Proceeding of 6th International Conference on the Teaching of English and Literature
Bengkulu, Indonesia, November 8th, 2025

E-ISSN: 2986-819X
Page 1-9

Infusion of Computational Thinking into EFL Writing Courses: A Systematic Literature Review

Parlindungan Pardede
Parlindungan_9906922031@mhs.unj.ac.id
Universitas Negeri Jakarta
Corresponding email: parlpard2010@gmail.com

Abstract

To gain a more comprehensive idea of computational thinking (CT) integration into English as a foreign language (EFL) writing, there is an urgent need to systematically review and synthesize the growing number of recent studies in this area. To address this gap, this study reviewed 11 empirical studies published between 2016 and 2025. The purpose of this review is to examine and present empirical evidence on the features, trends, and challenges that educators face in incorporating CT into EFL writing lessons. Using a hybrid thematic analysis–constant comparative method across two databases, the study identified two EFL focus areas: academic writing and creative writing. It also analyzed the distribution of CT skills and cognitive-load levels. The findings show that CT integration has a consistent, favorable impact on learner outcomes. A gap analysis finds low teacher participation and four major barriers: knowledge gaps, time constraints, insufficient professional development, and ingrained views. The article concludes with focused recommendations for policymakers, English educators, and further study.

Keywords: Cognitive load; computational thinking; EFL; writing

Introduction

Computational thinking (CT), defined as a set of problem-solving methods involving thought processes such as decomposition, pattern recognition, abstraction, and algorithmic design, began to attract interest in education when Papert (1980) supported youngsters in developing procedural thinking skills using the LOGO programming language. Yet, it received widespread academic attention after Wing (2010) redefined it as a systematic and universally applicable thinking mode for developing solutions to problems that humans or machines can apply. The new perspective has converted CT into an effective multidisciplinary learning tool, which allows students to engage in one or more of the 19 cognitive and procedural strategies (Hsu et al., 2018) in learning, knowledge creation, and real-world problem-solving activities. Recognizing the huge benefits it offers, CT has been infused into K–12 and higher education curricula across the world (Liu et al., 2024). At first, only computer science and STEM disciplines adopted CT because of their close epistemological proximity (Li et al., 2024). However, over time, CT's relevance to the learning process in the social sciences (Manfra et al., 2022), and humanities (Christensen, 2023), including English education (Jacob et al., 2018; Mensing et al., 2013; Yu et al., 2024) has become more widely acknowledged due to its transdisciplinary nature and reconceptualization as a universally applicable thinking skill.

Various studies on English as a foreign language (EFL) have reported that main CT skills, such as abstraction, algorithms, generalization, debugging, and evaluation, can effectively scaffold language proficiency. CT infusion into EFL classrooms enhanced reading comprehension and vocabulary acquisition (Sabitzer et al., 2018), improved grammar knowledge and use (Youjun & Xiaomei, 2022), and lessened language anxiety (Hsu & Liang, 2021). CT integration can effectively help students advance EFL higher-order thinking and writing skills (Wu et al., 2024). Fu & Relyea (2024) found that

the development of decomposition and abstraction skills through mind mapping use helped students' ideas and story structure visualization, which eventually enhanced their writing fluency and coherence.

CT is a cognitively demanding process because it is abstract and has many levels. Thus, when designing and incorporating CT into learning, educators and instructional designers must consider cognitive load—the mental work needed to absorb information. There are three levels of cognitive load for CT skills: high, medium, and low. High load CT skills include algorithm design, abstraction, debugging, and evaluation, all of which need iterative reasoning and schema construction (Shin et al., 2025). Moderate load CT skills include decomposition and pattern recognition (Krell et al., 2022). They require constant attention but could be effectively managed through the implementation of proper educational design. Low load CT skills include procedural CT strategies, such as sequencing and basic data analysis (Bakar et al., 2019). According to Liu et al. (2024), avoiding a disproportionate cognitive load during CT-EFL learning integration improves knowledge construction and comprehension by allowing learners to manage complex concepts without feeling overburdened. Educators are recommended to use visual aids, bilingual scaffolding, chunking work, and student-friendly protocols in CT integration to avoid excessive cognitive load.

