Mapping the Research Trends of Computational Thinking in Mathematics Education: A Bibliometric Analysis

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ABSTRACT

Computational thinking (CT) has become an important competency in mathematics education (ME), supporting students' problem-solving, reasoning, and algorithmic thinking. However, the development of research on CT in ME, including publication trends, influential studies, collaboration patterns, and research themes, has not been comprehensively mapped. This study aims to map the research landscape of CT in ME through a descriptive bibliometric analysis. Publication data were retrieved from Google Scholar, Crossref, and Scopus using the keywords computational thinking, education, and mathematics. After relevance screening, 140 publications from 2016 to 2026 were selected for analysis. Publication trends, citation performance, collaboration networks, and keyword co-occurrence were analyzed using VOSviewer. The findings show a substantial increase in publications since 2020, with the highest output recorded in 2023 and 2024. Citation analysis identifies highly cited studies that have contributed to the conceptual development of CT in ME, while the Journal of Pedagogical Research emerged as the most productive journal. The collaboration network indicates emerging but still limited international collaboration, particularly involving researchers from Sweden, Denmark, and the United Kingdom. Keyword co-occurrence analysis reveals three interconnected research areas: CT implementation in mathematics learning, core CT processes such as decomposition, pattern recognition, abstraction, and generalization, and CT assessment and measurement. The findings show that CT research remains focused on measurement and assessment, while pedagogical approaches, creativity, teacher education, and elementary mathematics education are less explored, highlighting the need for systematic, contextual approaches that connect CT processes with meaningful mathematics learning.

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1. Introduction

In the 21st century, an essential skill for every individual to possess is Computational Thinking (CT). Proven by related research, CT is among the vital abilities that students should possess (Valovičová et al., 2020; Yang et al., 2020). CT refers to a cognitive approach to problem-solving that involves formulating or breaking down problems into smaller parts to find and understand solutions (Grover et al., 2020; Leung et al., 2024; Rachman, 2026). Recent studies highlight students' CT abilities by focusing on algorithmic thinking, decomposition, debugging, abstraction, pattern recognition, sequencing, iteration, composition, representation, and causality, all of which play a crucial role in enhancing their cognitive and problem-solving skills (Guss et al., 2024; Montuori et al., 2024; Tariq et al., 2025). Additionally, Lehmann's (2025) study examines how CT skills are used by students throughout the problem-solving process, providing insights into the application of formal steps in an educational context.

CT skills play a strategic role in solving various problems and are highly relevant for application in mathematics and science learning (Hinterplattner et al., 2020; Taslibeyaz et al., 2020). Some studies specifically examined the application of CT in mathematics education (ME) and found it relevant to increasing students' interest and engagement, problem-solving abilities, critical thinking, creativity, and self-confidence (Chytas et al., 2024; Fauzi et al., 2024). Furthermore, Nurlaelah et al. (2024) study showed a harmonious relationship between CT skills and logical-mathematical intelligence, which is very important in the process of solving mathematical problems. In line with this, some researchers emphasize the main characteristics of CT in ME, including cognitive processes, problem-solving, and transposition (Kallia et al., 2021; Urhan, 2022). Given the relevance of CT in ME, Kamalodeen's (2022) study recommends formally incorporating CT skills into the education curriculum.

As interest in its benefits and feasibility grows, CT has become a highly sought-after research topic across various disciplines (Roussou & Rangoussi, 2020). In the field of education, interest in CT has also continued to grow over the past decade, as reflected in the abundance of academic literature and various implementation initiatives at different levels (Muhammad et al., 2023). This indicates that CT is not only theoretically recognized as a 21st-century skill but is also beginning to gain practical attention in the educational curriculum, particularly to support the development of students' cognitive and non-cognitive skills in ME.

There are several approaches to conducting a literature review that can be utilized to obtain the latest information (Suseelan et al., 2022; Xiao & Watson, 2019). Content analysis of literature can be done manually using a qualitative approach, based on the research question formulation, involving a limited number of previous studies used as part of the systematic review process (Angraini et al., 2023; Funa & Prudente, 2021). For example, a meta-analysis study, which is a statistical technique that quantitatively combines empirical evidence from various studies on similar topics to summarize findings and address discrepancies in results across studies (Dettori et al., 2022; K. W. Lee et al., 2020; Suseelan et al., 2022). However, the study by Steingrimsson et al. (2024) found a weakness of meta-analysis: the heterogeneity of initial data (covariates) across studies in the meta-analysis can lead to the systematic loss of important information, thus reducing the accuracy and precision of interpreting the results for the target population.

Opposed to meta-analysis, which quantitatively combines empirical data, the bibliometric approach analyzes and maps publication patterns, research trends, and knowledge networks within a field (Ferrer-Serrano et al., 2025; Hu et al., 2024). Bibliometrics is a research method that uses various statistical techniques and knowledge mapping quantitatively, enabling the identification of the most significant publications in a field and providing comprehensive information about the development of that science (Passas, 2024; Zyoud et al., 2023). Throughout its development, bibliometrics has become an important tool for analyzing and mapping published knowledge across various fields, similar to meta-analysis in its broad scope of literature, making it beneficial for researchers in identifying gaps and research focuses (Chen et al., 2019; Rana & Pragati, 2024; Suseelan et al., 2022).

Previous studies have mapped trends in computational thinking in mathematics education (Fitriyah et al., 2024; Irawan et al., 2024; Muhammad et al., 2023). Building on these studies, the present research provides an updated bibliometric analysis of publications from 2016 to 2026 by examining three complementary dimensions: publication and citation patterns, international collaboration networks, and dominant research themes, emerging trends, and research gaps. This broader analysis enables the study not only to describe the growth and scholarly contributions in the field, but also to reveal how researchers and countries collaborate and which research areas remain underexplored. Thus, the study extends previous bibliometric mappings by providing a more comprehensive and current overview of computational thinking research in mathematics education and identifying directions for future research. The research questions guiding this study are as follows:

1. What is the annual publication distribution, the profile of the most cited authors, and the journals that most frequently publish CT in ME during the period 2016–2026?
2. How is the pattern of collaboration among authors from different countries established in CT research publications in ME during the period 2016–2026?
3. What are the dominant research themes, emerging trends, and research gaps in computational thinking research in mathematics education during the period 2016–2026?

