Jurnal Review Pendidikan Dasar:
Jurnal Kajian Pendidikan dan Hasil Penelitian
Vol 12(1), Februari 2026

e-ISSN: 2460-8475
http://journal.unesa.ac.id/index.php/PD
https://doi.org/10.26740/jrpd.v12n1.p59-68

Integrating Computational Thinking into Natural and Social Science Learning in Elementary Education

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Abstract: Computational thinking (CT) has been proposed as a way to strengthen problem solving in school curricula, yet evidence on its integration into integrated natural and social science learning in elementary education remains dispersed, and this study aims to examine how CT has been conceptualized and integrated, what evidence exists on its association with problem-solving skills, which implementation strategies have been reported, and which challenges and opportunities have been identified. A narrative literature review was conducted on 23 peer-reviewed articles from Scopus-indexed journals published between 2006 and 2024, covering conceptual papers, systematic reviews, meta-analyses, and empirical studies. The results show that CT is commonly framed as a set of problem-solving practices embedded in science and mathematics contexts, that meta-analytic evidence reports moderate to large effects on CT and related cognitive outcomes with variation across educational levels, strategies, and measures, and that direct evidence on problem solving in elementary natural and social science learning remains limited, with social science represented in only 2 of 49 studies in one review. Unplugged, plugged, and combined strategies have been reported alongside recurring challenges in teacher readiness, assessment for young learners, and resources, which suggests that CT integration is a promising approach that requires further testing with explicit measures of problem solving.

Keywords: computational thinking; problem-solving skills; elementary education; natural and social science learning; unplugged activities.

How to Cite: Roosyanti, A., & Larasati, D.A. (2026). Integrating Computational Thinking into Natural and Social Science Learning in Elementary Education. *Jurnal Review Pendidikan Dasar: Jurnal Kajian Pendidikan dan Hasil Penelitian, 12*(1), 59-68. https://doi.org/10.26740/jrpd.v12n1.p59-68

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Article Information:
Received: December, 2025; Accepted: February 18, 2026; Published online: February 28, 2026

Published by:
Elementary Education, State University of Surabaya

INTRODUCTION

Computational thinking (CT) has attracted sustained attention in education since Wing (2006) described it as a way of solving problems, designing systems, and understanding human behavior by drawing on concepts fundamental to computer science. This description positioned CT as a skill relevant to everyone, which opened the way for its discussion in school curricula. Grover and Pea (2013) reviewed the state of the field of CT in K-12 education at an early stage of this discussion. Shute et al. (2017) later reported that definitions, interventions, assessments, and models of CT were diverse, and they described CT mainly as a way of thinking and acting that can be observed through particular skills.

Research has examined how computational thinking (CT) can be integrated into science and mathematics learning. Weintrop et al. (2016) proposed a taxonomy of CT practices for mathematics and science classrooms, while Sengupta et al. (2013) developed a theoretical framework for integrating CT into K-12 science through agent-based computation, highlighting modeling and abstraction as practices relevant to scientific disciplines. In elementary education, Waterman et al. (2020) examined CT activities in science and mathematics curriculum modules, while Cabrera et al. (2023) developed a framework to support teachers' integration of CT into elementary science. In Indonesia, *Ilmu Pengetahuan Alam dan Sosial* (IPAS: Natural and Social Sciences), introduced through the *Kurikulum Merdeka* (Merdeka Curriculum), provides a context for examining CT integration across natural and social science content.

Previous syntheses have reported positive transfer effects associated with CT instruction. Ye et al. (2022) reviewed 55 empirical studies and reported generally significant transfer of CT skills to other subject areas. Li and Oon (2024) analyzed 37 studies involving 7,832 students and found a moderate overall CT-STEM transfer effect, moderated by educational level, sample size, instructional strategy, and intervention duration. Scherer et al. (2019) synthesized 105 studies on computer programming and reported a moderate overall transfer effect ($g = 0.49$), with larger effects in studies using untreated rather than active control groups. These findings primarily concern CT skills and broader transfer outcomes.

Existing syntheses have primarily examined CT in computer science, STEM, mathematics, and broader educational settings. Chen et al. (2023) reported that only two of the 49 studies in their review of unplugged activities focused on social science. Merino-Armero et al. (2022b) examined an unplugged CT intervention involving 14 sixth-grade students in social science and found increased CT without significant differences in academic achievement. Yeni et al. (2024) mapped CT integration across K-12 subjects, including integration levels and instructional strategies. Collectively, these studies document cross-curricular implementation, while the association between CT integration and explicitly measured problem-solving skills in elementary natural and social science learning warrants further empirical investigation.