CT integration into EFL instruction can be implemented using three modalities: plugged, unplugged, and hybrid. Plugged approaches depend on digital technologies, such as digital games, coding platforms, instructional robots, and interactive simulations (Durak, 2020; Parsazadeh et al., 2020). Unplugged approaches promote CT using physical or conceptual tasks, such as diagrams, idea maps, puzzles, and board games (e.g., Howell et al., 2011; Sabitzer et al., 2018). Hybrid approaches scaffold CT development by combining digital and tangible strategies (Hsu & Liang, 2021).

In contrast to CT-STEM integration that has reached a level of pedagogical maturity (Hsu et al., 2018; Tariq et al., 2024), CT-EFL writing course integration pedagogy is still disorganized and experimental (Parekh & Sadaria, 2024). Despite the increasing interest and growing number of recent studies on CT-EFL writing integration, no review has been conducted in this area, causing the ideas for optimizing CT to support EFL writing instructions unclear.

This gap is essential to address to get a more comprehensive understanding of CT-EFL writing integration, which is necessary to guide curriculum innovation, teacher development, and future research. The present systematic literature review (SLR) examines recent empirical studies. The following research questions guide the review:

RQ1: What educational contexts integrate CT into EFL writing courses?
RQ2: What pedagogical approaches are employed in CT-EFL writing integration?
RQ3: What CT skills are most frequently integrated into EFL writing instructions across the studies?
RQ4: What challenges and opportunities do educators face in CT-EFL writing integration?

Research Methodology

Review Framework

This study applies the PRISMA-P (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols) guidelines for ensuring rigor and transparency in protocol development and reporting (Shamseer et al., 2015). The protocol includes two stages (Vázquez-Parra et al., 2022): (1) planning, in which the objectives are established, and research questions that guide literature identification and analysis are formulated; and (2) action, in which the systematic search, screening, eligibility assessment, and final inclusion of studies are executed.

Database Selection

Since CT-EFL writing instruction infusion is a relatively new practice, to obtain a comprehensive coverage of CT-EFL writing integration research, I selected two complementary databases, i.e., Google Scholar (GS) and ERIC. The selection of GS was based on its wide-ranging indexing of academic publications and provision of early access to emerging pedagogical studies. ERIC was chosen to complement GS because it focuses on indexing peer-reviewed educational research, assuring high-quality empirical studies.

Inclusion and exclusion criteria

To help determine a study's eligibility, the inclusion and exclusion criteria were formulated, guided by two questions: Is the study relevant to the review's purpose? Is it acceptable for review? Table 1 presents the criteria.

Table 1. Inclusion and Exclusion Criteria

Inclusion	Exclusion
Empirical CT-EFL writing integration studies	Review/synthesis articles
ELT studies in EFL settings	ELT studies in non-EFL settings
Published in 2016 to 2025	Pre-2016 publications
Published in refereed journals/proceedings	Non-journal/proceeding articles
Published in English	Published in non-English

This review includes only empirical studies because they are evidence-based, presenting methodological clarity and analytical precision. The year 2016 was taken as the lower bound this review encapsulates that empirical research on CT-EFL writing integration began to accelerate after 2015, and the decade from 2016 to 2025 encompasses key milestones in CT-EFL writing scholarship due to the emergence of CT-TPACK (Technological Pedagogical Content Knowledge) frameworks that explicitly integrate CT principles with language pedagogy.

Search and Screening Procedure

To obtain relevant scientific documents, this review applied the PRISMA analysis method (Page et al., 2021) in five steps. As Figure 1 illustrates, the retrieval began by searching GS employing "computational thinking" "EFL" AND "writing skills" as the search terms with 2016–2025 as the timeframe on August 15, 2025, yielding 814 records. Importing them in RIS format to Zotero, 346 duplication and 391 non-journal articles or conference proceedings were removed. To ensure they were research articles, the remaining 77 records were screened based on title and keywords, yielding 41 documents and saved them in Mendeley.