2. Method

This study followed a bibliometric approach using Google Scholar, Crossref, and Scopus to identify publications on computational thinking in mathematics education. The literature search was conducted using Publish or Perish (PoP) with the keywords “computational thinking”, “mathematics”, and “education”, and was limited to publications from 2016 to 2026. The complete search string was “computational thinking” AND (“mathematics” OR “mathematics education”) AND “education”. This period was selected to provide an up-to-date overview of publication trends, conceptual developments, collaboration patterns, and research gaps in computational thinking in mathematics education. The 2016–2026 period covers eleven publication years when calculated inclusively. Retrieved publications were subsequently screened for relevance before being included in the bibliometric analysis (Lismaya et al., 2025).

The initial search generated 1,783 articles, but many were irrelevant to the research context, duplicates, or inaccessible. To ensure relevance, articles were screened based on the following criteria: (1) articles were published in scientific journals, (2) titles contained the keywords CT and ME, (3) abstracts were accessible, (4) articles were not duplicates, and (5) articles were relevant to ME. Following this screening, 152 articles met the eligibility criteria. During the subsequent data preparation for bibliometric analysis, 12 articles were excluded because their bibliographic records were incomplete or could not be processed consistently. Consequently, 140 articles were retained for the final analysis.

The final dataset was saved in .ris and .csv formats and analyzed using Microsoft Excel and VOSviewer version 1.6.21 to map bibliometric and research networks. VOSviewer was used to conduct keyword co-occurrence and co-authorship analyses using the full counting method, with a minimum occurrence threshold of three occurrences for keywords. The keyword data were reviewed for consistency before the analysis to minimize duplicate or inconsistent terms. VOSviewer was then used to visualize relationships among keywords, authors, and countries, facilitating the identification of dominant research themes, emerging trends, thematic clusters, and scientific collaboration networks in computational thinking research in mathematics education. The research procedure was adapted from previous research (Lismaya et al., 2025), as shown in Figure 2.

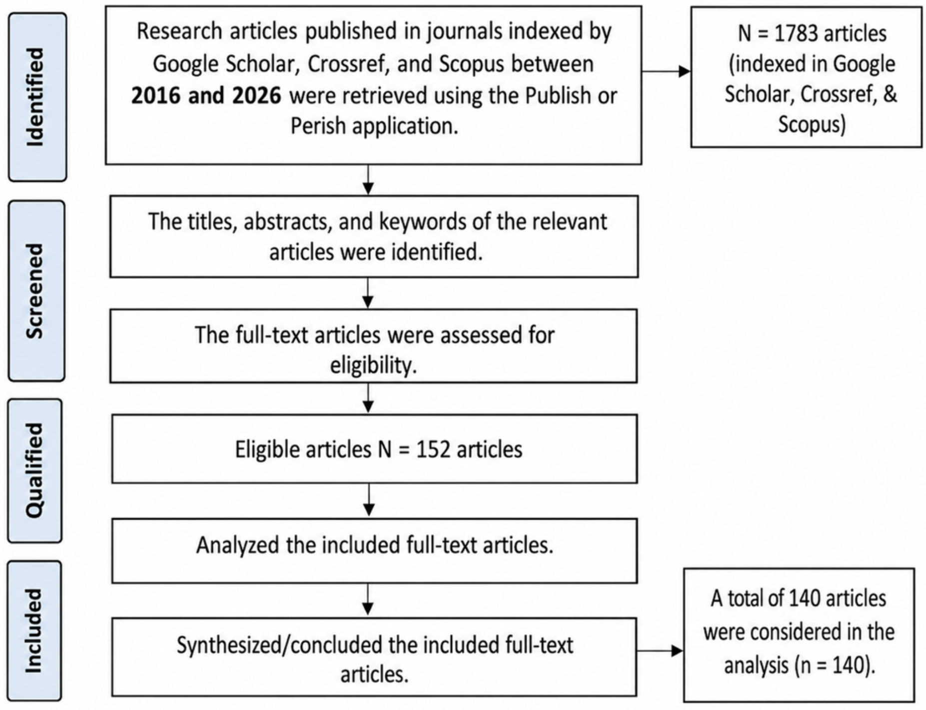

Figure 1. Research Procedure

3. Research Findings and Discussion

The Annual Publication Distribution, Most Influential Authors, and Most Productive Journals in CT Research in ME.

Distribution of Annual Publications, Most Influential Authors, and Most Productive Journals in CT Research in ME. There has been an overall upward trend in the distribution of research publications on CT in the ME context during the 2016–2026 period, although some annual fluctuations were observed. Based on Figure 3, publication output increased gradually from 2016 and reached its peak in 2023 and 2024, with 30 articles in each year. The number of publications subsequently declined to 20 articles in 2025 and 12 articles in 2026. The lower number in 2026 may reflect that the year had not yet ended when the data were collected. The development of research publications on CT in ME from 2016 to 2026 is presented in Figure 2.

