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Computational Thinking Assessment: Bibliometric Analysis-VOSviewer

Reny Refitaningsih Peby Ria
reny@universitasbumigora.ac.id
Program Studi Ilmu Komputer
Universitas Bumigora

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Abstract : Computational thinking is a very important because it has a role in supporting problem solving in education. Seeing the role of computational thinking in education, an assessment is needed to assess students' skill in applying computational thinking, especially in learning computer science. The aim of this research is to present a bibliometric review of various literatures on computational thinking assessment. This type of research is a bibliometric analysis using VOSviewer. Literature was collected from the Scopus database of 191 articles published in 2019-2023. The results of this study indicate that there are 5 clusters in the network visualization results. Meanwhile, on the results of overlay visualization and density visualization, the computational thinking assessment research shows that when it is associated with the themes of instrument, validity, reliability, and computer science education, not much research has been done so that there are opportunities for renewable research by taking these themes**.**

Keywords : Assessment, Computational thinking, Bibliometric.

INTRODUCTION

Computational thinking (CT) skills are becoming increasingly important in Industry 4.0, characterized by the integration of advanced technologies such as AI, robotics, IoT, and big data into various aspects (Chong, 2019; Nguyen et al., 2019; Ansari, 2020; Maharani, 2020). Initially, CT was used for developing computer applications but in its development it also played a role in supporting problem-solving in all disciplines (Yasin, 2020). Moreover, the transition towards industry 5.0 has caused almost all aspects of life to be related to computer systems, all activities have their own information systems, not only in the technical field but also have an impact on education (Rosadi et al., 2020; Ruppert et al., 2023). According to Buchari et al. (2019), understanding CT is a method that can be used to solve problems by thinking in a computer way. Computer thinking does not have to know programming code in a certain way but is focused on the importance of problem reasoning (Rosyda & Azhari, 2020). Thus, it is not surprising that CT is considered a competency that students must possess to hone HOTS (Zaharin et al., 2018; Diantary & Akbar, 2022; Youjun & Xiaomei, 2022).

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In addition, CT also directs students to have skills in think critically, creatively, communicatively, and collaborate in solving everyday problems (Winata et al., 2022; Akhmad et al., 2023). These conditions require educators to apply CT skills in the learning process in classroom (Lytle et al., 2019; Chevalier et al., 2020). Therefore, there is a need to improve the application of CT as a learning method to facilitate learning through critical thinking and problem-solving in students. (Nurmahmudah et al., 2020). In connection with that, to assess the computational thinking ability of students, an assessment is needed. Moreover, the increasing attention to computational thinking in education has prompted many researchers to investigate how to conduct assessments (Chan et al., 2020; Tang et al., 2020; Yin et al., 2020; Rowe et al., 2021; Weintrop et al., 2021). In order to be able to measure computational thinking ability with good and unbiased instruments it is necessary to have good validity and reliability(Korkmaz et al., 2017; Korkmaz & Bai, 2019; Yağcı, 2019; Kılıç et al., 2021; El-Hamamsy et al., 2022) .

Several previous research studies have discussed CT assessment in mathematics, science, biology, physics, technology, engineering, english education (Weng & Wong, 2017; Rodríguez-Martínez et al., 2019; Lee et al., 2020; Ogegbo & Ramnarain, 2022; Schmidthaler et al., 2022). Based on previous research, the novelty of this research is to discuss CT assessment in computer science education using bibliometric. Considering this, the aim of this research is to carry out comprehensive bibliometric analysis with helpf of VOSviewer software to close research gaps in mapping research on CT assessment literature collected through the Scopus database.

RESEARCH METHOD

This type of research uses bibliometric analysis. Data in the form of 191 articles were obtained from the Scopus database via the www.scopus.com page using the search for the keyword "Computational Thinking Assessment". The data that has been obtained is compiled in RIS format and then analyzed using VOSviewer. In order to enrich the knowledge of mapping, network analysis is carried out using clustering and visualization. (Gillani et al., 2022;Tamala et al., 2022). Hierarchical grouping is used to analyze grouping while visualization analysis uses network visualization, overlay visualization, and density visualization (Dewantara et al., 2021;Mulyawati & Ramadhan, 2021; Bilad, 2022). Some literature states that there are five steps to carry out a bibliometric analysis (Hossain et al., 2020; Haryandi et al., 2021; Satria, 2023) as presented in Figure 1.