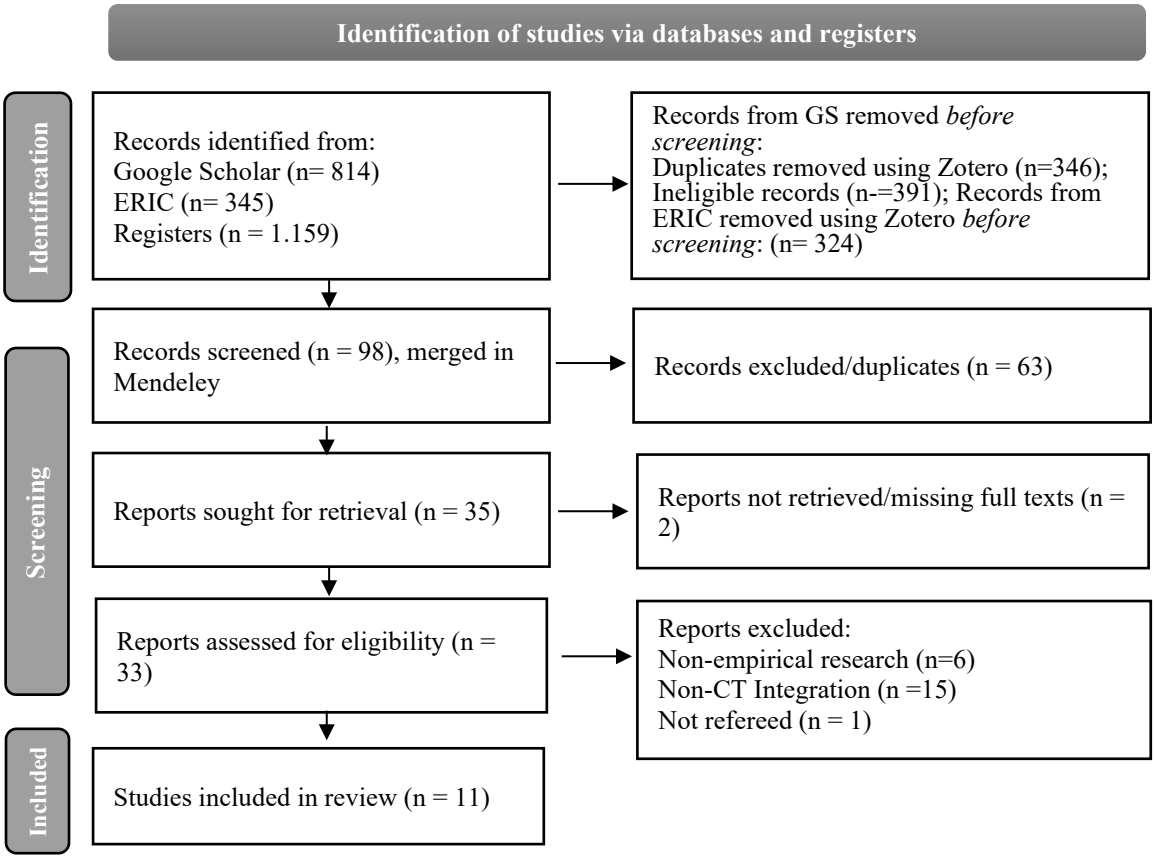

Figure 1. PRISMA 2020 Flow Diagram of Study Selection

The second search was conducted in ERIC, using Boolean logic "computational thinking" "EFL" AND "writing" search terms, “peer reviewed only” category, “since 2016“ for publication date, and “writing skills” descriptor, yielding 345 initial records. Screening them using the same procedure for the records obtained from GS, 21 records were obtained and combined with the 77 records obtained from GS in Mendeley. After deleting 63 duplicates, I retrieved the 35 records but found two of them irretrievable. The remaining 33 documents were rescreened individually by reading their titles and abstracts and evaluating their details to decide their eligibility according to the inclusion and exclusion criteria. The results provided 11 studies to include in the review.

