

Review Article

Cite this article: Budiyanto, C. W., Wahyudi, M. N. A., Widiastuti, I., & Latifah, R. (2025). Teaching Computational Thinking in Indonesia: Trend in Conception, Methods, Technology, and Evaluation. *Educational Process: International Journal*, 17, e2025308. <https://doi.org/10.22521/edupij.2025.17.308>

Received May 6, 2025

Accepted June 18, 2025

Published Online July 7, 2025

Keywords: Computational thinking, conception, evaluation, methodology, technology.

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Teaching Computational Thinking in Indonesia: Trend in Conception, Methods, Technology, and Evaluation

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Abstract

Background/purpose. Computational Thinking (CT) has gained widespread attention in education as a core cognitive skill essential for solving complex problems in both academic and real-world contexts. While Indonesian educators have actively adopted CT as part of national educational reforms, questions remain about how closely current practices align with the original theoretical underpinnings of CT.

Materials/methods. This study conducted a systematic literature review of Scopus-indexed research articles focusing on CT in Indonesian education. Using PRISMA guidelines, 35 eligible articles were selected from an initial pool of 130. The analysis combined bibliographic mapping using VOSviewer and thematic analysis to explore trends related to CT conception, teaching methods, technologies used, and assessment practices.

Results. The findings reveal that Indonesian researchers conceptualize CT in various ways—as a problem-solving skill, a digital literacy component, and a pedagogical approach linked to subjects such as mathematics, physics, and language. Nine pedagogical strategies were identified, with problem-based learning and hybrid models being the most prominent. Although educational technologies, such as Ed-Tech apps and robotics, are increasingly used to support CT, nearly half of the studies reviewed did not incorporate digital tools. Assessments primarily rely on self-reporting and mathematical problem-solving tasks, with limited evidence of comprehensive evaluation frameworks for CT skills.

Conclusion. Despite growing interest and diverse applications of CT in Indonesia, inconsistencies in conceptual understanding and a lack of standardized evaluation methods highlight the need for more straightforward guidelines and stronger collaboration across stakeholders. This study contributes a national overview and suggests pathways for improving CT integration in Indonesian education.

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1. Introduction

While Computational Thinking (CT) has gained global attention, its foundational definitions vary significantly. Papert (1980), for example, emphasized constructivist learning, viewing CT as a form of learning through making—building knowledge via hands-on projects and the use of tangible technology. Wing (2006) framed CT as a universal cognitive skill essential for problem-solving across disciplines. Brennan and Resnick (2012) further refined CT as a set of core practices—abstraction, decomposition, algorithmic thinking, and debugging—focusing on the practical skills necessary for computational fluency. These epistemological differences shape how CT is interpreted, taught, and applied, particularly within the Indonesian educational context this study examines.

A cognitive approach to problem-solving characterizes CT by formulating problems and devising solutions that can be expressed and executed using computational methods (Ng *et al.*, 2023). Moreover, Hoppe and Werneburg (2019) described CT as a problem-solving procedure that encompasses the following key aspects: (1) Identification, Analysis, and Implementation of Solutions: This involves discerning potential solutions, analyzing their feasibility, and executing them to achieve an optimal combination of steps and resources; and (2) Generalization and Transferability: CT extends beyond specific problems, it entails the ability to generalize and apply the problem-solving process to a diverse range of challenges. CT aims to improve moral, social, and creative abilities while fostering a mindset similar to that of a computer scientist, involving analytical thinking, systematic reasoning, and step-by-step problem-solving when addressing real-world problems (Kamha & Chookhampaeng, 2023; Lee *et al.*, 2024). The term and concept of CT are over two decades old; their application and recognition in education and other fields have grown significantly over the years (Corecco *et al.*, 2023; DeJarnette *et al.*, 2022; Djordje M Kadijevich *et al.*, 2023; Payne *et al.*, 2022; Wu *et al.*, 2024; Zhou & Zhang, 2024). Research on CT has also gathered substantial interest in recent times (Ma *et al.*, 2023; Ye *et al.*, 2023), both globally and within Indonesia.

In the context of education, CT is often viewed as a foundational framework that supports teachers in developing students' computational skills and literacies (MacAnn & Yadav, 2023). In Indonesia, numerous studies discussed CT teaching and learning across various domains, especially STEM (Science, Technology, Engineering, and Mathematics) (Anistyasari *et al.*, 2021; Kusnendar & Prabawa, 2018, 2019; Safaah & Karyaningsih, 2020; Safrudin *et al.*, 2021; Sofyan *et al.*, 2021; Sunendar *et al.*, 2020), within the context of high school (Hanif *et al.*, 2021; Lia *et al.*, 2020; Safrudin *et al.*, 2021; Sulistiyo & Wijaya, 2020; Zamzami *et al.*, 2020), junior high and elementary school (Abidin *et al.*, 2023; Achsan *et al.*, 2021; Andi Rachman *et al.*, 2021; Handayani *et al.*, 2023; Kusnendar & Prabawa, 2018; Usodo *et al.*, 2020; Yuliana *et al.*, 2019), higher education (Al Yakin *et al.*, 2023; Hu *et al.*, 2022; Masfuah & Fakhriyah, 2019; Muthmainnah *et al.*, 2023; Sanjaya *et al.*, 2018; Semiawan, 2019; Sondakh *et al.*, 2019), and even in early childhood education (Isnaini *et al.*, 2019; Magta & Mahardika, 2023; Umam *et al.*, 2019).

In Indonesia, the Ministry of Education has promoted the incorporation of CT, especially within a newly introduced Coding and Artificial Intelligence course at the elementary, junior, and high school levels. Multiple studies indicate its utilization in mathematics, physics, and language education (Aminah *et al.*, 2022; Herwinarso *et al.*, 2023; Wu *et al.*, 2024), employing pedagogical methods that include problem-based learning, game-based instruction, and robotics-enhanced teaching (Amri *et al.*, 2022; Budiyanto *et al.*, 2022). Despite the growing body of research, a comprehensive synthesis on the conception, instruction, and assessment of CT across educational tiers in Indonesia is lacking. Research frequently varies in its definition of CT, utilizes disparate methodology, and seldom evaluates its long-term effects or consistency with the foundational theoretical frameworks.

The absence signifies the necessity for a rigorous examination of Indonesian literature to delineate existing conceptualizations, ascertain dominant teaching methodologies, assess the

importance of digital tools, and investigate assessment processes in CT education. This review synthesizes findings from Scopus-indexed studies to present a national overview of CT teaching and learning practices, enhancing the knowledge of its integration within Indonesia's distinctive educational framework.