Figure 1. Five Stage of Bibliometric Analysis Method

RESULTS AND DISCUSSION

Output Structure of Publications and Citations. The keyword “Computational Thinking Assessment” is used to conduct a literature search in the Scopus database because the database contains several good quality literatures. The selection of keywords is written in the sub-section of the document, namely the search document. The “article title, abstract, keywords” format in the Scopus database was chosen to find more literature. The results of the literature search are shown in Table 1.

Table 1. Search Data Matrix

Matrix Data	Search
Source	Computational Thinking Assessment
Publication year	2019-2023
Paper	191
Citation	1605
Cite/year	401,25
Author/paper	3,52
h-indeks	18
g-index	35
hI,norm	9
hI,annual	2,25
hA-index	11

Based on Table 1, it was obtained literature data of 191 relevant articles in the study with the keyword "Computational Thinking Assessment" which had the most cited papers. The top 10 articles with the most citations are shown in Table 2.

Table 2. Top 10 Articles

Year	Author	Title	Source	Cites
2020	X. Tang, Y. Yin, Q. Lin, R. Hadad, X. Zhai	Assessing Computational Thinking: A Systematic Review of Empirical Studies	Computer and Education	192
2019	L. Zhang, J. Nouri	A Systematic Review of Learning Computational Thinking Through Scractch in K-9	Computer and Education	167

2020	C. Angeli, N. Valanides	Developing Young Children's Computational Thinking with Educational Robotics: An Interaction Effect Between Gender and Scaffolding Strategy	Computer in Human Behavior	138
2021	C. Tikva, E. Tambouris	Mapping Computational Thinking Through Programming in K-12 Education: A Conceptual Model Based on a Systematic Literature Review	Computers and Education	61
2019	S. Pila, F. AladÃ, K.J. Sheehan, A.R. Lauricella, E.A. Wartella	Learning to Code Via Tablet Applications: An Evaluation of Daisy the Dinosaur and Kodable as Learning Tools for Young Children	Computers and Education	47
2021	E. Relkin, L.E. de Ruiter, M.U. Bers	Learning to Code and the Acquisition of Computational Thinking by Young Children	Computers and Education	45
2019	Y. Allsop	Assessing Computational Thinking Process Using a Multiple Evaluation Approach	International Journal of Child-Computer Interaction	45
2021	J. Fagerlund, P. HÃ¤kkinen, M. Vesisenaho, J. Viiri	Computational Thinking in Programming with Scratch in Primary Schools: A Systematic Review	Computer Applications in Engineering Education	44
2019	A. Hershkovitz, R. Sitman, R. Israel-Fishelson, A. EguÃ-luz, P. Garaizar, M. Guenaga	Creativity in the Acquisition of Computational Thinking	Interactive Learning Environments	34
2019	E. Wiebe, B.W. Mott, J. London, K.E. Boyer, O. Aksit, J.C. Lester	Development of a Lean Computational Thinking Abilities Assessment for Middle Grades Students	50th ACM Technical Symposium on Computer Science Education	31

The following shows the results of Vosviewer's output related to networks, overlays, and density visualization.