Data Analysis

To analyze the data, this review employed a combination of thematic analysis (TA) and the constant comparative method (CCM) to encapsulate both the depth of concept and clarity of themes. TA was administered in the initial code creation and their organization into nominee themes. The process follows Braun and Clarke's (2021) six-phase procedure, including familiarization, preliminary coding, topic development, review and refinement, theme definition and naming, and visualization. CCM was used to compare codes and themes amongst the studies, regional contexts, and CT modalities. Three processes were involved: (1) comparing theme frequencies and contextual subtleties across studies; (2) refining categories iteratively by combining, dividing, or renaming themes based on additional examples; and (3) creating comparative matrices (e.g., educational level vs. CT modality). Since CCM allows probable inference and synthesis of theoretical frameworks (Sun et al., 2025), its integration with the interpretive rigor of TA enabled the identification of recurrent pedagogical patterns while permitting cross-contextual comparison and iterative refinement.

Findings and Discussion

Findings

Educational Contexts

Figure 2 shows that higher education (HE) dominates CT-EFL writing course integration (73%), which situates it as a center for pedagogical innovation. Secondary school (SS) represents 18%, which suggests structural or curricular issues. Primary school (PS) was included only in 9%, which probably reflects the global trends to expose CT as early as possible.

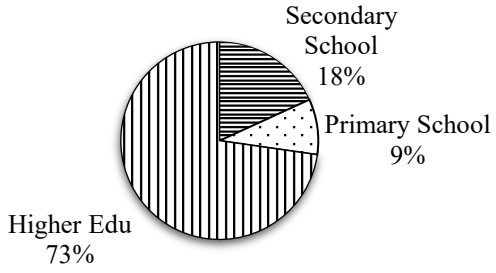

Figure 2. CT-EFL Writing Course Integration Educational Contexts

Pedagogical Approaches

As shown in Table 2, the CT-EFL a majority (82%) of writing instructions in higher education (HE) and secondary schools (SS) was dominated by the unplugged methods. The plugged approach was employed by the single study in primary school (PS) and one study in HE. No hybrid method was used in the selected studies.

Table 2. Pedagogical Approaches in CT-EFL Writing Integration

CT Approach	Primary School (PS)	Secondary School (SS)	Higher Education (HE)	Total
Plugged	1	0	1	2
Unplugged	0	2	7	9
Hybrid	0	0	0	0

CT Skills Distribution

Table 3 portrays the distribution of CT skills by writing genres and cognitive load. It illustrates how CT-infused writing tasks—both academic and creative—continually enact high cognitive load, due to the use of recursive abstraction, algorithmic structuring, and evaluative reasoning. Shin et al. (2025) reported that tasks involving debugging and algorithm design significantly increased cognitive load in collaborative programming, a pattern that echoed in EFL writing contexts. While writing, EFL learners should construct coherent arguments, direct genre conventions, and engage in iterative revision, which demands sustained cognitive effort.

Table 3. CT Skills Distribution by EFL Writing Genre and Cognitive Load

Writing Genres	Dominant CT Skills	Pedagogical Implications	Cognitive Load
Academic Writing	Abstraction, algorithm design, decomposition, debugging, evaluation, generalization.	CT scaffolds idea generation, argument development, paragraph constructing, coherence enhancement, and cycles of peer-review.	High High
Creative Writing	Abstraction, logical reasoning, pattern recognition, debugging, algorithm design, decomposition	CT scaffolds information selection, analysis of structure, genre exploration, and multimodal writing.	High

EFL Educators' Challenges and Opportunities in CT–EFL Writing Integration

The voices of educators in CT integration into writing classes in EFL settings are still underrepresented, despite the rising enthusiasm the practice. Only three of the 11 analyzed studies directly engaged classroom teachers (Table 4), indicating a significant knowledge gap on the real-world obstacles and favorable circumstances for CT–EFL writing integration. A synthesis of these situations not only highlights strategic potential for durable implementation but also reveals four interconnected barriers: knowledge gaps, time restrictions, poor professional development (PD), and nascent attitudes.