While Indonesian educators and researchers joined the bandwagon as prescribed by the Ministry of Education, concerns were raised about whether their conception of CT, methods of teaching and learning, and technology adopted in the pedagogy were in line with the original conception suggested by the initial scholars. Although there is already a considerable amount of literature on CT in Indonesia, no research was found that systematically maps the diversity of CT conceptualizations, pedagogical practices, technology integration, and assessment approaches in the Indonesian context. According to Aminah *et al.* (2022), CT education should be systematically prepared, encompassing the design of learning activities, teaching CT, assessing CT, and utilizing technology to convey CT concepts. These aims were articulated into four research questions (RQs), as shown below.

RQ 1. What are the prevalent conceptual understandings of CT in Indonesian education?

RQ 2. What pedagogical strategies are currently utilized in teaching CT in Indonesia?

RQ 3. How is technology being integrated into the teaching of CT in Indonesia?

RQ 4. What methodologies are employed in the evaluation of CT teaching in Indonesia?

2. Literature Review

Computational Thinking (CT) has emerged as a central concept in global education reform; however, its definitions, pedagogical frameworks, and implementation strategies vary considerably across different contexts. Papert's (1980) constructivist approach emphasized learning through making, positioning CT as an active, project-based process that fosters creativity and problem-solving through engagement with technology such as programming and robotics. Wing (2006) broadened this perspective, advocating for CT as a universal cognitive skill—a fundamental mode of problem-solving akin to reading, writing, and arithmetic—that applies across all disciplines, regardless of the specific tools used. In contrast, Brennan and Resnick (2012) operationalized CT as a set of core practices, including abstraction, decomposition, and debugging, emphasizing the design of learning experiences that cultivate these competencies within specific learning contexts. It is becoming more widely recognized for its capacity to promote analytical problem-solving across a range of academic fields and real-world situations (Hoppe & Werneburg, 2019; Ng *et al.*, 2023).

Internationally, CT has been embedded in STEM curricula and recognized as essential for fostering analytical thinking, creativity, and problem-solving in the digital age, in addition to its value as a programming-related skill (Payne *et al.*, 2022; Zhou & Zhang, 2024). However, studies reveal diverse approaches: some focus on technology-rich environments, such as robotics and coding platforms (Djordje M. Kadijevich *et al.*, 2023; Ma *et al.*, 2023), while others emphasize CT as a transversal skill embedded in subjects like mathematics and language (Ng *et al.*, 2023; Wu *et al.*, 2024). Despite this growing body of research, there is limited synthesis of how CT is conceptualized, taught, and assessed within a non-Western context, particularly in Indonesia.

In the Indonesian context, research has proliferated following the Ministry of Education's introduction of CT into national curricula. Studies explore CT integration across levels—ranging from early childhood education (Isnaini *et al.*, 2019) to higher education (Al Yakin *et al.*, 2023)—and in various subjects, including mathematics (Aminah *et al.*, 2022), physics (Herwinarso *et al.*, 2023), and language (Peng *et al.*, 2023). Common pedagogical strategies include problem-based learning (Abidin *et al.*, 2023), project-based approaches, and the use of educational technologies such as Scratch, EdTech apps, and robotics kits (Budiyanto *et al.*, 2022). However, critical gaps remain: many studies

emphasize definitions of CT without engaging in deeper theoretical analysis, and few examine how Indonesian interpretations align with global frameworks. Additionally, assessment practices tend to focus on self-report surveys or mathematical problem-solving tasks, often lacking robust tools to evaluate broader CT competencies, such as abstraction and debugging (Susanti *et al.*, 2023).

This review highlights the need for a systematic synthesis of CT conceptualizations, teaching methods, technology integration, and assessment approaches within the Indonesian education system. Such an analysis is essential for informing policy, guiding curriculum development, and supporting educators in effectively fostering CT skills in diverse Indonesian classrooms.

3. Methodology

While the focus is on understanding how CT was practiced and learned in Indonesia, this study conducts an in-depth literature review using thematic analysis. Following Braun and Clarke (2006), the six-phase procedure involves familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. All included articles were organized and analyzed manually using a structured spreadsheet, which enabled flexible categorization of key content and facilitated the traceable development of codes. Two independent coders participated in the coding process to ensure credibility and minimise individual bias. Both coders initially reviewed and coded a subset of the selected studies independently, mainly performing deductive coding based on prior literature and research questions. The initial coding schemes were then compared and discussed in joint review sessions to resolve discrepancies. The finalized themes—such as CT conceptualizations, teaching strategies, technology use, and assessment methods—were agreed upon based on frequency and conceptual relevance. Analytical memos were maintained throughout to ensure transparency and rigor.

Pertinent to the endeavour, this research aimed to help educators decide on and develop effective CT teaching and learning materials. In addition to the literature review, a bibliographic analysis was conducted to gain insights into the trends related to CT teaching and learning in Indonesia. To ensure the alignment with national research standards, this study limited its literature selection to articles indexed in Scopus, in accordance with the Indonesian Ministry of Education's research evaluation guidelines, which prioritize Scopus-indexed publications as indicators of scholarly quality and impact.

3.1. Bibliographic Analysis

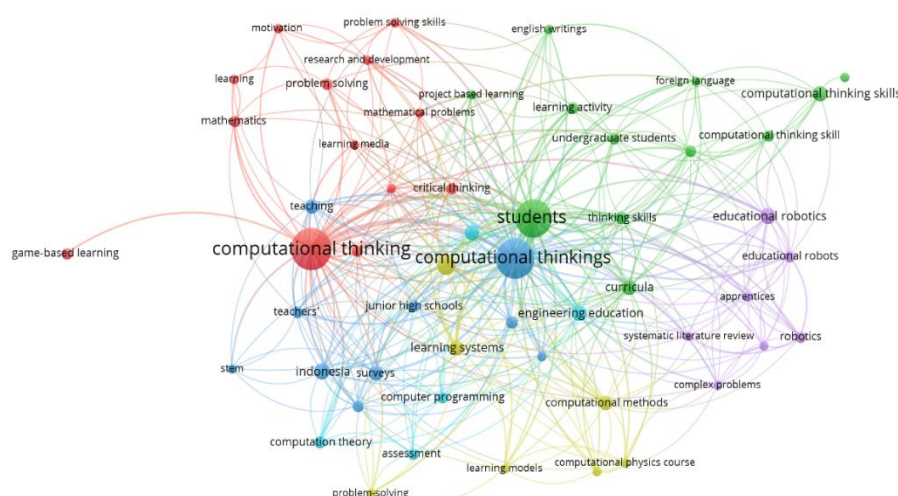


Figure 1. VOSviewer Network of Keywords

To delve into the literature, the bibliographic analysis summarized the bibliometric and intellectual structure (Donthu *et al.*, 2021) of the CT practices in Indonesia by analyzing two main topics: a network of keywords and publication year trends of the nominated papers. These articles were analyzed and visualized using VOSviewer software in a bibliometric study. This software visually represents the connections between each keyword node and cluster, forming a network (Salmerón-Manzano & Manzano-Agugliaro, 2018). Each node corresponds to a specific keyword. The larger the node, the more articles are associated with that keyword. Conversely, a cluster is a group of several keyword nodes that share a common theme. Figure 1 illustrates the article keyword network, and Figure 1 displays the trend year distribution for each cluster.