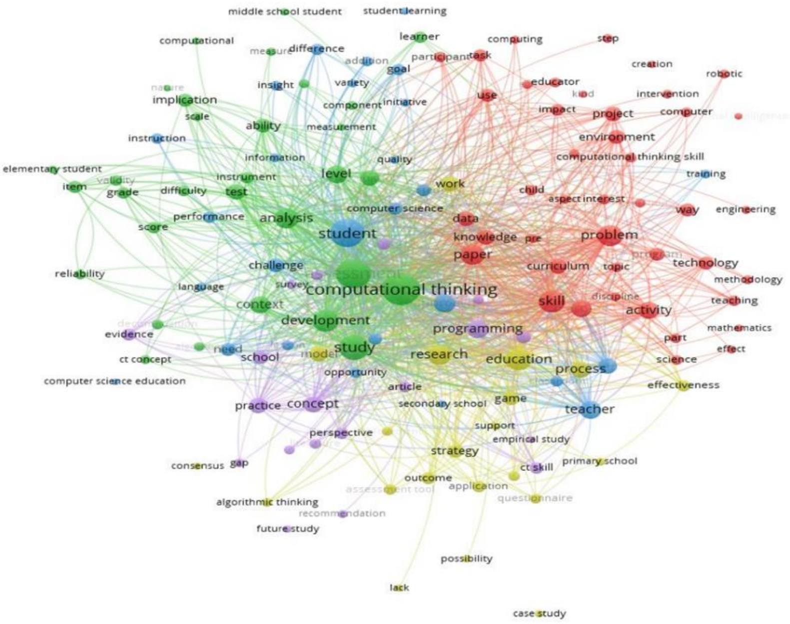

Figure 2. Network Visualization_CT Assessment

In Figure 2 the CT research is divided into 5 color clusters connected to 141 items. The keywords representing each cluster are shown in Table 3.

Table 3. Keywords Representing Each Cluster

No	Cluster	Elemen
1	Cluster 1 (43 items)	Activity, artificial intelligence, aspect, child, computational thinking, computer, computing, creation, curriculum, data, discipline, educator, effect, end, engineering, environment, impact, integration, interest, intervention, kind, knowledge, learning, mathematics, methodology, paper, part, participant, pre, problem, program, project, robotic, science, skill, step, task, teaching, technology, topic, university, use, way
2	Cluster 2 (31 items)	Ability, algorithm, analysis, assessment, component, computational, computational thinking, context, ct concept, decomposition, development, difficulty, elementary student, evaluation, grade, implication, instrument, item, learner, level, measure, measurement, middle school student, nature, relationship, reliability, scale, score, study, test, validity
3	Cluster 3 (27 items)	Addition, approach, challenge, classroom, computer science, computer science education, course, difference, goal, implementation, information, initiative, insight, instruction, language, lesson, need, opportunity, performance, quality, secondary school, student, student learning, system, teacher, training, variety
4	Cluster 4 (21 items)	Algorithm thinking, application, assessment tool, case study, consensus, content, education, effectiveness, game, improvement, lack, model, outcome, possibility, primary school, process, questionnare, research, strategy, support, work
5	Cluster 5 (19 items)	Article, concept, ct skill, emprical study, evidence, framework, future study, gap, importance, literature, perspective, practice, progamming, progamming language, recommendation, researcher, school

Referring to Figure 2 and Table 3, CT research is focused on cluster 2 on the keyword "instrument, validity, reliability" and cluster 3 on the keyword "computer science education". This is because the link between CT and the keywords "instrument, validity, reliability" is not so strong as indicated by a small circle. Meanwhile, CT with the keyword "computer science education" does not have a link that is connected by marked computer science education has a small circle. According to Karim et al. (2022) the meaning of a small circle in network visualization is that not many research results have been carried out related to these keywords so that there are opportunities for further research.

In Figure 3 it shows that there are several old research topics and the latest topics in CT assessment research. The VOSviewer software shows that CT assessment when it is linked to the themes of instrumentation, validity, reliability, and computer science education has recently received attention for research. This is shown in blue, green, and yellow with the time range of article publication from 2020 to 2021. This means that the brighter the color of the year, the newer the year of publication of the research (Hufiah et al., 2021; Hanifah et al., 2022; Muntazhimah et al., 2022; Abraham, 2022; Indriyanti et al., 2023).