Table 4. The Challenges and Opportunities Educators Face in CT-EFL Integration

Studies	Challenges	Opportunities
Dijaya et al. (2017)	Instructors feel underprepared in CT pedagogies and report insufficient time to plan and deliver CT-infused lessons.	Use collaborative lesson-planning sessions; embed CT tasks within existing syllabus structures to reduce extra workload.
Bayraktar & Gulbahar (2022)	Pre-service teachers initially unaware of CT skills, requiring foundational training before classroom application.	Use iterative, scaffolded workshops during teacher education to foster CT fluency; encourage peer-led demonstration lessons.
Parsazadeh et al. (2020)	Lack of knowledge and confidence in designing CT activities for EFL contexts.	Pair language instructors with CT-specialist mentors; create micro-credentialing pathways in CT–EFL integration.

Discussion

The predominance of CT incorporation into EFL writing instruction in HE settings might be due to two reasons. First, while writing plays a significant role in learning all other subjects, enhancing critical thinking, and fostering effective communication and research abilities, it remains the most difficult ability to master by EFL learners. Thus, the researchers expected CT integration could meet

the challenge. Second, in HE, the instructors have autonomy, and the students are ready for abstract reasoning necessitated in the integration of an advanced pedagogical tool such as CT. In this review, Suciati et al.'s (2023) research is a pilot study, and some other studies were conducted on the researchers' initiative. These reiterate the assertion that CT integration in humanities remains fragmented and experimental (Parekh & Sadaria, 2024). To move beyond pilot efforts, CT should be infused into core EFL writing curricula, supported by scalable models, instructors' development, and institutional backing.

The results indicate the SS students' cognitive readiness for CT integration. Murti et al. (2023) and Peng et al. (2023) revealed that CT concepts promoted students' English writing organization and structure, increased their writing motivation, and reduced their writing anxiety. The students also had more positive perceptions of their writing course. Yet, the practice is implemented only when it is explicitly mandated (Li et al., 2024). Furthermore, it calls for clear, interesting, and well-supported instruction. Weng et al. (2018) accentuate the importance of designing instructions that correspond to students' prior knowledge as essential.

CT integration into PS's EFL writing course reflects the worldwide trend's early introduction of CT to young learners. In this context, Parsazadeh et al. (2020) reported that Scratch can be used to promote digital fluency and CT habits among young learners, which will eventually enhance their learning outcomes. This confirms research findings that the use of different digital tools like Alice (Durak, 2020) and educational robots (Hsu & Liang, 2021; Hsu et al., 2022) can align well with the developmental stage of young learners' logical reasoning, algorithmic thinking, and systematic problem solving.

The dominance of the unplugged techniques in HE and SS indicates that what makes CT integration into EFL writing important is its use as an educational and cognitive strategy rather than the use of technology as a writing tool. This trend is triggered by two main factors. First, metacognition and interdisciplinary integration have been extensively implemented in writing courses (Hsu et al., 2022). Metacognitive focus supports learners to activate their prior knowledge; practice and implement new strategies for the writing process, and reflect on their strengths and challenges while writing, Interdisciplinary incorporation motivates learners to blend information from several sources and disciplines and empowers them to handle real-world problems innovatively. Second, faculty-led innovation is promoted based on interpretive or constructivist paradigms that prioritize meaning-making, reflection, and learner agency (e.g., Weng et al., 2018).

Interpretivism is the most frequent pedagogical approach used by language educators. Unplugged CT integration into EFL writing instruction can support interpretivism in three ways. First, through debating and analogical thinking activities, it promotes decomposition, pattern recognition, and conceptual reasoning skills. Second, it develops student agency through exercises in algorithmic narrative, logic-based grammar, and CT-infused reading practices. Third, unplugged CT integration enables adaptability to disciplinary contexts such as literary analysis and writing. Bayraktar and Gulbahar's (2022) study on CT integration into poetry writing through peer reflection and project work demonstrates that unplugged CT fosters the development of thinking habits that are deeply embedded in analysis, interpretation, and expression, which makes it a good choice for HE settings.