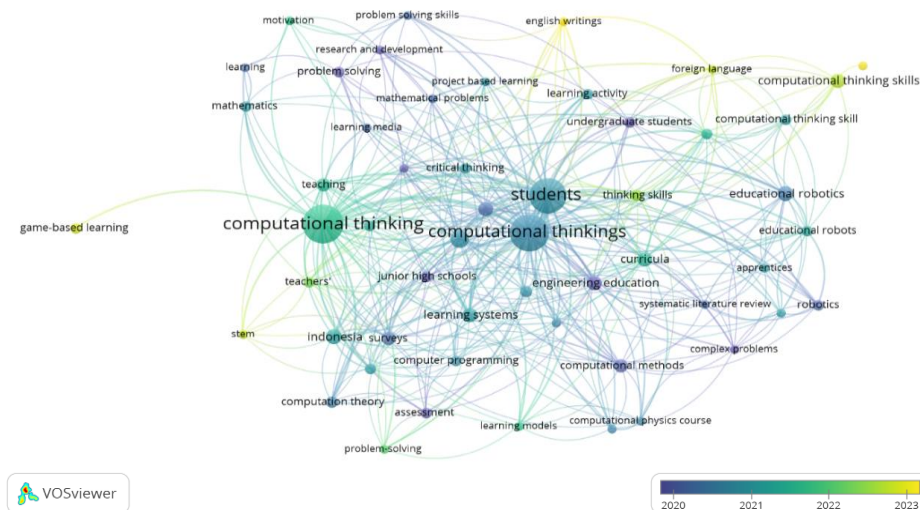


Figure 2. VOSviewer Publication Year Distribution Trends

Figure 2 illustrates the trend of publication years across all nodes and clusters. It is evident that the majority of nodes or articles were published between 2021 and 2022, with 2020 publications following closely behind. The least number of publications, indicated by the least visible color, occurred in 2023. This suggests that research on CT in Indonesia reached its pinnacle in 2021-2022 and saw a decline in 2023.

3.2. Systematic Literature Review Method

The literature review process was carried out by the Systematic Literature Review framework proposed by Okoli (2015) and Robinson and Lowe (2015). The method of article selection was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009; Page *et al.*, 2021). The research articles reviewed in this study were sourced from the Scopus database, adhering to the following search query: TITLE-ABS-KEY (“CT”) AND (LIMIT-TO (AFFILCOUNTRY, “Indonesia”)).

As depicted in Figure 3, the process of selecting articles involved searching the Scopus database using a predefined query, which yielded 130 articles published between 2018 and 2024. Specific inclusion criteria were established to narrow down the selection of articles. The criteria for the selection of articles for this review were as follows: (1) The type of publication needed to be peer-reviewed empirical journal articles that included a clear presentation of research questions, and methods, and provided interpretations grounded in theory and evidence, (2) the language of the articles had to be in English or Bahasa Indonesia (3) lastly, the subject of the studies had to be specifically focused on the teaching of CT in Indonesia. After undergoing the selection process, a total of 35 articles were deemed suitable for the review process based on the criteria.

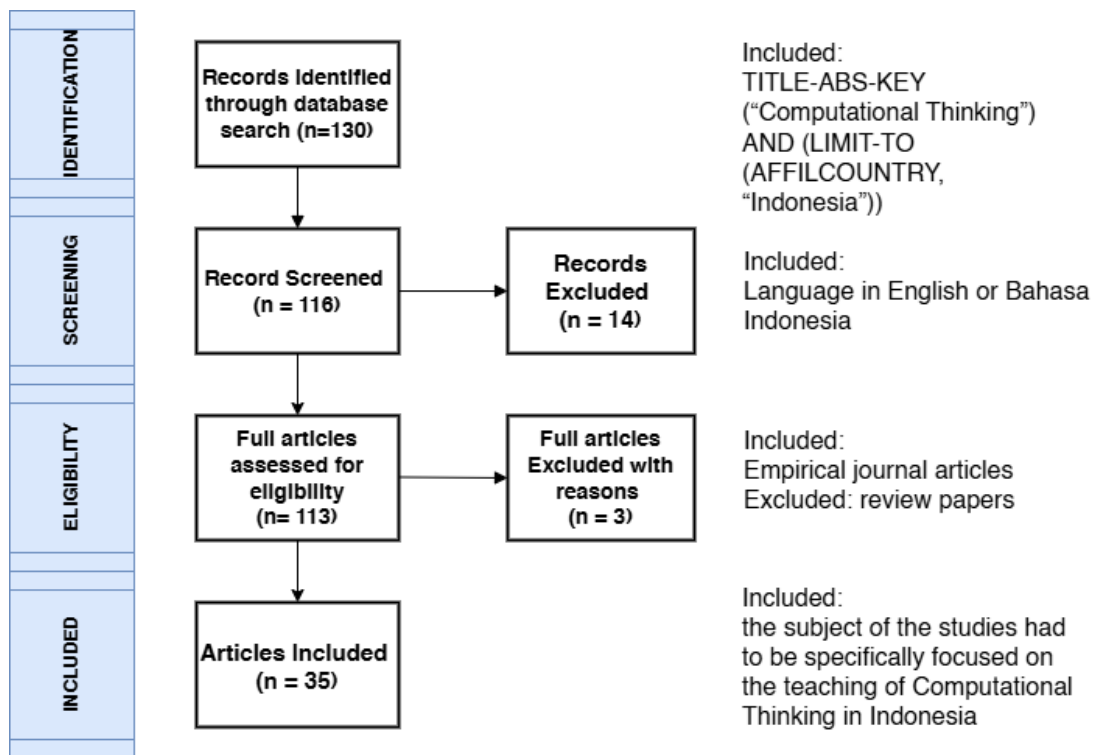


Figure 3. PRISMA Flow Diagram

4. Results

This section exhibits the trends of keywords used in CT research in Indonesia, the distribution of terminology clusters, and the elaboration of the circumstances.

4.1. Cluster 1 (Red): Computational Thinking

As presented in Figure 4, the cluster encompasses numerous keywords, including CT, critical thinking, game-based learning, learning, learning media, mathematical problems, mathematics, mathematics education, motivation, problem-solving, problem-solving skills, programming, and research and development. This cluster reflects the intertwined studies exploring the incorporation of CT into education through game-centred learning. Furthermore, it delves into its correlation with students' critical thinking proficiencies and problem-solving capabilities.