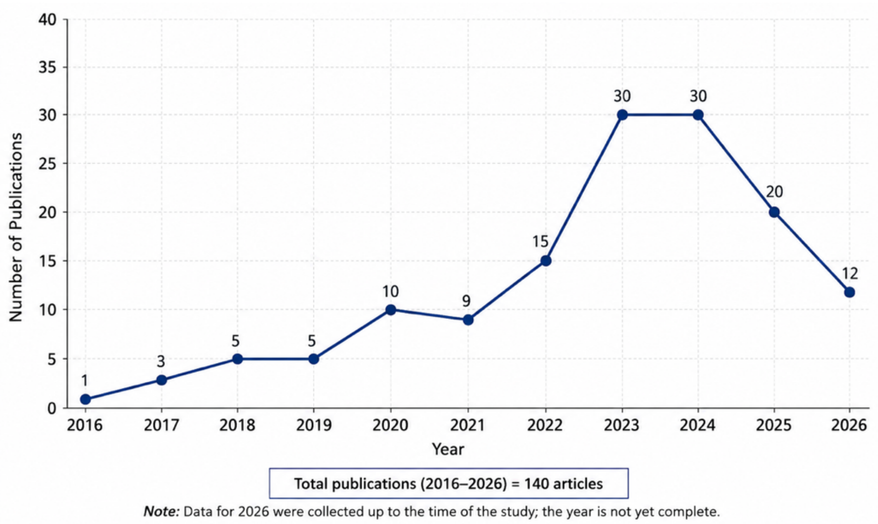

Figure 3. Publication Distribution (2016-2026)

At the beginning of the study period (2016–2019), the number of publications remained relatively low, ranging from 1 to 5 articles per year. In 2020, research on computational thinking (CT) in mathematics education (ME) began to gain momentum, increasing to 10 publications. Although a slight decline was observed in 2021, with 9 publications, the number increased again to 15 in 2022. A substantial increase occurred in 2023 and 2024, with 30 publications in each year, indicating growing scholarly interest in CT within mathematics education. The number of publications subsequently declined to 20 in 2025 and 12 in 2026. The lower number in 2026 may be attributed to the fact that the year had not yet ended when the data were collected. Overall, the publication distribution shows an upward trend with some annual fluctuations, reflecting increasing scholarly attention to CT research in mathematics education during the 2016–2026 period.

In addition to examining publication trends, citation analysis was conducted to identify the most influential authors in computational thinking research within mathematics education. The authors with the highest citation counts are presented in Table 1.

Table 1. Most Highly Cited Articles

No	**Author**	**Title**	**Total Citations**
1	Weintrop et al. (2016)	Defining Computational Thinking for Mathematics and Science Classrooms	2342
2	Rodríguez-Martínez et al. (2020)	Computational thinking and mathematics using Scratch: an experiment with sixth-grade students	328
3	Sung et al. (2017)	Introducing Computational Thinking to Young Learners: Practicing Computational Perspectives Through Embodiment in Mathematics Education	243
4	Kallia et al. (2021)	Characterising computational thinking in mathematics education: a literature-informed Delphi study	220
5	Gadanidis (2017)	Artificial intelligence, computational thinking, and mathematics education	199
6	Hickmott et al. (2018)	A scoping review of studies on computational thinking in K–12 mathematics classrooms	169
7	Barcelos et al. (2018)	Mathematics Learning through Computational Thinking Activities: A Systematic Literature Review	168
8	Pérez (2018)	A framework for computational thinking dispositions in mathematics education	132
9	Rich et al. (2020)	Teacher implementation profiles for integrating computational thinking into elementary mathematics and science instruction	131
10	Gadanidis et al. (2017)	Computational thinking in mathematics teacher education	117

Bibliometric analysis identified a number of prominent authors in CT research in ME, characterized by high citations and significant contributions to the development of CT concepts and practices. The most cited article, Weintrop et al. (2016), with 2342 citations, discusses the definition and framework of CT in the context of ME, serving as a key reference and conceptual foundation for subsequent research in understanding the dimensions of CT for teachers and students. Additionally, several highly cited articles discuss the application of CT through various media and teaching strategies. For example, Rodríguez-Martínez, González-Calero, et al. (2020), with 328 citations, highlighted the implementation of CT using Scratch for sixth-grade students, while Sung et al. (2017), with 243 citations, emphasized an embodied approach to teaching CT to young learners. Other research, such as Pérez (2018) with 132 citations and Gadanidis (2017) with 199 citations, emphasizes the importance of the computational thinking disposition framework and the integration of smart technology to support more effective ME. This finding indicates that the development of CT in ME is multidimensional, encompassing conceptual aspects, learning strategies, thinking dispositions, as well as technological and pedagogical innovations.

In addition to examining the author's contribution, an analysis was also conducted on the publication sources to identify the journals that published the most CT articles in ME. The list of journals with the highest number of CT publications in the context of ME is presented in Table 2.

Table 2. Journal Distribution by Highest Number of Publications

No	Journal	Country of Origin	TP
1	Journal of Pedagogical Research	Turkey	5
2	Digital Experiences in Mathematics Education	Germany	3
3	Education Sciences	Switzerland	3
4	Eurasia Journal of Mathematics, Science and Technology Education	Turkey	3
5	International Journal of Education in Mathematics, Science and Technology	Turkey	3
6	Journal on Mathematics Education	Indonesia	3
7	Education and Information Technologies	USA	2
8	Frontiers in Education	Switzerland	2
9	International Journal of Academic Research in Progressive Education and Development	Pakistan	2
10	International Journal of STEM Education	Germany	2

The distribution of CT research publications in ME shows a global contribution, with the Journal of Pedagogical Research (Turkey) ranking first (five publications), followed by Digital Experiences in Mathematics Education (Germany), Education Sciences (Switzerland), and Eurasia Journal of Mathematics, Science and Technology Education (Turkey), each with three articles. Several other journals, such as the International Journal of Education in Mathematics, Science and Technology (Turkey) and the Journal on Mathematics Education (Indonesia), also published three articles, reflecting Asian interest in CT. Education and Information Technologies (USA) and Frontiers in Education (Switzerland) each had two articles, and the International Journal of Academic Research in Progressive Education and Development (Pakistan) and the International Journal of STEM Education (Germany) each contributed two publications, indicating the increasing global spread of CT research. Overall, CT publications in mathematics education are distributed across journals from Europe, Asia, and North America, with notable contributions from Turkey, Germany, Switzerland, Indonesia, the United States, and Pakistan.