Most EFL educators have possessed general digital literacy. Yet, only a small percentage of them demonstrate the pedagogical ability for translating CT principles into writing assignments. For example, the teachers in the study of Parsazadeh et al. (2020) did not have the confidence and expertise required to design CT learning activities. This highlights the high need for curricula that clearly chart necessary CT constructs onto communicative activities that facilitate teachers applying computational frameworks to support the learning objectives. Such curriculum availability becomes more urgent because current personal development (PD) models have not sufficiently prepared teachers for CT–EFL integration due to time restrictions and conflicting obligations (Dijaya et al., 2017). The conventional PD often prioritizes technical expertise over pedagogical application. Parsazadeh et al. (2020) also noted that although teachers manage to possess software skills after accomplishing such sessions, they lack the strategies necessary to encourage students' reflection, collaboration, or language growth through CT. Consequently, it is critical to create PD models that are more effective. Bayraktar and Gulbahar (2022) found that pre-service teachers without prior experience with CT might become confident advocates after joining just one semester of contextualized, hands-on training. Additionally, in the STEM

education contexts, Liu et al. (2024) highlighted that teachers' CT integration skills can be best developed through a consistent, practice-oriented PD.

Conclusion and Suggestion

Based on the findings, CT-EFL writing integration reveals a positive influence on students' learning outcomes. However, although integrating high-load CT skills such as abstraction, algorithm design, and debugging with writing activities may seem straightforward, appropriate support is required to ensure accessibility. Although teachers' perspectives are limited in this study, they highlight persistent challenges in terms of knowledge, time, professional development, and beliefs. Therefore, addressing these gaps by providing sustainable, classroom-ready CT–EFL models that prioritize both learner gains and educator experiences is crucial.

This SLR provides a distinct contribution by synthesizing evidence on CT-EFL writing integration, underlining pedagogical benefits for learners and the practical challenges teachers encountered, which offers a balanced foundation for CT–EFL practice development. Grounded on the contribution, the following recommendations are proposed. Policy makers need to create frameworks that include CT ideas in EFL writing courses and afford funding for continuing PD programs that specifically combine CT theory with co-planning workshops and coaching cycles. English teachers should include CT task integration into existing lesson plans and participate in professional learning communities to collaboratively create CT–EFL integrated writing units, exchange rubrics, and conduct peer demos. Further study is needed to carry out longitudinal studies monitoring teacher adoption, attitude transformation, and CT-EFL integrated writing classroom sustainability, extend qualitative inquiry into educators' experiences, and examine CT-EFL writing integration in a variety of educational settings and across proficiency levels to increase generalizability.

References

Bakar, M. A., Mukhtar, M., & Khalid, F. (2019). The development of a visual output approach for programming via the application of cognitive load theory and constructivism. *International Journal of Advanced Computer Science and Applications*, *10*(11), 305–312. https://doi.org/10.14569/IJACSA.2019.0101142

Bayraktar, A., & Gulbahar, Y. (2022). Computational thinking in language arts when teaching creative and expository writing. *Proceedings of Sixth APSCE International Conference on Computational Thinking and STEM Education 2022*, 128–133. https://doi.org/10.34641/ctestem.2022.4

Braun, V., & Clarke, V. (2021). *Thematic analysis: A practical guide*. Sage.

Christensen, I. F. (2023). Integrating computational thinking in humanistic subjects in higher education. In M. J. Spector, B. B. Lockee, & M. D. Childress (Eds.), *Learning, design, and technology* (pp. 1–45). https://doi.org/https://doi.org/10.1007/978-3-319-17727-4_180-1

Dijaya, S., Wang, G., & Makbul, D. S. (2017). Innovation in English language teaching for EFL Context: Students ' perceptions toward writing story activity using computational thinking process. *Journal of Education and Practice*, *8*(22), 72–78.