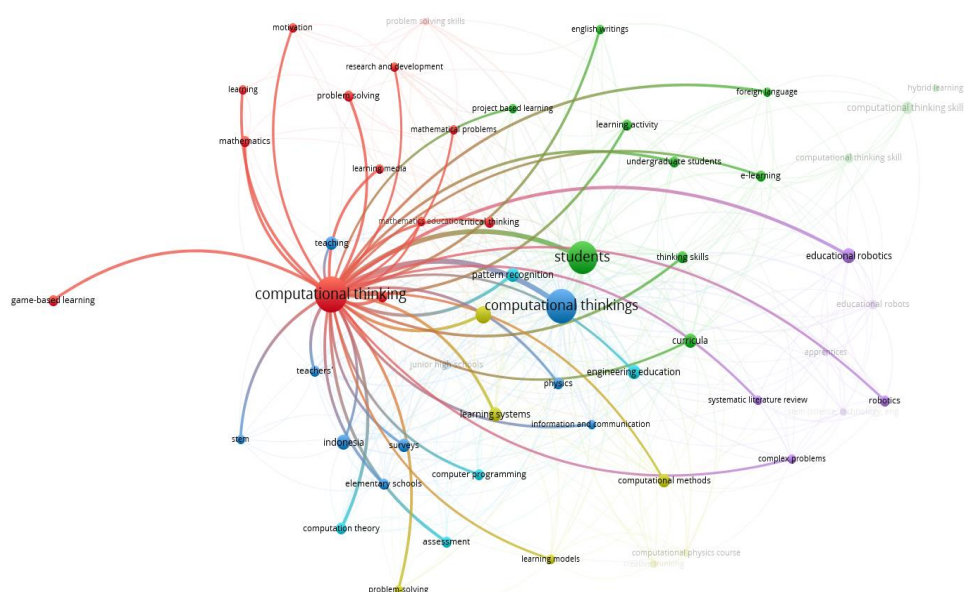


Figure 4. Cluster 1

4.2. Cluster 2 (Green): Students

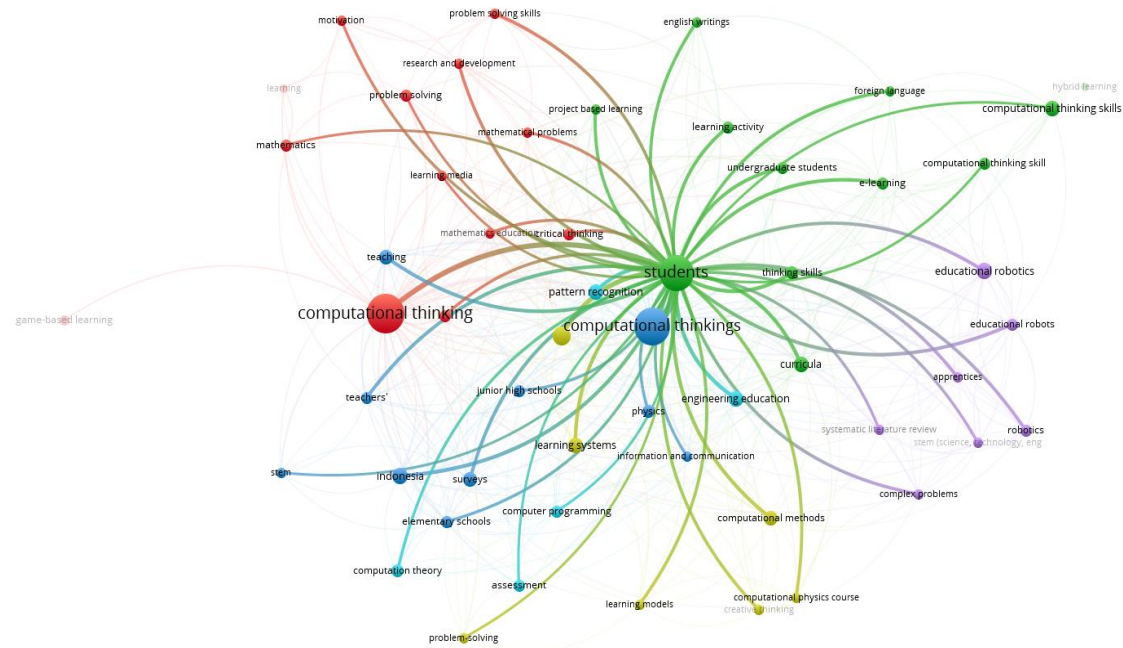


Figure 5. Cluster 2

The green cluster in Figure 5 encompasses various terms, including CT skills, curricula, e-learning, English writing, foreign language, hybrid learning, learning activities, project-based learning, students, thinking skills, and undergraduate students. This cluster demonstrates that interconnected research explores the integration of CT skills into learning curricula using e-learning, hybrid learning, and project-based learning.

4.3. Cluster 3 (Blue): Computational Thinking

The blue cluster in Figure 6 encompasses various terms, including CT, elementary schools, Indonesia, information and communication technologies, junior high schools, Physics, STEM, Surveys, teachers, and Teaching. This collection indicates that interrelated studies examine the incorporation of CT into STEM education, particularly in physics and information technology. It is also apparent that Indonesian researchers use different terminology for CT.