This study synthesizes evidence from Scopus-indexed publications on CT integration in elementary natural and social science learning, focusing on conceptualization, problem-solving outcomes, implementation strategies, and implementation challenges. It examines whether and how CT integration is associated with problem-solving skills and identifies conditions that may influence implementation. To achieve this aim, the review addresses four research questions: 1) How has CT been conceptualized in relation to problem solving and to natural and social science learning in elementary education? 2) What evidence exists regarding the association between CT integration and students' problem-solving skills? 3) Which implementation approaches and strategies, including plugged, unplugged, and combined approaches, have been reported for elementary learning? 4) What challenges and opportunities have been identified for implementing CT in elementary natural and social science learning?

METHODS

Research Design

This study used a narrative literature review to synthesize conceptual frameworks, systematic reviews, meta-analyses, and empirical studies on CT in elementary education. A narrative approach was appropriate because the included sources differed in research objectives, designs, and outcome measures. No new pooled effect size was calculated; reported effects were taken from the original sources.

The review included peer-reviewed English-language articles published in Scopus-indexed journals between 2006 and 2024. Searches combined terms related to computational thinking (CT), elementary education, science and social science, instructional approaches, problem-solving, teaching, and assessment. Bibliographic details and DOIs were verified against publisher or repository records, while eligibility was determined by source type, indexing, publication period, language, topic relevance, and DOI availability. The review followed identification, verification, screening, corpus formation, and thematic synthesis (Figure 1), resulting in 23 articles: three conceptual or theoretical papers, 13 reviews or meta-analyses, and seven empirical or validation studies.

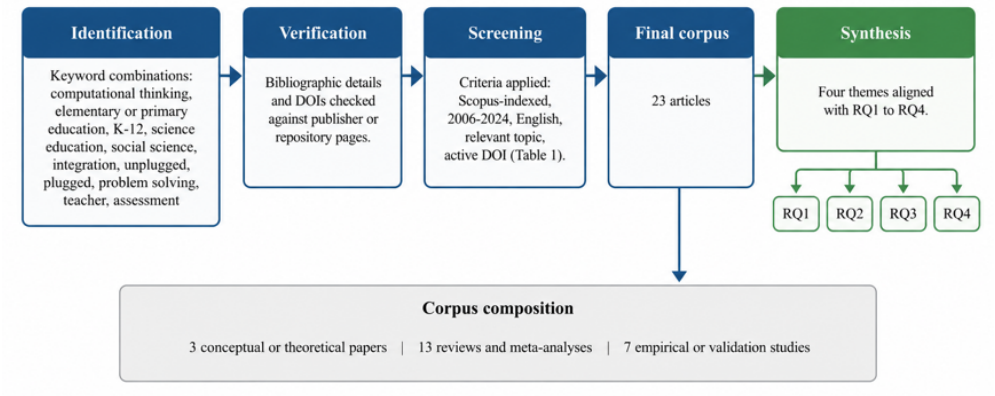


Figure 1. Procedure of the Narrative Literature Review

Data Extraction and Analysis

Data were extracted on study type, educational level, subject context, instructional approach, outcomes, and limitations. Findings were synthesized into four themes aligned with the research questions: CT conceptualization and integration, evidence on problem-solving skills, implementation strategies, and challenges and opportunities. Differences in study designs, samples, and outcome measures were considered during interpretation. Findings from broader K-12 reviews were treated as indicative evidence for elementary education.

RESULTS

Conceptualization of CT and Its Relationship with Problem Solving

The first research question concerns how CT has been conceptualized in relation to problem solving and science learning. Six sources contributed conceptual or review-based accounts that define or frame CT. Table 1 summarizes their contributions and the way each relates to problem solving.

Table 1. Conceptual Contributions on CT and Its Relation to Problem Solving

Source	Conceptual contribution	Relation to problem solving
Wing (2006)	CT as a way of solving problems, designing systems, and understanding human behavior using concepts fundamental to computer science	Problem solving is the central idea of the definition
Grover & Pea (2013)	Review of the state of the field of CT in K-12 education	Provides an early overview of how CT entered school settings
Shute et al. (2017)	Definitions, interventions, assessments, and models vary; CT is a way of thinking and acting shown through particular skills	Skills are the basis for observing CT in performance
Weintrop et al. (2016)	Taxonomy of four categories: data practices, modeling and simulation practices, computational problem solving practices, and systems thinking practices	Problem solving is one of four practice categories
Sengupta et al. (2013)	CT includes practices such as modeling, abstraction, reformulation, simulation, and verification, connected to scientific disciplines	Links CT practices to scientific problem solving through agent-based computation
Scherer et al. (2019)	Discussion of whether programming should be viewed as a form of problem solving	Identifies an ongoing debate on the overlap between the two

Note. CT = computational thinking.