Durak, H. Y. (2020). The Effects of using different tools in programming teaching of secondary school students on engagement, computational thinking and reflective thinking skills for problem solving. *Technology, Knowledge and Learning*, *25*(1), 179–195. https://doi.org/10.1007/s10758-018-9391-y

Fu, X., & Relyea, J. E. (2024). Exploring the role of mind mapping tools in scaffolding narrative writing in English for middle-school EFL students. *Education Sciences*, *14*(10), 11–19. https://doi.org/10.3390/educsci14101119

Howell, L., Jamba, L., Kimball, A. S., & Sanchez-Ruiz, A. (2011). Computational thinking: Modeling applied to the teaching and learning of English. *Proceedings of the Annual Southeast Conference*, 48–53. https://doi.org/10.1145/2016039.2016059

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*. https://www.sciencedirect.com/science/article/pii/S0360131518301799

Hsu, Ting Chia, Chang, C., Wu, L. K., & Looi, C. K. (2022). Effects of a pair programming educational robot-based approach on students' interdisciplinary learning of computational thinking and language learning. *Frontiers in Psychology*, *13*(May). https://doi.org/10.3389/fpsyg.2022.888215

Hsu, Ting Chia, & Liang, Y. S. (2021). Simultaneously improving computational thinking and foreign language learning: Interdisciplinary media with plugged and unplugged approaches. *Journal of Educational Computing Research*, *59*(6), 1184–1207. https://doi.org/10.1177/0735633121992480

Jacob, S., Nguyen, H., Tofel-grehl, C., Richardson, D., & Warschauer, M. (2018). Teaching Computational Thinking to English Learners. *Nys Tesol Journal*, *5*(2), 12–24. https://par.nsf.gov/servlets/purl/10073683

Krell, M., Xu, K. M., Rey, G. D., & Paas, F. (2022). Editorial: Recent Approaches for assessing cognitive load from a validity perspective. *Frontiers in Education*, *6*(January), 1–7. https://doi.org/10.3389/feduc.2021.838422

Li, X., Sang, G., Valcke, M., & van Braak, J. (2024). Computational thinking integrated into the English language curriculum in primary education: A systematic review. In *Education and Information Technologies* (Vol. 29, Issue 14). Springer US. https://doi.org/10.1007/s10639-024-12522-4

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). https://doi.org/10.1186/s40594-024-00510-6

Manfra, M. M. G., Hammond, T. C., & Coven, R. M. (2022). Assessing computational thinking in the social studies. *Theory and Research in Social Education*, *50*(2), 255–296. https://doi.org/10.1080/00933104.2021.2003276

Mensing, K., Mak, J., Bird, M., & Billings, J. (2013). Computational, model thinking and computer coding for U.S. Common Core Standards with 6 to 12 year old students. *2013 IEEE 11th International Conference on Emerging ELearning Technologies and Applications (ICETA)*, 17–22. https://doi.org/10.1109/ICETA.2013.6674397

Murti, A. T., Sumardiyani, L., & Wu, T. T. (2023). An analysis of student perceptions of computational thinking in writing classes. In Y. M. Huang & T. Rocha (Eds.), *Innovative Technologies and Learning. ICITL 2023. Lecture Notes in Computer Science* (pp. 560–566). Springer, Cham. https://doi.org/https://doi.org/10.1007/978-3-031-40113-8_55

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *The BMJ*, *372*, 1–7. https://doi.org/10.1136/bmj.n71

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books.