Collaboration Patterns of Authors in CT Research in ME

The authors' collaboration patterns reflect cooperative working relationships among researchers in developing CT studies in the field of ME, demonstrating scientific interaction both at the individual and international levels, as well as the global development of CT research thru multidisciplinary collaboration and exchange of ideas. The visualization of this collaboration pattern is shown in Figure 4.

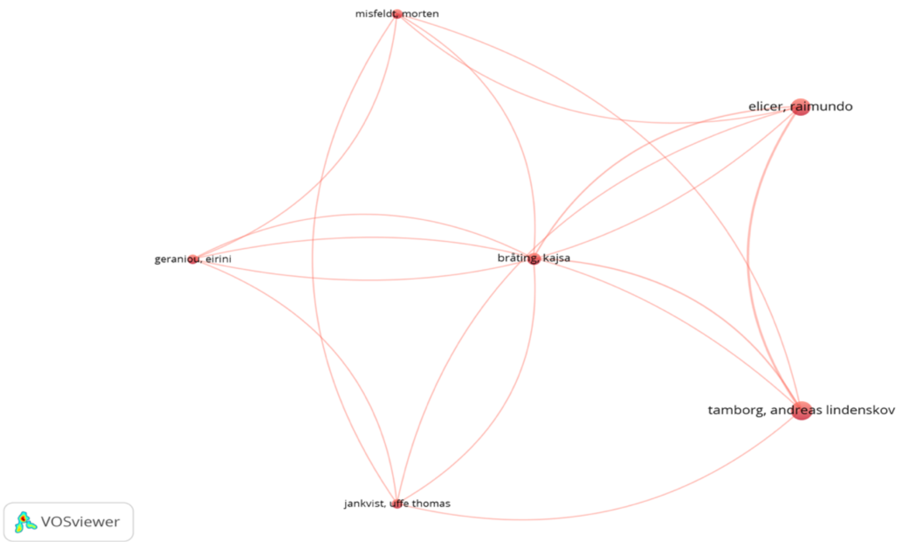

Figure 4. Collaboration Pattern Among Authors

Visualization of author collaboration using VOSviewer shows that the collaboration network in computational thinking (CT) research within mathematics education (ME) remains relatively limited, with nodes representing authors and edges indicating collaborative relationships between researchers (Fitriyah et al., 2024). A small collaborative cluster was identified, consisting of Kajsa Bråting (Sweden), Andreas Lindenskov Tamborg, Raimundo Elicer, Morten Misfeldt, and Uffe Thomas Jankvist (Denmark), together with Eirini Geraniou (United Kingdom), with Bråting serving as the central node. However, collaboration among authors remained sporadic and had not yet developed into a broader international research network. These findings suggest that international collaboration in CT research within ME is currently centered on a small group of researchers from Sweden, Denmark, and the United Kingdom, indicating an emerging collaborative network within Europe.

In addition to reviewing the overall collaborative network structure, an analysis was also conducted to examine the development of author collaboration patterns based on publication year, to understand the dynamics of CT research cooperation in ME over time. The visualization of this development is shown in Figure 5.

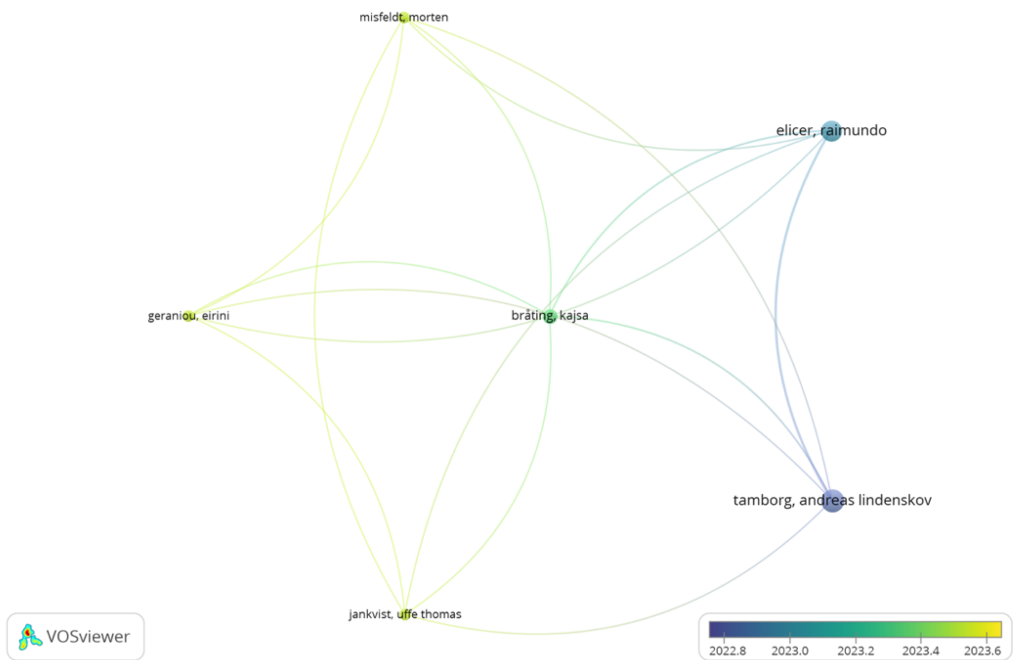

Figure 5. Collaboration Pattern Among Authors Based on Year of Publication

The visualization of the author collaboration overlay illustrates the temporal interconnectedness between researchers in CT studies in mathematics education during the period from 2022 to 2023. The color of the nodes indicates the average year of publication, with Tamborg (Denmark) and Elicer (Denmark) being active earlier around late 2022, while Geraniou (UK), Misfeldt (Denmark), and Jankvist (Denmark) were more dominant in mid-2023. Bråting (Sweden) became a hub for collaboration, connecting with all the other authors, but the network formed was still small and hadn't yet formed large clusters. This indicates that although collaboration has already begun, its intensity and scope are still limited, leaving significant opportunities for expanding cross-country and cross-institutional research collaboration in this field.