CT Integration in Elementary Natural and Social Science Contexts

Waterman et al. (2020) examined CT integration in elementary science and mathematics modules, while Cabrera et al. (2023) developed a teacher-oriented framework for elementary science. Ye et al. (2023) reviewed 24 studies on CT in K-12 mathematics, and Yeni et al. (2024) mapped interdisciplinary integration across K-12 subjects. In social

science, Merino-Armero et al. (2022b) reported increased CT following an unplugged intervention involving 14 sixth-grade students, without significant differences in academic achievement.

The second part of the results concerns where CT integration research has been conducted. Chen et al. (2023) reported the distribution of 49 reviewed studies by subject and educational level. Figure 2 visualizes these distributions as two bar charts.

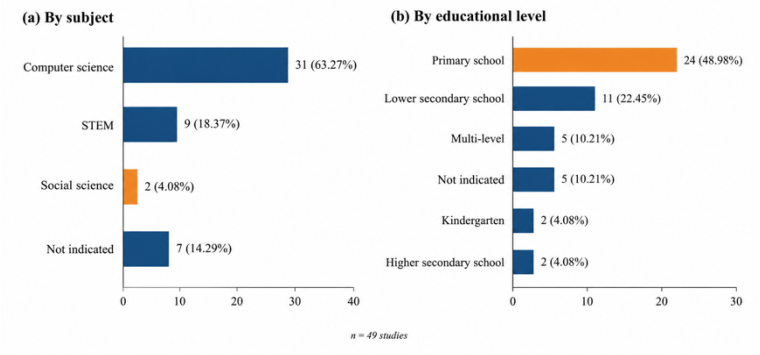


Figure 2. Distribution of 49 Reviewed Studies by Subject and Educational Level

Evidence on Problem-Solving Skills and Related Outcomes

The third part addresses the second research question on the association between CT integration and problem-solving skills. Six sources reported effects of CT-related interventions through systematic reviews, meta-analyses, or an intervention study. Table 2 summarizes the evidence base, the reported effect, and the notes on moderators for each source.

Table 2. Reported Effects of CT Interventions in the Reviewed Sources

Source	Reported effect
Ye et al. (2022)	Generally significant transfer of CT skills to other subject areas
Li & Oon (2024)	Moderate overall transfer; moderate near and far transfer; stronger effect on cognitive than noncognitive benefits
Scherer et al. (2019)	Overall g = 0.49; near transfer g = 0.75; far transfer g = 0.47
Chen et al. (2023)	Overall g = 1.028, 95% CI [0.641, 1.415], p < 0.001
Merino-Armero et al. (2022a)	Programming was the most efficient learning tool among intervention types
Merino-Armero et al. (2022b)	CT increased significantly (d = 1.305) with no differences in academic achievement

Note. g = Hedges's g; d = effect size reported in the original study; CI = confidence interval.

The numerical effect sizes reported in the sources can be compared visually. Figure 3 plots the effect sizes reported by Scherer et al. (2019), Chen et al. (2023), and Merino-Armero et al. (2022b). The figure distinguishes Hedges's g values from the d value because they come from different designs.

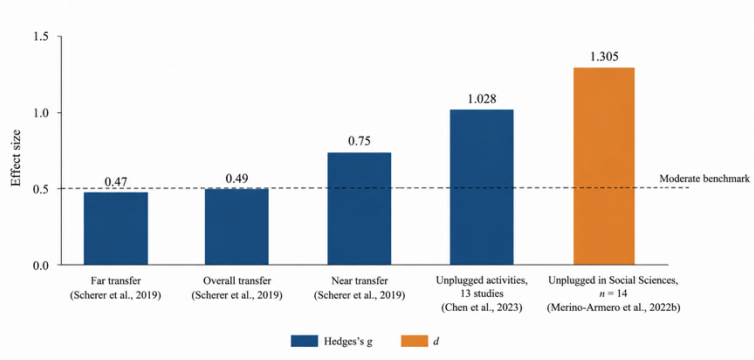


Figure 3. Effect Sizes Reported in Selected Sources

Note. g = Hedges's g; d = effect size reported in the original study. Values come from different outcomes, designs, and samples and are not directly comparable.