Parekh, R. B., & Sadaria, P. D. (2024). The implication of computational thinking in higher education: challenges and opportunities. In V. Goar, A. Sharma, J. Shin, & M. F. Mridha (Eds.), *Deep Learning and Visual Artificial Intelligence. ICDLAI 2024. Algorithms for Intelligent Systems* (pp. 115–122). Springer. https://doi.org/https://doi.org/10.1007/978-981-97-4533-3_9

Parsazadeh, N., Cheng, P. Y., Wu, T. T., & Huang, Y. M. (2020). Integrating computational thinking concept into digital storytelling to improve learners' motivation and performance. *Journal of Educational Computing Research*, *59*(3), 470–495. https://doi.org/10.1177/0735633120967315

Peng, H. H., Murti, A. T., Silitonga, L. M., & Wu, T. T. (2023). Effects of the fundamental concepts of computational thinking on students' anxiety and motivation toward K-12 English writing. *Sustainability (Switzerland)*, *15*(7), 1–16. https://doi.org/10.3390/su15075855

Sabitzer, B., Demarle-Meusel, H., & Jarnig, M. (2018). Computational thinking through modeling in language lessons. *IEEE Global Engineering Education Conference, EDUCON*, *2018-April*(2), 1913–1919. https://doi.org/10.1109/EDUCON.2018.8363469

Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A., Altman, D. G., Booth, A., Chan, A. W., Chang, S., Clifford, T., Dickersin, K., Egger, M., Gøtzsche, P. C., Grimshaw, J. M., Groves, T., Helfand, M., … Whitlock, E. (2015). Preferred reporting items for systematic review and meta-analysis protocols (prisma-p) 2015: Elaboration and explanation. *BMJ (Online)*, *349*(January), 1–25. https://doi.org/10.1136/bmj.g7647

Shin, Y., Jung, J., Choi, S., & Jung, B. (2025). The influence of scaffolding for computational thinking on cognitive load and problem-solving skills in collaborative programming. *Education and Information Technologies*, *2*, 583–606. https://doi.org/https://doi.org/10.1007/s10639-024-13104-0

Suciati, S., Elsa, Silitonga, L. M., Lin, J., & Wu, T. (2023). Enhancing English writing skills through rubric-referenced peer feedback and computational thinking: A pilot study. *Innovative Technologies and Learning. ICITL 2023. Lecture Notes in Computer Science*, 587–596. https://doi.org/https://doi.org/10.1007/978-3-031-40113-8_58

Sun, Y., Chen, Z., & Li, L. (2025). Teaching Creative Thinking in the ELT Context: Beliefs and Practices. *SAGE Open*, *15*(1), 1–15. https://doi.org/10.1177/21582440251315235

Tariq, R., Aponte Babines, B. M., Ramirez, J., Alvarez-Icaza, I., & Naseer, F. (2024). Computational thinking in STEM education: Current state-of-the-art and future research directions. *Frontiers in Computer Science*, *6*(January). https://doi.org/10.3389/fcomp.2024.1480404

Vázquez-Parra, J. C., Cruz-Sandoval, M., & Carlos-Arroyo, M. (2022). Social entrepreneurship and complex thinking: A bibliometric study. *Sustainability (Switzerland)*, *14*(20), 1–17. https://doi.org/10.3390/su142013187

Weng, X., Chai, C. S., Jong, M. S. Y., & Wong, G. K. W. (2018). Perceptions of teacher and students towards integrating computational thinking into language education: A pilot study. *ICCE 2018 - 26th International Conference on Computers in Education, Workshop Proceedings*, 670–675.

Wing, J. M. (2010). Computational Thinking: What and Why? *Thelink - The Magaizne of the Varnegie Mellon University School of Computer Science*, *6*, 20–23.

Wu, T. T., Silitonga, L. M., & Murti, A. T. (2024). Enhancing English writing and higher-order thinking skills through computational thinking. *Computers & Education*, *213*(105012). https://doi.org/https://doi.org/10.1016/j.compedu.2024.105012

Youjun, T., & Xiaomei, M. (2022). Computational thinking: A mediation tool and higher-order thinking for linking EFL grammar knowledge with competency. *Thinking Skills and Creativity*, *46*(October), 101143. https://doi.org/10.1016/j.tsc.2022.101143

Yu, X., Soto-Varela, R., & Gutiérrez-García, M. Á. (2024). How to learn and teach a foreign language through computational thinking: Suggestions based on a systematic review. *Thinking Skills and Creativity*, *52*(101517), 1–15. https://doi.org/10.1016/j.tsc.2024.101517