Mapping of Themes, Conceptual Framework, and Future Research Directions for CT in ME

The bibliometric mapping of this research used VOSviewer to create, visualize, and explore the network of publication citations (Abdullah, 2021), with data from Google Scholar, Crossref, and Scopus serving as a highly reputable scientific basis (Budianto & Dewi, 2023). The results are visualized to map the development, trends, and interconnections of CT topics in ME, displaying a concept map, relationships between themes, and several main clusters colored green, red, blue, yellow, and purple, which show the interconnections of keywords forming the main research themes, as seen in Figure 6.

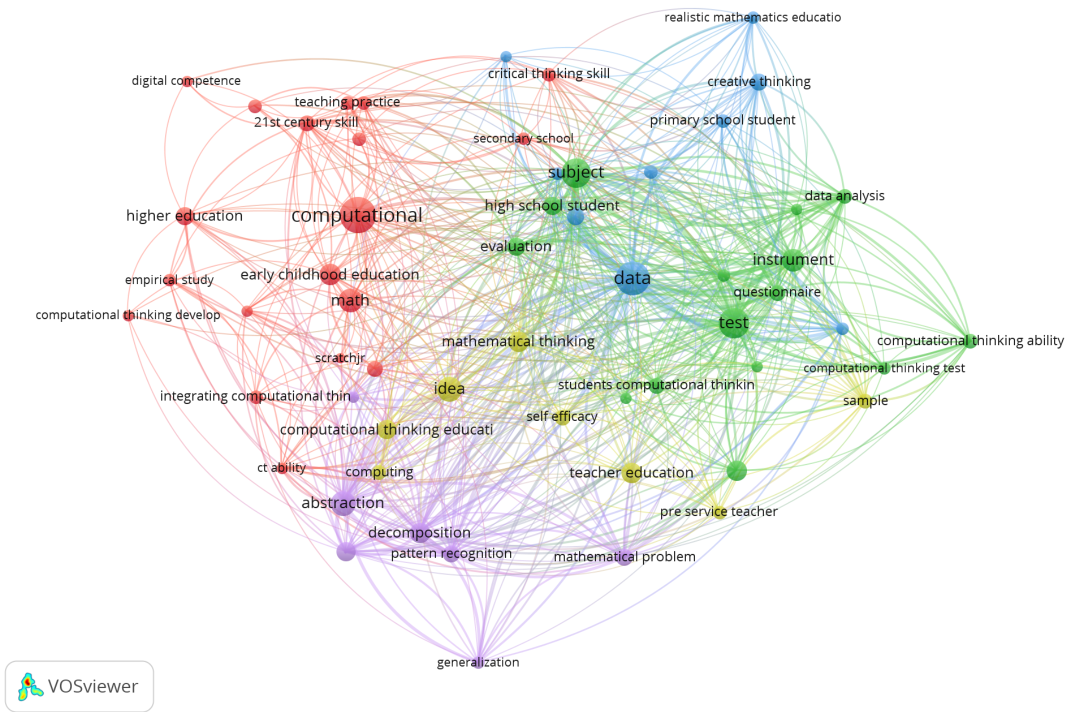

Figure 6. Visualization of Keyword Pair Network Based on Number of Occurrences

The red cluster represents the integration and implementation of CT in ME through keywords such as computational, math, early childhood education, teaching practice, and Scratch. This pattern is supported by studies represented within this research network that examine CT implementation through various learning approaches, including activities for young learners (Sung et al., 2017), CT activities in K–12 mathematics classrooms (Hickmott et al., 2018), mathematics learning through CT activities (Barcelos et al., 2018), and Scratch-based programming in mathematics learning (Rodríguez-Martínez, González-Calero, et al., 2020). The green cluster is dominated by CT assessment and measurement, as indicated by keywords such as test, instrument, questionnaire, data analysis, and computational thinking ability. This focus is also reflected in studies within the research network addressing the characterization of CT in mathematics education (Kallia et al., 2021). Meanwhile, the purple cluster highlights core CT processes, including decomposition, pattern recognition, abstraction, and generalization, which are reflected in conceptual studies of CT and computational thinking dispositions in mathematics education (Pérez, 2018; Weintrop et al. 2016). Overall, the relationships among the keywords and studies across the three clusters indicate that CT research in ME has developed around three interconnected aspects: learning implementation, cognitive processes, and assessment. For mathematics education, this pattern suggests that CT is not only introduced through programming activities or measured through assessment instruments but is also connected to reasoning processes such as decomposition, pattern recognition, abstraction, and generalization that can support mathematical problem solving.

After the main clusters were identified through network visualization, the analysis continued with overlay visualization to illustrate the temporal development and emerging trends in computational thinking (CT) research in mathematics education (ME). The overlay visualization covers the 2021–2023 period, with colours representing the average publication year of each keyword. Keywords shown in blue and purple indicate relatively earlier research topics around 2021, whereas green and yellow indicate more recent topics that emerged closer to 2023. This visualization provides an overview of changes in research focus on CT in mathematics education during the 2021–2023 period, as shown in Figure 7.