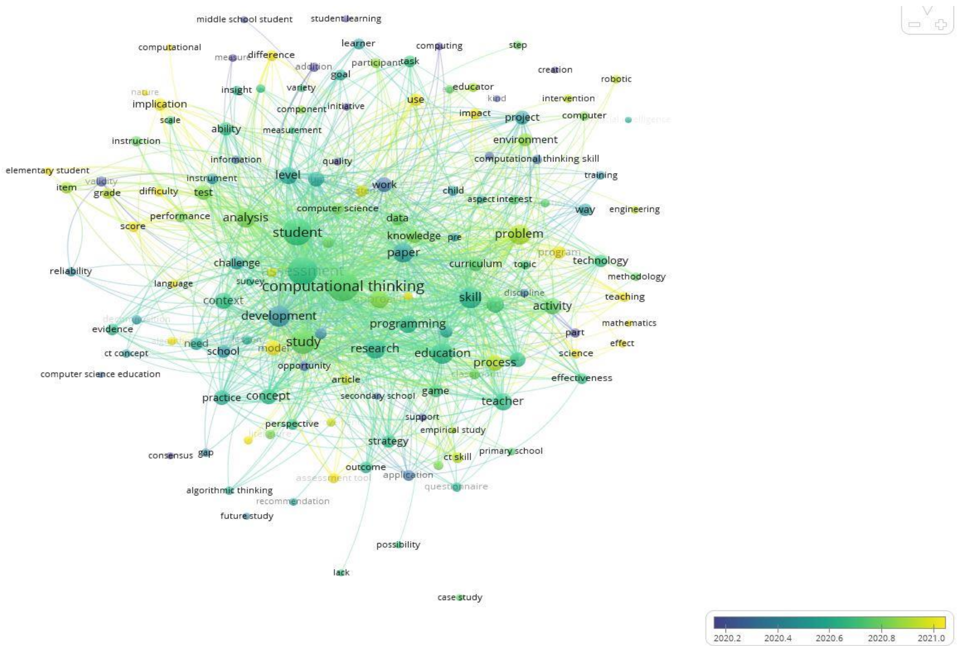

Figure 3. Overlay Visualization_CT Assessment

Figure 3 shows that the dimmer color, themes are rarely studied (Habibi et al., 2022; Sarman & Soebagyo, 2022; Supinah & Soebagyo, 2022;Lestari et al., 2023; Nurfaiziya et al., 2023). Therefore, in CT assessment research with the theme of discussing instruments, validity, reliability, and computer science education, there have not been many updates produced by previous researchers. Thus, there are opportunities for renewable research on these themes.

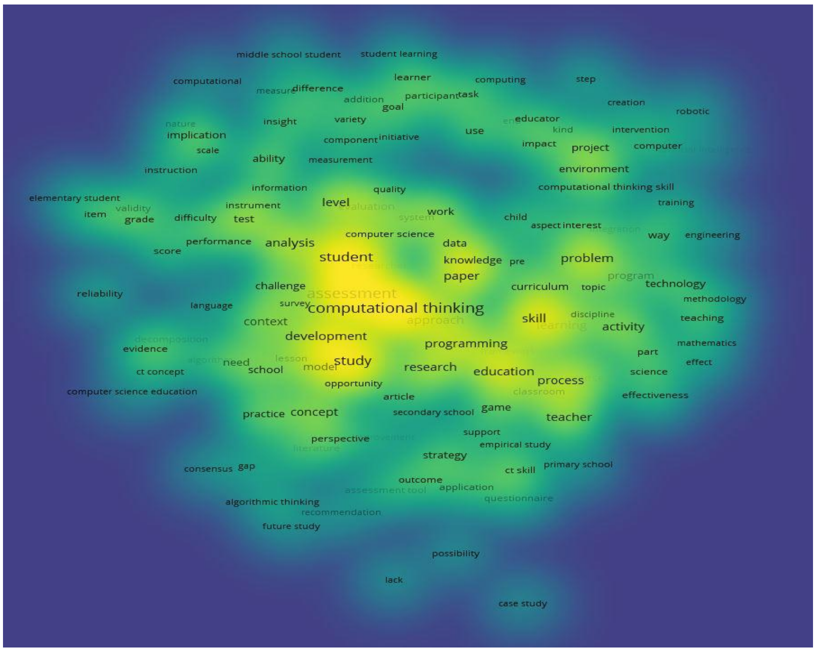

Figure 4. Density Visualization_CT Assessment

CONCLUSION

Based on the findings of this study, the VOSviewer output results on network visualization found 5 cluster themes. Meanwhile, on the results of overlay visualization and density visualization, the CT assessment research shows that when it comes to the themes of instrumentation, validity, reliability, and computer science education, not much research has been conducted so that there are opportunities for renewable energy. research by taking these themes. The researcher understands that this research has limitations that affect the results of the research, namely this research is limited by the small number of keywords captured by the Scopus database. Therefore, future researchers are advised to increase the number of keywords used and improve database accessibility.

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