Implementation Strategies

The fourth part addresses the third research question on implementation strategies. Sources reported project-based, problem-based, cooperative, and game-based strategies, as well as digital programming, unplugged activities, and sequences that combine unplugged and plugged work. Table 3 summarizes the strategies, the sources that reported them, and the main findings.

Table 3. Implementation Strategies Reported in the Reviewed Sources

Strategy	Source	Key finding
Project-, problem-, cooperative, and game-based learning	Hsu et al. (2018)	Commonly adopted strategies in studies published between 2006 and 2017
Digital programming (plugged)	Merino-Armero et al. (2022a)	Most efficient intervention tool in the reviewed K-12 studies
Unplugged games	Chen et al. (2023)	Board and card games were most common; overall effect g = 1.028
Early-primary unplugged activities	Del Olmo-Muñoz et al. (2020)	Examined CT activities in early primary education
Unplugged social science activities	Merino-Armero et al. (2022b)	CT increased, with no significant difference in academic achievement (n = 14)
Unplugged-to-plugged sequence	Saxena et al. (2020)	Supported pattern recognition, sequencing, and algorithm design
Critical review of unplugged pedagogy	Huang & Looi (2021)	Identified unresolved issues and proposed ten research questions
Teacher-oriented framework	Cabrera et al. (2023)	Developed a framework for CT integration in elementary science

Note. CT = computational thinking.

Challenges and Opportunities

The fifth part addresses the fourth research question on challenges and opportunities. Sources identified challenges related to teachers, assessment, definitions, and resources, as well as opportunities linked to integration into existing subjects and low-cost unplugged activities. Table 4 groups these findings by theme.

Table 4. Challenges and Opportunities Identified in the Reviewed Sources

Theme	Source	Key finding	Type
Teacher readiness	Liu et al. (2024)	Teachers face challenges integrating CT into classroom learning.	Challenge
Teacher implementation	Cabrera et al. (2023)	Implementation by elementary teachers influences CT integration in science lessons.	Challenge and opportunity
Assessment for young learners	Relkin et al. (2020)	Developmentally appropriate assessments, such as TechCheck, are needed.	Challenge and opportunity
Measurement validity	Román-González et al. (2017)	Examined CT Test criterion validity against other cognitive abilities.	Challenge
Assessment research	Tang et al. (2020)	Reviewed empirical research on CT assessment.	Challenge
Definitional variability	Shute et al. (2017)	CT definitions, interventions, assessments, and models vary.	Challenge
Resource conditions	Chen et al. (2023)	Unplugged activities offer a low-cost approach to CT learning.	Opportunity
Equity and cost	Merino-Armero et al. (2022b)	Unplugged activities provide a cost-effective, inclusive approach.	Opportunity
Subject integration	Yeni et al. (2024)	Mapped subjects, integration levels, teaching strategies, and assessment approaches.	Opportunity

Note. CT = computational thinking.

DISCUSSION

CT Integration and Problem-Solving Skills

The reviewed literature reports positive effects of computational thinking (CT) instruction on CT skills and related cognitive outcomes, but direct evidence of its effects on problem-solving in elementary natural and social science remains limited. Weintrop et al. (2016) included computational problem-solving practices in their CT taxonomy, while Sengupta et al. (2013) linked modeling and abstraction to scientific work. Studies by Ye et al. (2022) and Li and Oon (2024) suggest potential transfer benefits, although Scherer et al. (2019) found stronger near-transfer than far-transfer effects and emphasized the influence of comparison conditions. Chen et al. (2023) reported positive effects of unplugged activities on CT, but differences in samples, outcomes, and study designs limit cross-study comparisons. Further research should assess problem-solving directly through tasks requiring students to decompose environmental or social problems into manageable questions.

Unplugged, Plugged, and Combined Approaches

The literature supports both digital and non-digital CT instruction, although outcomes vary across interventions and contexts. Merino-Armero et al. (2022a) identified programming as the most efficient intervention, whereas Chen et al. (2023) reported positive effects of unplugged activities, and Huang and Looi (2021) identified unresolved questions about unplugged pedagogy. Saxena et al. (2020) introduced concrete

experiences and vocabulary through unplugged activities before digital tasks, but their preschool study cannot be directly generalized to elementary natural and social science learning. Given limited comparative evidence, schools with restricted technological resources could begin with non-digital science and social topics before introducing digital simulations or programming, consistent with resource considerations discussed by Chen et al. (2023) and Merino-Armero et al. (2022b). Design-based or quasi-experimental studies should test whether combined approaches improve problem-solving in Indonesian IPAS classrooms.