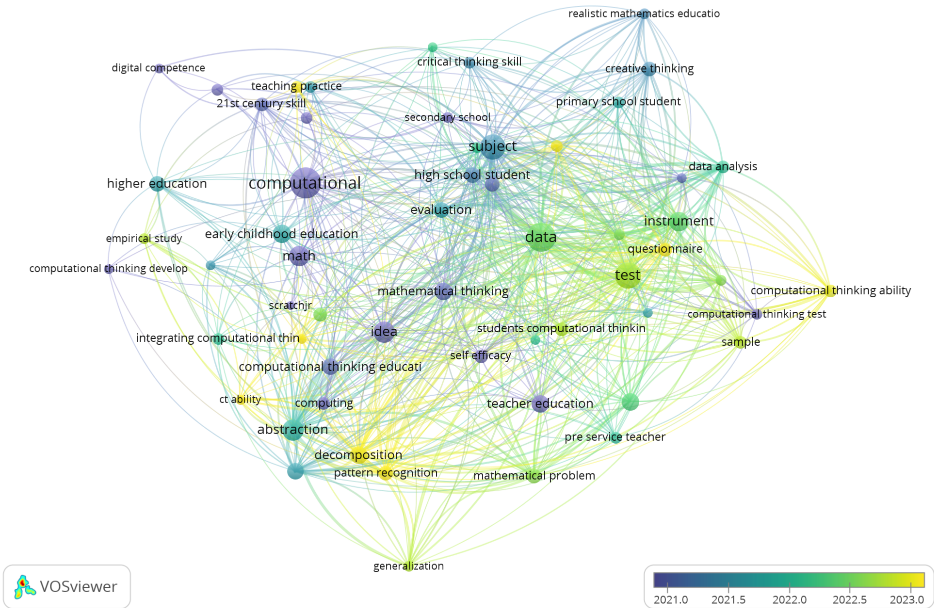

Figure 7. Visualization of Keyword Interconnection Overlay

At the beginning of the period (2021), the focus of the study was still conceptual, such as the integration of CT in education and 21st-century skills. 2022 marked a shift toward empirical research focused on developing instruments, assessments, and measuring CT abilities using keywords such as test, instrument, and data analysis. Meanwhile, the latest trends in 2023 point toward a more applied direction with themes of mathematical thinking ability, self-efficacy, and problem-solving. Overall, CT research in ME has evolved from conceptual studies toward implementation and evaluative application.After the overlay results illustrated the development and novelty of CT research themes in ME, the subsequent analysis focused on the intensity level of research shown through density visualization maps. This map provides an overview of the density and strength of the relationships between the research topics that most frequently emerged during the analysis period. The visualization of this density can be seen in Figure 8.

Figure 8. Visualization of Keyword Pair Density

The yellow area signifies high-frequency themes, such as computational, math, data, test, and instrument, indicating the dominance of quantitative approaches in CT research on ME. The green area, with keywords like mathematical thinking, teacher education, and pattern recognition, reflects a shift in focus toward developing higher-order thinking skills and improving teacher competency. Meanwhile, the blue area, containing terms like early childhood education, generalization, and creative thinking, shows themes that are rarely studied but have significant potential. The results of this visualization guide future research to expand its focus on pedagogical dimensions, innovation in learning strategies, and the implementation of CT from the elementary level to produce a more comprehensive and contextual approach.

4. Conclusion

A bibliometric analysis of CT publications in ME from 2016 to 2026 shows an overall upward trend, with publication output peaking in 2023 and 2024. Highly cited articles contributed to establishing the conceptual foundation of CT, while the Journal of Pedagogical Research emerged as the most productive journal, with five publications. The international collaboration network remains limited, particularly involving researchers from Sweden, Denmark, and the United Kingdom, indicating an emerging but still relatively small European collaboration network. Thematic analysis shows that CT research in ME is strongly oriented toward measurement and assessment, while pedagogical approaches, creativity, teacher education, and elementary-level implementation remain relatively underexplored. Future research should therefore strengthen contextual and pedagogically oriented approaches that integrate CT with mathematical thinking, creativity, and problem-solving to support meaningful computational competencies in students. This study has several limitations. First, the analysis covers publications from 2016 to 2026, so earlier developments in CT research may not be fully represented. Second, the dataset was retrieved from Google Scholar, Crossref, and Scopus, meaning that relevant publications indexed in other databases may have been omitted. Future research could broaden the database coverage by including sources such as Web of Science.

5. Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

6. Author Contributions

K.R. and N.A. conceptualized the research idea, designed the study, collected and analyzed the data, interpreted the findings, and drafted the manuscript. Both authors contributed to the revision of the manuscript, approved the final version of the article, and agree to be accountable for all aspects of the work. The percentage contributions to the conceptualization, data collection, analysis, writing, and revision of this paper are as follows: K.R.: 60% and N.A.: 40%.

7. Data Availability Statement

The bibliographic dataset was retrieved from Google Scholar, Crossref, and Scopus using the search strategy described in the Methods section. The final dataset was used for the bibliometric analysis in this study.

REFERENCES

Abdullah, K. H. (2021). Mapping of marine safety publications using VOSviewer. *ASM Science Journal*, *16*, 1–9. https://doi.org/10.32802/asmscj.2021.774

Angraini, L. M., Yolanda, F., & Muhammad, I. (2023). Augmented Reality: The Improvement of Computational Thinking Based on Students' Initial Mathematical Ability. *International Journal of Instruction*, *16*(3), 1033–1054. https://doi.org/10.29333/iji.2023.16355a

Barcelos, T. S., Muñoz-Soto, R., Villarroel, R., Merino, E., & Silveira, I. F. (2018). Mathematics Learning through Computational Thinking Activities: A Systematic Literature Review. . . *Univers. Comput. Sci., 24*(7), 815-845. https://doi.org/10.3217/jucs-024-07-0815

Budianto, E. W. H., & Dewi, N. D. T. (2023). Research mapping of Working Capital Turnover (WCT) ratio in Islamic and Conventional Banking: Vosviewer bibliometric study and literature review. *Global Financial Accounting Journal*, *7*(2), 181. https://doi.org/10.37253/gfa.v7i2.7709

