational outcomes. Motivation, engagement, usability, feasibility, and general academic achievement may support the implementation of digital game-based learning, but these outcomes should not be interpreted as direct evidence of CT development unless CT is explicitly assessed. The review also identifies considerable variation in the conceptualisation and measurement of Computational Thinking. Future research should therefore adopt clearer theoretical frameworks, explicitly identify the CT competencies targeted by DGBL interventions, and employ transparent and theoretically grounded assessment procedures. Future studies should also use stronger comparative and longitudinal research designs, provide detailed descriptions of digital game mechanics and instructional integration, and investigate the retention and transfer of CT competencies beyond the game environment. Such approaches would strengthen the evidence base and provide more precise guidance for teachers and educational technology developers seeking to integrate DGBL into elementary CT education.

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AUTHOR CONTRIBUTION STATEMENT

Ani Setiawati contributed to the conceptualization, methodology, literature search, data screening, data curation, formal analysis, and writing of the original draft. Decky Avrilianda contributed to supervision, validation, and writing through review and editing. Both authors reviewed and approved the final version of the manuscript.

AI DISCLOSURE STATEMENT

Generative artificial intelligence (AI) tools were used during the preparation of this manuscript to assist with language refinement, manuscript organization, and identification of areas requiring clarification. AI tools were not used to generate, fabricate, or alter the empirical evidence, study selection decisions, extracted data, statistical findings, or conclusions of the systematic review. All methodological decisions, eligibility assessments, data interpretation, and final content were reviewed and verified by the authors, who take full responsibility for the accuracy and integrity of the manuscript.

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