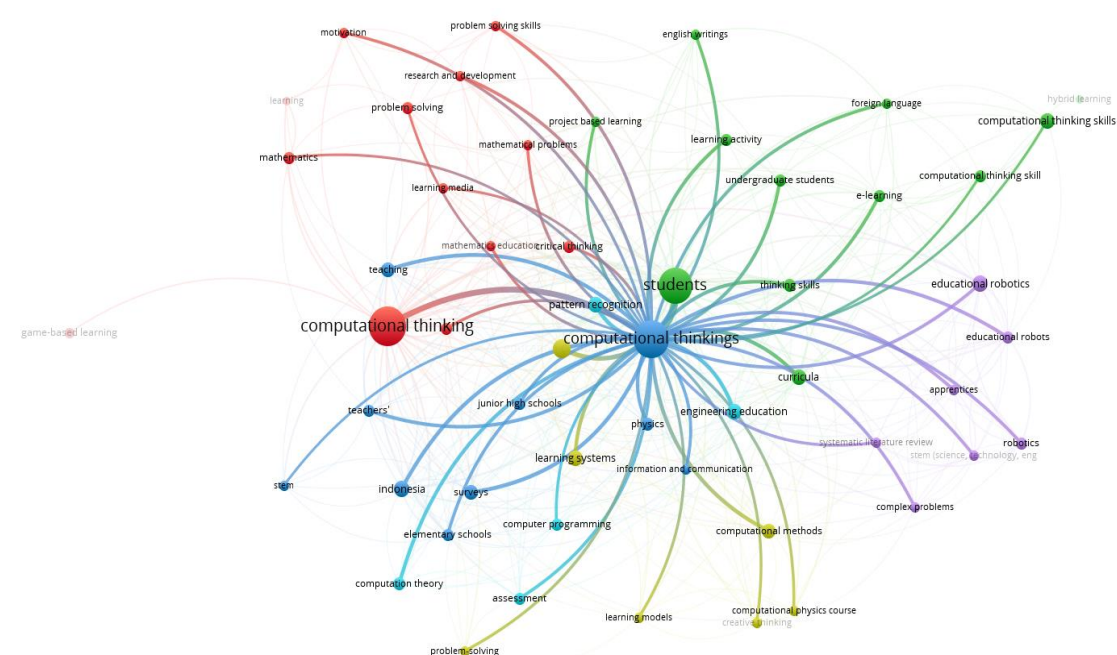


Figure 6. Cluster 3

4.4. Cluster 4 (Yellow): Education Computing

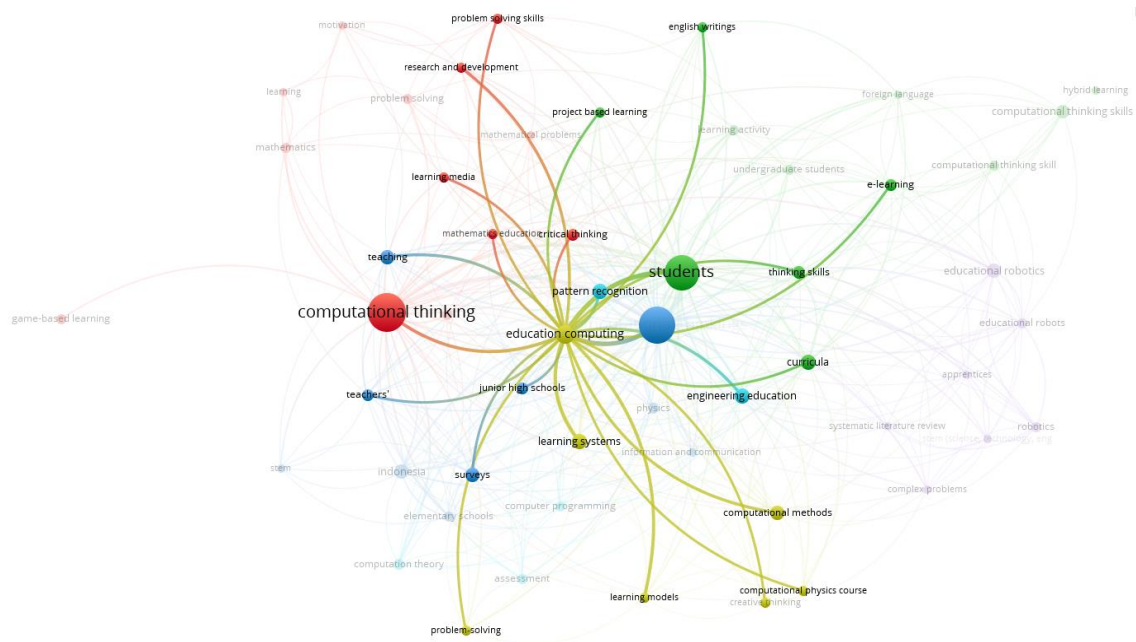


Figure 7. Cluster 4

A different perspective in Figure 7 represents multiple keywords such as computational methods, computational physics course, creative thinking, education computing, learning models, learning systems, and problem-solving. This set of studies reveals interconnected discussions on employing CT as an approach, framework, and educational strategy to enhance students' innovativeness and problem-solving proficiencies.

4.5. Cluster 5 (Violet): Educational Robotics

An essential teaching/learning tool became the center for Cluster Violet in Figure 8. This cluster encompasses several terms, including apprentices, complex problems, educational robotics, educational robots, robotics, STEM (science, technology, engineering, and mathematics), and systematic literature reviews. This compilation highlights interconnected research on integrating CT into education via robotics media, especially within STEM fields, to equip students with skills to solve complex challenges.