Chen, X., Wang, S., Tang, Y., & Hao, T. (2019). A bibliometric analysis of event detection in social media. *Online Inf. Rev.*, *43*(1), 29–52. https://doi.org/10.1108/oir-03-2018-0068

Chytas, C., Borkulo, S. P. Van, Drijvers, P., Barendsen, E., & Tolboom, J. L. J. (2024). Computational thinking in secondary mathematics education with GeoGebra: Insights from an intervention in calculus lessons. *Digital Experiences in Mathematics Education*, *10*(2), 228–259. https://doi.org/10.1007/s40751-024-00141-0

Dettori, J. R., Norvell, D. C., & Chapman, J. R. (2022). Fixed-effect vs random-effects models for meta-analysis: 3 points to consider. *Global Spine Journal*, *12*(7), 1624–1626. https://doi.org/10.1177/21925682221110527

Fauzi, A. L., Kusumah, Y. S., Nurlaelah, E., & Juandi, D. (2024). Computational Thinking in Mathematics Education : A Systematic Literature Review on its Implementation and Impact on Students' Learning. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *10*(2), 640–653. https://doi.org/10.33394/jk.v10i2.11140

Ferrer-Serrano, M., Fuentelsaz, L., & Latorre-Martínez, M. P. (2025). Knowledge Transfer and Networks: A Bibliometric Approach Through Performance Analysis, Science mapping, and Dynamic Network Analysis. *Journal of the Knowledge Economy*, 1–36. https://doi.org/10.1007/s13132-025-02814-6

Fitriyah, Y., Dahlan, J. A., & Wahyudin, W. (2024). Review and Trend Analysis of Computational Thinking Research in Mathematics Education (2013-2023). *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika*, *10*(2), 381–394. https://doi.org/10.29407/jmen.v10i2.22039

Funa, A. A., & Prudente, M. S. (2021). Effectiveness of Problem-Based Learning on Secondary

Students' Achievement in Science: A Meta-Analysis. *International Journal of Instruction*, *14*(4), 69–84. https://doi.org/10.29333/iji.2021.1445a

Gadanidis, G. (2017). Artificial intelligence, computational thinking, and mathematics education. *The International Journal of Information and Learning Technology*, *34*(2), 133–139. https://doi.org/10.1108/ijilt-09-2016-0048

Gadanidis, G., Cendros, R., Floyd, L., & Namukasa, I. (2017). Computational thinking in mathematics teacher education. *Contemporary Issues in Technology and Teacher Education*, *17*(4), 458–477.

Grover, S., Fisler, K., Lee, I., & Yadav, A. (2020). Integrating computing and computational thinking into K-12 STEM learning. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education* (pp. 481–482). ACM. https://doi.org/10.1145/3328778.3366970

Guss, S. S., Clements, D. H., Sharifnia, E., Sarama, J., Holland, A., Lim, C.-I., & Vinh, M. (2024). Designing Inclusive Computational Thinking Learning Trajectories for the Youngest Learners. *Education Sciences*, *14*(7), 733. https://doi.org/10.3390/educsci14070733

Hickmott, D., Prieto-Rodriguez, E., & Holmes, K. (2018). A Scoping Review of Studies on Computational Thinking in K–12 Mathematics Classrooms. *Digital Experiences in Mathematics Education*, *4*(1), 48–69. https://doi.org/10.1007/s40751-017-0038-8

Hinterplattner, S., Skogø, J. S., Kröhn, C., & Sabitzer, B. (2020). The Children's Congress: A Benefit to All Levels of Schooling by Strengthening Computational Thinking. *International Journal of Learning and Teaching*, *6*(4), 241–246. https://doi.org/10.18178/ijlt.6.4.241-246

Hu, J., Li, C., Ge, Y., Yang, J., Zhu, S., & He, C. (2024). Mapping the Evolution of Digital Health Research: Bibliometric Overview of Research Hotspots, Trends, and Collaboration of Publications in JMIR (1999-2024). *Journal of Medical Internet Research*, *26*, e58987. https://doi.org/10.2196/58987

Irawan, E., Rosjanuardi, R., & Prabawanto, S. (2024). Research trends of computational thinking in mathematics learning: A bibliometric analysis from 2009 to 2023. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(3), em2417. https://doi.org/10.29333/ejmste/14343

Kallia, M., van Borkulo, S. P., Drijvers, P., Barendsen, E., & Tolboom, J. (2021). Characterising computational thinking in mathematics education: a literature-informed Delphi study. *Research in Mathematics Education*, *23*(2), 159–187. https://doi.org/10.1080/14794802.2020.1852104

Kamalodeen, V. J. (2022). Computational thinking for all: a new skill for the digital age. *Caribbean Curriculum*, *29*, 223–250. https://doi.org/https://journals.sta.uwi.edu/ojs/index.php/cc/article/view/8324

Lee, K. W., Loh, H. C., Ching, S. M., Devaraj, N. K., & Hoo, F. K. (2020). Effects of Vegetarian Diets on Blood Pressure Lowering: A Systematic Review with Meta-Analysis and Trial Sequential Analysis. *Nutrients*, *12*(6), 1604. https://doi.org/10.3390/nu12061604

Lehmann, T. H. (2025). Examining the interaction of computational thinking skills and heuristics in mathematical problem solving. *Research in Mathematics Education*, *27*(2), 269–290. https://doi.org/10.1080/14794802.2025.2460460

Leung, S. K. Y., Wu, J., & Li, J. W. (2024). Children's knowledge construction of computational thinking in a play-based classroom. *Early Child Development and Care*, *194*(2), 208–229. https://doi.org/10.1080/03004430.2023.2299405