Teacher Readiness, Assessment, and Resources

Teacher readiness is central to CT integration, as emphasized by Cabrera et al. (2023), while Liu et al. (2024) reported challenges in classroom implementation. Professional development should help teachers connect CT practices with disciplinary content and lesson objectives, with the applicability of findings from other contexts to Indonesian elementary classrooms examined empirically. Assessment requires equal attention: Relkin et al. (2020) highlighted the need for developmentally appropriate instruments, Román-González et al. (2017) examined the criterion validity of the CT Test against other cognitive abilities, and Tang et al. (2020) systematically reviewed empirical CT assessment research. These findings underscore the need to select age-appropriate instruments and report validity evidence for the target population.

Integration across Natural and Social Science

The reviewed literature focuses mainly on computer science, STEM, and mathematics, with less attention to social science learning. Chen et al. (2023) found few social science studies, while Ye et al. (2023) noted that mathematics studies often did not explain how CT supports subject learning. Merino-Armero et al. (2022b) reported improved CT among sixth-grade students following a social science intervention but no significant difference in academic achievement, with the small sample limiting interpretation. In Indonesian IPAS, CT could structure problem-solving across natural and social science through tasks involving problem decomposition, pattern identification in simple data, and the sequencing of solutions. Empirical studies are needed to establish whether these activities improve problem-solving performance in both domains.

Limitations

This narrative review did not include a formal risk-of-bias assessment and was restricted to English-language articles in Scopus-indexed journals, excluding Indonesian studies published in national journals. Several included reviews covered K–12 education broadly, and effect sizes from different outcomes and study designs are not directly comparable. The corpus also contained few primary empirical studies on CT integration in elementary natural and social science, reflecting the limited evidence currently available in this area.

CONCLUSION

CT is commonly framed as problem-solving practices integrated into science and mathematics, although definitions vary. Meta-analyses report moderate to large effects

on CT and related cognitive outcomes, but evidence on problem solving in elementary IPAS remains limited. Plugged, unplugged, and combined approaches have been explored, but their comparative effectiveness requires further testing. Key challenges include teacher readiness, age-appropriate assessment, and limited resources, while subject integration and low-cost activities offer opportunities. Future studies should compare these approaches using validated instruments, clear control conditions, and quasi-experimental or design-based methods.

AI Use Statement

The authors used AI tools, if applicable, for language editing and proofreading. The authors take full responsibility for the manuscript's content.

Author Contributions

AR: contributed to conceptualization, literature review, data synthesis, and manuscript drafting. DAL: contributed to literature analysis and manuscript revision. All authors approved the final manuscript.

Funding Statement

This research received no specific funding from public, commercial, or nonprofit funding agencies.

Conflict of Interest

The authors declare no conflict of interest.

REFERENCES

Cabrera, L., Ketelhut, D. J., Mills, K., Killen, H., Coenraad, M., Byrne, V. L., & Plane, J. D. (2023). Designing a framework for teachers' integration of computational thinking into elementary science. *Journal of Research in Science Teaching*. Advance online publication. https://doi.org/10.1002/tea.21888

Chen, P., Yang, D., Metwally, A. H. S., Lavonen, J., & Wang, X. (2023). Fostering computational thinking through unplugged activities: A systematic literature review and meta-analysis. *International Journal of STEM Education, 10*(1), 1-25. https://doi.org/10.1186/s40594-023-00434-7

Del Olmo-Muñoz, J., Cózar-Gutiérrez, R., & González-Calero, J. A. (2020). Computational thinking through unplugged activities in early years of Primary Education. *Computers & Education, 150*, Article 103832. https://doi.org/10.1016/j.compedu.2020.103832

Grover, S., & Pea, R. (2013). Computational thinking in K-12: A review of the state of the field. *Educational Researcher, 42*(1), 38-43. https://doi.org/10.3102/0013189X12463051

Hsu, T.-C., Chang, S.-C., & Hung, Y.-T. (2018). How to learn and how to teach computational thinking: Suggestions based on a review of the literature. *Computers & Education, 126*, 296-310. https://doi.org/10.1016/j.compedu.2018.07.004

Huang, W., & Looi, C.-K. (2021). A critical review of literature on "unplugged" pedagogies in K-12 computer science and computational thinking education. *Computer Science Education, 31*(1), 83-111. https://doi.org/10.1080/08993408.2020.1789411