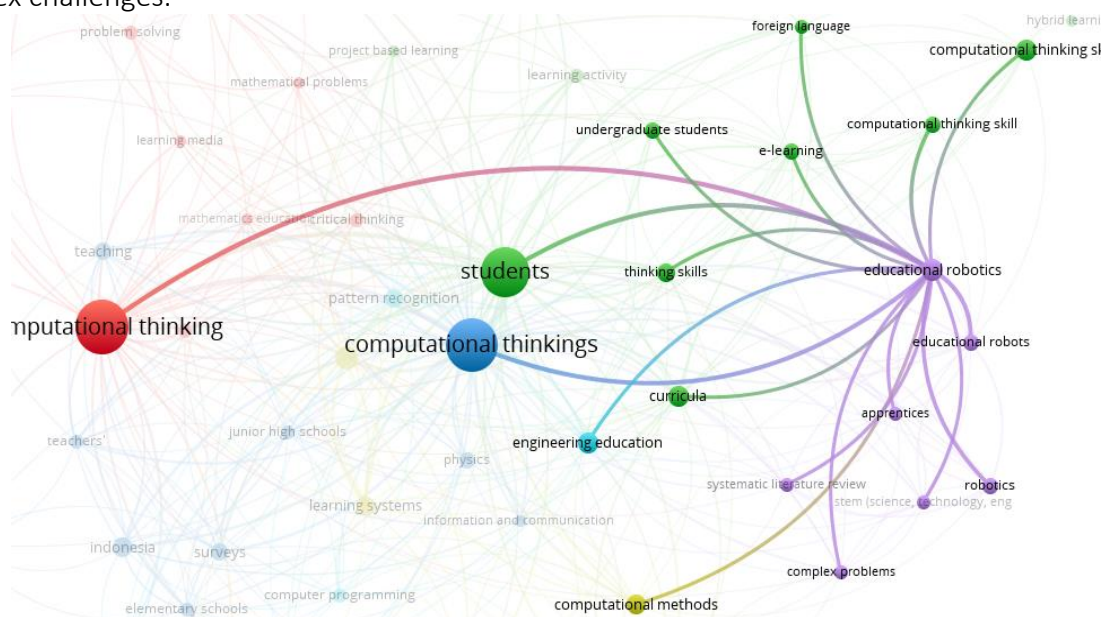


Figure 8. Cluster 5

4.6. Cluster 6 (Light Blue): Computation Theory

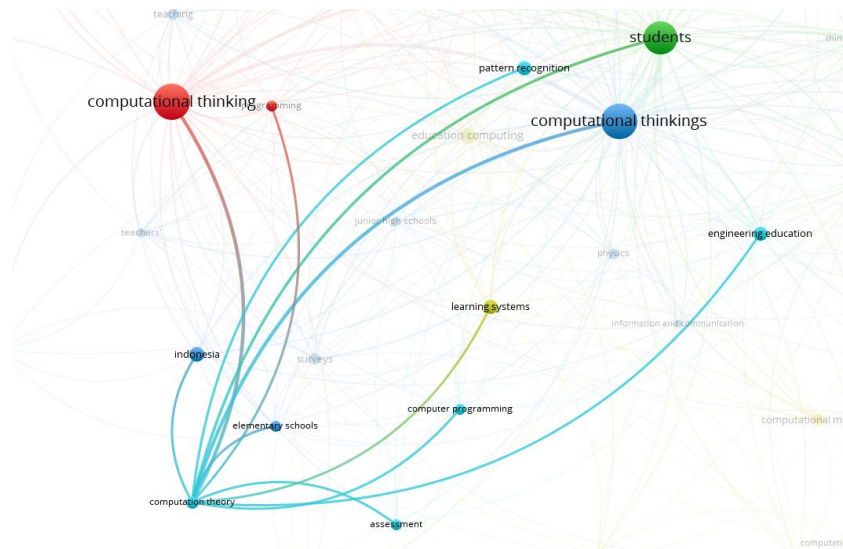


Figure 9. Cluster 6

The final cluster in Figure 9 indicates the CT relationship with computer science. The cluster includes several keywords such as assessment, computational theory, computer programming, engineering education, and pattern recognition. This assortment signifies intertwined studies examining the evaluation of CT instruction in engineering education, focusing on computational theory and programming.

4.7. Bibliographic Study Results

The interconnected research clusters in Indonesia explore various aspects of CT teaching and its application across different educational contexts. These clusters explore CT instruction through various methods, including game-based learning, e-learning, hybrid learning, and project-based learning. They also emphasize CT's relevance in STEM fields, particularly in physics and information technology, spanning from elementary to junior high levels. Moreover, the research examines the impact of CT on enhancing critical thinking, problem-solving, and creative thinking skills. Additionally, it explores the integration of robotics media in CT teaching to tackle complex problems and addresses assessment methods within engineering education, focusing on computational theory and programming. Overall, these bibliographic findings highlight a multifaceted approach to CT education in Indonesia, encompassing diverse instructional strategies and domains within the educational landscape.

5. Discussion

This section discusses the results of the systematic literature review that has been conducted previously. The discussion focuses on trends in conception, methods, technology, and assessment types in CT teaching in Indonesia.

5.1. Conceptualizations of CT in the Indonesian Context

Since its first discovery in 1996 (Kalelioglu et al., 2016), many Indonesian researchers have different insights about CT. In this study, we discovered that CT is conceived as a mandatory skill that falls into six concepts, namely CT as a problem-solving skill, CT as a computational concept, CT as data analysis support skill, CT is associated with a particular course, CT as a component of digital literacy, and CT as a teaching approach practice.

CT, as a problem-solving skill, is the definition of CT that is most familiar to researchers. Aristawati et al. (2018) argue that CT is a problem-solving skill used to deal with real-world problems. Many researchers also consider that CT is a fundamental skill and attitude for developing problem-solving skills in everyday life (Andriyani, 2023; Budiyanto et al., 2022; Huda & Rohaeti, 2024; Magta & Mahardika, 2023; R. R. Richardo et al., 2023), especially those related to the development of computer applications (Muchsini et al., 2022). Problem-solving skills are also related to CT as a computational concept. Problem-solving skills need to adopt computer scientists' way of thinking and systematic procedures to find a solution (Amri et al., 2022; Sondakh et al., 2020a, 2020b). Therefore, CT as a problem-solving skill involves ideas, data, logical reasoning, and understanding of the actual situation (Fakhriyah et al., 2019; Muchsini et al., 2023; Sawiji et al., 2024; Syafril et al., 2022; Triswidrananta et al., 2022).

In the third concept, CT is associated with a particular course. Zakwandi et al. (2024) stated that CT is becoming increasingly integrated into diverse learning experiences. In this study, we found that there were four courses implemented CT namely science, mathematics, physic, and English. CT promotes new ways of thinking to various scientific disciplines (Mulyati et al., 2022) including mathematics (Aminah et al., 2023) and physics (Herwinarso et al., 2023). CT in mathematics involves solving mathematic problems by recognizing the pattern of numbers and applying relevant rules (Aminah et al., 2022; Aminah et al., 2023; Angraini et al., 2023; Helsa et al., 2023; Maharani et al., 2019; Munawarah et al., 2021; Purwasih et al., 2024; Susanti et al., 2023). In a physics course, CT has becomes a common ability to understand physical phenomenon (Herwinarso et al., 2023). CT can be applied to English course as well. It is argued that CT in an English course facilitated students' language and writing skills improvement (Peng et al., 2023; Wu et al., 2024).

CT as a teaching approach practice, on the other hand, is related to CT as data analysis support skill. Andriyani (2023) argued that CT is basic skill needed in learning of any subjects. As a teaching approach practice, educators can use CT as a cognitive tool to identify, evaluate, and apply efficient solutions to problems (Abidin et al., 2023; Aminah et al., 2022). Therefore, this is where CT plays a role as a supporting skill for data analysis. CT helps students and teachers understand human behaviour, analyse learning, and provide strategies by drawing on the basic concepts of computer science (Indrawati et al., 2024; Peng et al., 2023; Sawiji et al., 2024).

Lastly, CT as a component of digital literacy. Digital literacy is a skill and competence in managing digital technology to carry out activities and solve problems in everyday life (Reddy et al., 2020). As a component of digital literacy, CT is related to the development of computer applications (Lubis et al., 2023; Muchsini et al., 2022). According to Kumala et al. (2023), CT is the ability to describe, analyse, and solve complex problems using the working principles of computers. Rusydiyah et al. (2020) also assert that CT is an ability to define problems before solving them with computational tools.

The study reveals that Indonesian literature adopts diverse conceptualizations of CT, ranging from its framing as a generic problem-solving skill to a component of digital literacy. However, this diversity reflects the absence of a unified national framework. Unlike countries such as the U.S. and U.K., where national curricula provide consistent definitions of CT aligned with cognitive and procedural dimensions (Brennan & Resnick, 2012), Indonesian applications are shaped by top-down policy implementation with limited interpretive guidance at the classroom level. This has resulted in inconsistencies across educational levels and regions, with local educators often interpreting CT based on available training or instructional materials.