Lismaya, L., Hartono, H., Subali, B., Sumarni, W., Ridlo, S., & Nuswowati, M. (2025). Higher order thinking skills research trends: a bibliometric analysis in selected journals (2014 to 2023). *International Journal of Evaluation and Research in Education (IJERE)*, *14*(1),

695. https://doi.org/10.11591/ijere.v14i1.29590
Montuori, C., Gambarota, F., Altoé, G., & Arfé, B. (2024). The cognitive effects of computational thinking: A systematic review and meta-analytic study. *Computers & Education*, *210*, 104961. https://doi.org/10.1016/j.compedu.2023.104961
Muhammad, I., Rusyid, H. K., Maharani, S., & Angraini, L. M. (2023). Computational Thinking Research in Mathematics Learning in the Last Decade: A Bibliometric Review. *International Journal of Education in Mathematics, Science and Technology*, *12*(1), 178–202. https://doi.org/10.46328/ijemst.3086
Nurlaelah, E., Usdiyana, D., & Fadilah, N. (2024). The Relationship Between Computational Thinking Ability and Logical Mathematical Intelligence. *Mosharafa: Jurnal Pendidikan Matematika*, *13*(1), 87–96. https://doi.org/10.31980/mosharafa.v13i1.1978
Passas, I. (2024). Bibliometric Analysis: The Main Steps. *Encyclopedia*, *4*(2), 1014–1025. https://doi.org/10.3390/encyclopedia4020065
Pérez, A. (2018). A Framework for Computational Thinking Dispositions in Mathematics Education. *Journal for Research in Mathematics Education*, *49*(4), 424–461. https://doi.org/10.5951/jresematheduc.49.4.0424
Rachman, K. (2026). Analisis kemampuan computational thinking dalam menyelesaikan materi pecahan matematika pada siswa kelas v sekolah dasar. *Jurnal Riset Pendidikan Dasar (JRPD)*, *9*(10). https://doi.org/https://doi.org/10.26618/cc8m8z68
Rana, S., & Pragati. (2024). A Bibliometric and Visualization Analysis of Human Capital and Sustainability. *Vision: The Journal of Business Perspective*, *28*(3), 303–312. https://doi.org/10.1177/09722629221105773
Rich, K. M., Yadav, A., & Larimore, R. A. (2020). Teacher implementation profiles for integrating computational thinking into elementary mathematics and science instruction. *Education and Information Technologies*, *25*(4), 3161–3188. https://doi.org/10.1007/s10639-020-10115-5
Rodríguez-Martínez, J. A., González-Calero, J. A., & Sáez-López, J. M. (2020). Computational thinking and mathematics using Scratch: an experiment with sixth-grade students. *Interactive Learning Environments*, *28*(3), 316–327. https://doi.org/10.1080/10494820.2019.1612448
Roussou, E., & Rangoussi, M. (2020). On the Use of Robotics for the Development of Computational Thinking in Kindergarten: Educational Intervention and Evaluation. In *Robotics in Education* (pp. 31–44). Springer International Publishing. https://doi.org/10.1007/978-3-030-26945-6_3
Steingrimsson, J. A., Barker, D. H., Bie, R., & Dahabreh, I. J. (2024). Systematically missing data in causally interpretable meta-analysis. *Biostatistics*, *25*(2), 289–305. https://doi.org/10.1093/biostatistics/kxad006
Sung, W., Ahn, J., & Black, J. B. (2017). Introducing computational thinking to young learners: Practicing computational perspectives through embodiment in mathematics education. *Technology, Knowledge and Learning*, *10*(4), 1003–1029. https://doi.org/https://doi.org/10.1007/s10758-017-9328
Suseelan, M., Chew, C. M., & Chin, H. (2022). Research on Mathematics Problem Solving in Elementary Education Conducted from 1969 to 2021: A Bibliometric Review. *International Journal of Education in Mathematics, Science and Technology*, *10*(4), 1003–1029. https://doi.org/10.46328/ijemst.2198
Tariq, R., Aponte Babines, B. M., Ramirez, J., Alvarez-Icaza, I., & Naseer, F. (2025). Computational thinking in STEM education: current state-of-the-art and future research directions. *Frontiers in Computer Science*, *6*. https://doi.org/10.3389/fcomp.2024.1480404
Taslibeyaz, E., Kursun, E., & Karaman, S. (2020). How to Develop Computational Thinking:

A Systematic Review of Empirical Studies. *Informatics in Education*. https://www.ceeol.com/search/article-detail?id=914762

Urhan, S. (2022). Using Habermas' construct of rationality to analyze students' computational thinking: The case of series and vector. *Education and Information Technologies*, *27*(8), 10869–10948. https://doi.org/10.1007/s10639-022-11002-x

Valovičová, Ľ., Ondruška, J., Zelenický, Ľ., Chytrý, V., & Medová, J. (2020). Enhancing Computational Thinking through Interdisciplinary STEAM Activities Using Tablets. *Mathematics*, *8*(12), 1–15. https://doi.org/10.3390/math8122128

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

Xiao, Y., & Watson, M. (2019). Guidance on Conducting a Systematic Literature Review. *Journal of Planning Education and Research*, *39*(1), 93–112. https://doi.org/10.1177/0739456X17723971

Yang, K., Liu, X., & Chen, G. (2020). The Influence of Robots on Students' Computational Thinking: A Literature Review. *International Journal of Information and Education Technology*, *10*(8), 627–631. https://doi.org/10.18178/ijiet.2020.10.8.1435

Zyoud, S. H., Shakhshir, M., Koni, A., Shahwan, M., Jairoun, A. A., & Al-Jabi, S. W. (2023). Olfactory and Gustatory Dysfunction in COVID-19: A Global Bibliometric and Visualized Analysis. *Annals of Otology, Rhinology & Laryngology*, *132*(2), 164–172. https://doi.org/10.1177/00034894221082735

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