Li, Z., & Oon, P.-T. (2024). The transfer effect of computational thinking (CT)-STEM: A systematic literature review and meta-analysis. *International Journal of STEM Education, 11*, Article 44. https://doi.org/10.1186/s40594-024-00498-z

Liu, Z., Gearty, Z., Richard, E., Orrill, C. H., Kayumova, S., & Balasubramanian, R. (2024). Bringing computational thinking into classrooms: A systematic review on supporting teachers in integrating computational thinking into K-12 classrooms. *International Journal of STEM Education, 11*(1), 1-18. https://doi.org/10.1186/s40594-024-00510-6

Merino-Armero, J. M., González-Calero, J. A., & Cózar-Gutiérrez, R. (2022a). Computational thinking in K-12 education: An insight through meta-analysis. *Journal of Research on Technology in Education, 54*(3), 410-437. https://doi.org/10.1080/15391523.2020.1870250

Merino-Armero, J. M., González-Calero, J. A., Cózar-Gutiérrez, R., & del Olmo-Muñoz, J. (2022b). Unplugged activities in cross-curricular teaching: Effect on sixth graders' computational thinking and learning outcomes. *Multimodal Technologies and Interaction, 6*(2), Article 13. https://doi.org/10.3390/mti6020013

Relkin, E., de Ruiter, L., & Bers, M. U. (2020). TechCheck: Development and validation of an unplugged assessment of computational thinking in early childhood education. *Journal of Science Education and Technology, 29*(4), 482-498. https://doi.org/10.1007/s10956-020-09831-x

Román-González, M., Pérez-González, J.-C., & Jiménez-Fernández, C. (2017). Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test. *Computers in Human Behavior, 72*, 678-691. https://doi.org/10.1016/j.chb.2016.08.047

Saxena, A., Lo, C. K., Hew, K. F., & Wong, G. K. W. (2020). Designing unplugged and plugged activities to cultivate computational thinking: An exploratory study in early childhood education. *The Asia-Pacific Education Researcher, 29*(1), 55-66. https://doi.org/10.1007/s40299-019-00478-w

Scherer, R., Siddiq, F., & Sánchez Viveros, B. (2019). The cognitive benefits of learning computer programming: A meta-analysis of transfer effects. *Journal of Educational Psychology, 111*(5), 764-792. https://doi.org/10.1037/edu0000314

Sengupta, P., Kinnebrew, J. S., Basu, S., Biswas, G., & Clark, D. (2013). Integrating computational thinking with K-12 science education using agent-based computation: A theoretical framework. *Education and Information Technologies, 18*(2), 351-380. https://doi.org/10.1007/s10639-012-9240-x

Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017). Demystifying computational thinking. *Educational Research Review, 22*, 142-158. https://doi.org/10.1016/j.edurev.2017.09.003

Tang, X., Yin, Y., Lin, Q., Hadad, R., & Zhai, X. (2020). Assessing computational thinking: A systematic review of empirical studies. *Computers & Education, 148*, Article 103798. https://doi.org/10.1016/j.compedu.2019.103798

Waterman, K. P., Goldsmith, L., & Pasquale, M. (2020). Integrating computational thinking into elementary science curriculum: An examination of activities that support students' computational thinking in the service of disciplinary learning. *Journal of Science Education and Technology, 29*(1), 53-64. https://doi.org/10.1007/s10956-019-09801-y

Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining computational thinking for mathematics and science classrooms. *Journal of Science Education and Technology, 25*(1), 127-147. https://doi.org/10.1007/s10956-015-9581-5

Wing, J. M. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33-35. https://doi.org/10.1145/1118178.1118215

Ye, H., Liang, B., Ng, O.-L., & Chai, C. S. (2023). Integration of computational thinking in K-12 mathematics education: A systematic review on CT-based mathematics instruction and student learning. *International Journal of STEM Education, 10*(1), 1-26. https://doi.org/10.1186/s40594-023-00396-w

Ye, J., Lai, X., & Wong, G. K.-W. (2022). The transfer effects of computational thinking: A systematic review with meta-analysis and qualitative synthesis. *Journal of Computer Assisted Learning, 38*(6), 1620-1638. https://doi.org/10.1111/jcal.12723

Yeni, S., Grgurina, N., Saeli, M., Hermans, F., Tolboom, J., & Barendsen, E. (2024). Interdisciplinary integration of computational thinking in K-12 education: A systematic review. *Informatics in Education, 23*(1), 223-278. https://doi.org/10.15388/infedu.2024.08