5.2. Pedagogical Practices: Global Trends and Local Realities

Nine pedagogical strategies that are currently utilised in teaching CT in Indonesia are depicted in Table 1. The nine pedagogical strategies are constructivist approach (6%), problem-based learning

(22%), digital literacy-based learning (6%), hybrid learning (11%), distance learning (3%), project-based learning (8%), collaborative modeling-based learning (3%), experiential learning (3%), and game-based learning (3%). Unfortunately, fifteen articles did not specifically elaborate the learning methods used in teaching CT (42%).

Table 1. Summary of Method Used in Teaching CT in Indonesia

No	Pedagogical Strategies	Number of Article
1	Constructivist Approach	2
2	Problem-Based Learning	8
3	Digital Literacy-Based Learning	2
4	Hybrid Learning	4
5	Distance Learning	1
6	Project-Based Learning	3
7	Collaborative Modeling-Based Learning	1
8	Experiential Learning	1
9	Game-Based Learning	1
10	Undefined	15

CT skills can be fostered by conducting classroom learning. Teachers must be able to integrate CT into classroom learning and develop CT activities through its components. The concept of problem-based learning is in accordance with the CT concept. Problem-based learning helps teachers integrate CT into the classroom by fostering students' ability to understand problems, identify key elements, and develop their own solutions (Abidin et al., 2023; Amri et al., 2022; Budiyanto et al., 2022). Through problem-based learning, students are expected to be able to view problems from different perspectives, formulate their own answers, and analyze everyday problems. CT is also consistent with collaborative model-based learning, where students collaboratively construct models as part of the learning process. Modelling helps students use scientific methods to acquire new knowledge about natural phenomena (Herwinarso et al., 2023).

The other learning methods—digital literacy-based learning, hybrid learning, distance learning, project-based learning, collaborative modelling-based learning, experience-based learning, and game-based learning—have one thing in common, which is using digital technology. The increasing use of technology allows teachers to integrate digital technologies into learning. Thus, the need for an effective learning strategy to enhance student motivation is clear, and digital technology offers a promising approach by encouraging both willingness to learn and self-awareness in formal and informal settings (Andriyani, 2023; Angraini et al., 2023; Kumala et al., 2023; Magta & Mahardika, 2023; Muchsini et al., 2022; Rusydiyah et al., 2020). When learning to design and develop a game, students are able to study CT, such as problem-solving, decomposition, abstraction, and pattern recognition (Sukirman et al., 2021).

Pedagogical practices in Indonesian CT education generally align with international trends emphasizing active, student-centered learning through problem-based (Sukkamart et al., 2024) and project-based (Fitrah et al., 2025) approaches. However, many implementations remain fragmented. While some studies integrate constructivist elements reminiscent of Papert's (1980) learning-by-

making philosophy, these applications often lack deep theoretical grounding. Unlike the integrated and structured approaches in countries like Finland (Fagerlund et al., 2022) or other Western countries (Mills et al., 2024), CT in Indonesia is frequently introduced as standalone modules or extra-curricular activities. This highlights a need for sustained teacher professional development that connects pedagogical strategies with CT theory and cognitive development.

5.3. Technology Integration and Infrastructure Disparities

Table 2 contains nine technologies used for teaching CT in Indonesia. The eight technologies are Robotic (8%), Ed-Tech Apps (17%), 3D Simulator (6%), Spreadsheets (8%), Scratch (8%), Virtual Reality (3%), Augmented Reality (3%), and Power Point (3%). It was also found that seventeen articles did not use technology when conducting CT research (48%).

In this study we found that Educational Technology Applications (Ed-Tech Apps) are the most frequently used technology. Ed-Tech Apps are software designed to assist learning, either in the form of websites, mobile applications, or desktop applications (Aminah et al., 2022). The Ed-Tech Apps used are the Learning Management System (LMS) (Muchsini et al., 2022), web-based Physics Computational and Science Literacy-Computerized Adaptive Test (PhysComLit-CAT) (Zakwandi et al., 2024), Arithmetic-CT Monkey Game (Andriyani, 2023), Smart PLS application (R. Richardo et al., 2023), and streaming applications (Kumala et al., 2023). Ed-Tech Apps make it easier for students to receive learning materials, discuss, and even receive assignments without being bound by space and time.

Robotics, 3D Simulators, Spreadsheets, Scratch, Virtual Reality (VR), Augmented Reality (AR), and PowerPoint are also CT materials to meet technological requirements. Each application requires problem-solving skills to operate it, especially Robotic applications. Robotics is considered a learning medium that can develop CT's skills because it integrates knowledge, skills, and attitudes (Amri et al., 2022; Aristawati et al., 2018). Robotics can also enhance students' higher-order thinking skills and improve their ability to solve complex problems (Budiyanto et al., 2022).

Table 2. Summary of the Use of Technology in Teaching CT in Indonesia

No	Technology	Number of Article
1	Robotic	3
2	Ed-Tech Apps	6
3	3D Simulator	2
4	Spreadsheets	3
5	Scratch	3
6	Virtual Reality	1
7	Augmented Reality	1
8	Power Point	1
9	No technology	17

Although digital tools such as Scratch, Arduino, and various educational apps are employed in Indonesian classrooms, nearly half of the reviewed studies did not involve technology integration. This is a stark contrast to contexts where CT is inseparable from technology-rich environments. The disparity reflects infrastructural inequalities between urban and rural schools and indicates that Indonesia's CT strategies must adapt to a range of technological access levels. International models

that assume universal access to digital tools may not be immediately transferable without contextual adaptation and investment in digital infrastructure.

5.4. Assessment Approaches and Comparative Gaps

Implementing CT education in Indonesia has largely emphasised problem-solving as a primary means of assessment (Maharani et al., 2019). Mathematical problem-solving tasks, for example, are commonly used to evaluate students' CT abilities (Susanti et al., 2023). This aligns with research highlighting the significance of such approaches in fostering logical reasoning and analytical skills. Studies indicate that such problem-solving assignments are frequently integrated into CT curricula to help students develop algorithmic thinking and structured problem-solving skills (Susanti et al., 2023). However, this narrow focus on mathematical problem-solving may overlook other dimensions of CT, such as abstraction, pattern recognition, and debugging, which are essential for a holistic understanding of CT principles. Furthermore, the heavy reliance on problem-solving tasks as assessment tools may limit the ability to measure students' broader CT competencies beyond mathematical contexts (Aristawati et al., 2018).

Despite the growing interest in CT education, there is an over-reliance on self-reported questionnaires for assessment (Rusydiyah et al., 2020), which may not provide an accurate reflection of students' actual CT skills. Many studies employ various self-assessment tools, such as the CT Scale (CTS) (Huda & Rohaeti, 2024); unfortunately, these instruments often fail to directly evaluate the effectiveness of teaching methodologies. Additionally, while emerging approaches such as observation, interviews (Budiyanto et al., 2022), and adaptive testing methods like the PhysComLit-CAT (Zakwandi et al., 2024) offer alternative means of assessment, their implementation remains limited. This lack of direct evaluation of CT instruction raises concerns about the extent to which existing teaching strategies truly enhance students' CT abilities. Without robust, objective assessment methods, it becomes challenging to determine whether current pedagogical approaches are effectively fostering CT skills in Indonesian classrooms.

Assessment of CT competencies in Indonesia is largely dominated by self-reported questionnaires and mathematics-based tasks. This narrow focus limits the capacity to evaluate key CT dimensions such as abstraction, decomposition, or debugging. In comparison, international practices increasingly employ authentic performance-based assessments and automated coding environments to capture student progress (Kong & Liu, 2020; Lai, 2021). The findings suggest an urgent need for localized, validated assessment tools that reflect the broader dimensions of CT and are feasible within Indonesia's diverse educational settings.

5.5. Alignment and Divergence with International Literature

Overall, the findings show partial alignment with global CT literature in areas such as pedagogy and policy ambition. However, significant divergences remain, particularly in conceptual clarity, integration depth, and assessment strategies. The Indonesian case illustrates how CT adoption is not only a matter of curricular content but also deeply shaped by contextual factors—such as teacher preparedness, resource availability, and socio-cultural expectations. Understanding these influences is vital for crafting CT policies that are both pedagogically sound and contextually responsive.

6. Conclusion

CT has certainly become a trendy term in educational discussions. This study, while the focus is on understanding how CT was practiced and learned in Indonesia, performs an in-depth literature review and using thematic analyses to shed light on the phenomena. In addition to the literature review, a bibliographic analysis was conducted to gain insights into the trends related to CT teaching and learning in Indonesia. The bibliographic analysis findings highlight a multifaceted approach to CT education in Indonesia, encompassing diverse instructional strategies and domains within the

educational landscape. While the thematic analyses delve into four topics: conception, methods, technology, and assessment strategies applied in CT teaching in Indonesia.

Indonesian researchers' conceptions of CT falls into six concepts, namely CT as a problem-solving skill, CT as a computational concept, CT as data analysis support skill, CT is associated with a certain course, CT as a component of digital literacy, and CT as a teaching approach practice. Many researchers also consider that CT is also a fundamental skill and attitude for developing problem-solving skills in everyday life. CT is applicable to a wide range of learning activities. Moreover, it can also help students and teachers understand human behaviour, analyse learning, and provide strategy by drawing on the basic concepts of computer science.

While pedagogical strategies are crucial to implement CT in learning, the capability to integrate CT into classroom learning and develop CT activities through its components may be challenging. The study revealed nine pedagogical strategies that currently utilized in teaching CT in Indonesia. The nine pedagogical strategies are constructivist approach, problem-based learning, digital literacy-based learning, hybrid learning, distance learning, project-based learning, collaborative modeling-based learning, experiential learning, and game-based learning. The concept of problem-based learning is in accordance with the CT concept. Problem-based learning helps teachers integrate CT into the classroom by fostering students' ability to understand problems, identify key elements, and develop their own solutions. Pedagogical strategies require the integration of digital technologies to increase their effectiveness.

CT is related to the development of computer applications. We found that Educational Technology Applications (Ed-Tech Apps) are the most frequently used technology. Ed-Tech Apps are software designed to assist learning, either in the form of websites, mobile applications, or desktop applications. While robotics is considered a fundamental learning medium that enables the development of CT's skills by integrating knowledge, skills, and attitudes.

There is a lack of research in Indonesia that advises on the methodology for evaluating the teaching of CT in Indonesia. This is despite the majority - if not all - of the investigated articles discussing the evaluation of the CT concept. The strategy for evaluating the teaching of CT within the Indonesian context is absent. It is recommended that future research address the scarcity and focus on developing and validating context-specific methodologies to evaluate the effectiveness of CT teaching in Indonesia, as existing studies largely overlook this aspect. This includes designing assessment frameworks aligned with the national curriculum, integrating diverse evaluation methods, and conducting empirical studies to ensure the practical applicability of findings in various educational settings.

7. Limitations and Suggestions

This study has several limitations. First, the literature review was limited to articles that were indexed in the Scopus database. This may have excluded pertinent studies published in regional or non-Scopus-indexed journals, including sources in local languages, even though it was in line with national research standards. This focus may limit the thoroughness of the insights, particularly when it comes to community-based or grassroots CT initiatives in Indonesia. Second, despite being methodical and based on qualitative rigour, thematic analysis is inherently interpretive. Despite the use of independent coders and consensus-building, the researchers' judgment was used to identify and categorise the themes, which adds a degree of subjectivity. Triangulating results with additional data sources or using quantitative synthesis for wider generalisability may be beneficial for future research.

This review highlights Indonesia's progress in integrating Computational Thinking (CT) into education and identifies key areas for further exploration. A shared national understanding of CT is

needed among educators, policymakers, and curriculum developers to ensure consistent learning experiences. Teacher training should move beyond theory to emphasize practical strategies for embedding CT across subjects and education levels. Existing assessment methods—often reliant on self-reports and math-based tasks—should be expanded to include tools that capture the full range of CT skills, such as abstraction, debugging, and creativity. Ultimately, stronger collaboration among researchers, educators, and EdTech developers is crucial for co-designing culturally relevant tools and curricula, thereby enabling more inclusive and impactful CT education in Indonesia.

Declarations

Author Contributions. Cucuk Wawan Budiyanto conceptualized the idea, synthesized the literature review results, and reviewed and finalized the manuscript. Muhamad Nur Azmi Wahyudi determined the methodologies, conducted a literature review, carried out data acquisition, and wrote the initial draft. Indah Widiastuti reviewed the article draft. Rizka Latifah updated the literature data and the manuscript.

Conflicts of Interest. The authors declare no conflict of interest related to this study.

Funding. This research was funded by the Institute for Research and Community Service of Universitas Sebelas Maret (LPPM UNS) Indonesia under the contract number 194.2/UN27.22/PT.01.03/2024. Indah Widiastuti was the Principal Investigator.

Ethical Approval. The study was generated from published literature that did not directly involve human a part of the experimentation. We believe that ethical approval was not required. This study was conducted with respect for integrity principle of systematic literature review.

Data Availability Statement. The data used in this investigation are derived from publicly accessible research articles indexed in the Scopus database. No new or private data was collected. However, any interest in the list of reviewed articles, the VOSviewer analysis files, or the specifics of how the selection of the studies, the corresponding author is more than willing to provide them upon request.

Acknowledgements. We sincerely thank Universitas Sebelas Maret (UNS) for its support of this research through the Research and Community Service Program.

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