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Systematic Literature Review: Trends Computational Thinking and Mathematical Disposition in Mathematics Learning

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Abstract. This research aims to provide comprehensive information on the trend of computational thinking ability and mathematical disposition in mathematics learning. The method used was a Systematic Literature Review (SLR). Data was collected by reviewing articles on computational thinking skills and mathematical disposition published in 2019-2024. There were 15 articles, nine related to computational thinking ability and six related to mathematical disposition, obtained from Google Scholar and Scopus. The results of this study indicate that the methods and research designs that tend to be used for research on computational thinking ability and mathematical disposition tend to use quantitative research with quasi-experimental design, and PBL learning models are widely used. Research on thinking ability is predominantly carried out on elementary school students but for mathematical disposition at the junior and senior high school levels with geometry, algebra, and statistics mathematics materials. Computational thinking skills and mathematical disposition are two important aspects of mathematics education that are interrelated and influence each other.
Keywords: computational thinking ability, mathematical disposition, mathematics learning

INTRODUCTION

Some experts believe computational thinking is an essential skill in the 21st century, even dubbed an upcoming skill (Juldial & Haryadi, 2024). Computational thinking can be an essential skill and core value for facing life and future challenges filled with increasing competition and complexity (Rahman, 2022). Computational thinking is a method for exploring problem-solving techniques everyone can utilize, not just those working in computing. It reflects attitudes and skills relevant to this domain (Pewkam & Chamrat, 2022). Computational thinking not only serves as a tool in problem-solving but also encourages individuals to think logically, creatively, and systematically when dealing with various complex situations. Thus, computational thinking skills are becoming increasingly relevant in education and

everyday life to prepare an adaptive and innovative generation to face the challenges of the 21st-century era.

Computational thinking is a cognitive approach defined as the ability to formulate problems and their solutions to efficiently operate computers, individuals, or other technological systems (Wing, 2017). It involves a combination of cognitive skills, where an educator must identify recurring patterns, tackle complex problems by breaking them down into smaller tasks, create step-by-step instructions to reach a solution, and generate data representations through simulations (Mauliani, 2020). In addition, computational thinking helps train the brain to think logically, structurally, and creatively (Angraini et al., 2023). In mathematics education, these skills are essential for solving complex problems, understanding abstract concepts, and improving students' analytical abilities (Supiarmo et al., 2022).

Mathematics also reinforces interrelated knowledge, attitudes, and skills. When someone learns mathematics, it fosters a tendency to think and act positively toward the subject, which is known as mathematical disposition (NCTM, 1989). Mathematical disposition refers to the awareness within students to be active in every learning activity (Febriyani et al., 2022). It plays a crucial role in mathematics education, as a positive attitude toward math can ignite the spirit and desire to solve mathematical problems (Depi et al., 2022). Developing mathematical disposition is essential as it can support students' success in learning mathematics (Dwinta & Karlimah, 2018). Indicators of students' mathematical disposition are as follows: 1) confidence in solving mathematical problems, expressing ideas, and providing justifications; 2) adaptability in exploring mathematical concepts and trying different approaches to solving problems; 3) perseverance in completing mathematical tasks; 4) interest, curiosity, and ability to discover new insights when engaging in mathematics; 5) tendency to monitor and reflect on their thought processes and performance; 6) evaluating the use of mathematics in other fields and everyday life; and 7) appreciating the role of mathematics in culture and its significance, both as a tool and as a language (NCTM, 1989). By utilizing their mathematical dispositions, students are expected to be able to solve problems,

cultivate positive mathematical habits, and take responsibility for their mathematics learning.

Research on computational thinking and mathematical disposition has been widely conducted in Indonesia. However, no one has comprehensively summarized students' computational thinking ability and mathematical disposition in mathematics learning. Therefore, this study aims to provide comprehensive information on computational thinking ability and mathematical disposition in mathematics learning.

RESEARCH METHODS

The method used in this research is a Systematic Literature Review (SLR). In this study, researchers identified, reviewed, reviewed, examined, and described systematically based on available research. The identification and review process carried out in this study refers to the steps proposed by (Triandini et al., 2019).

The first step is to create a research question (RQ) by adjusting the needs of the topic. In this study, the research questions (RQ) include (1) What types and research designs are used in articles from 2019-2024 related to computational thinking ability and mathematical disposition?; (2) What learning models are chosen in articles related to computational thinking ability and mathematical disposition from 2019-2024?; (3) What are the levels and materials related to students' computational thinking ability and mathematical disposition in 2019-2024? (4) Is there a relationship between computational thinking ability and mathematical disposition?

The second step is the search process, which finds relevant data to answer the research question (RQ). Researchers collected articles and journals to complete this research through the Google Scholar and Scopus databases with the keywords computational thinking and mathematical disposition in mathematics learning. The third step is inclusion and exclusion criteria. This step aims to classify whether the data obtained can be used in this study. This study can be selected if they meet the criteria in Table 1.

The fourth step is quality Assessment. The data obtained will be evaluated according to the assessment criteria, including (1) Was the journal article published

in 2019-2024?; (2) Does the article include the type and design of the research used?; (3) Does the article include the learning model used? Each article will be given a "YES" or "NO" answer. The fifth step is data collection. In this research, the primary data is primary data. Primary data is data or information collected through observation, surveys, interviews, and customized needs. The sixth step is Data Analysis. At the data analysis stage, the data collected is analyzed following the research question (RQ). The last step is a deviation from the protocol.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Relevant international or national articles related to computational thinking skills and mathematical disposition.	International or national articles that are not relevant to computational thinking and mathematical disposition.
International or national articles that are relevant to the research topic.	International or national articles that are not relevant to the research topic.
The period used is articles published in 2019-2024.	The timeframe used is articles published before 2019.
Articles obtained from Google Scholar and Scopus.	Articles were obtained in addition to Google Scholar and Scopus.
The language used is Indonesian or English.	The language used is either Indonesian or English.

RESULT AND DISCUSSION

Based on the analysis of several articles, 15 articles were obtained using the keywords. The articles that were obtained comprised nine on computational thinking ability and six on mathematical disposition. The following are the research results of the data in the reviewed articles related to computational thinking ability.

Table 2. Research Results of Computational Thinking Ability Articles

Source	Author & Year	Journal	Research result
Google Scholar	Supiarmo et al., (2022)	Journal Numeracy	Students' computational thinking skills improved in the experimental class utilizing RME learning compared to the control class. This is evidenced by the N-Gain score 0.7 for the experimental class, indicating a high category, while the control class achieved an N-Gain score of 0.5, categorized as medium.
Scopus	Helsa et al (2023)	Journal on Mathematics Education	The hybrid learning model grounded in Technology Pedagogy and Content Knowledge (TPACK) significantly impacts the development of computational thinking skills, demonstrating validity,

			practicality, and effectiveness. Effectiveness test results revealed that 21.9% of students achieved a moderate level, 6.3% were at a low level, and 71.9% fell into the very low category.
Google Scholar	Rahmawati et al., (2024)	Mathematics Teaching Research Journal	The results showed that the computational and mathematical thinking integrated thinking learning design is very suitable for implementation. According to expert assessment, the validity rate is 95.5%, with a practicability score of 93.75%. The instructional design applied in this study has proven effective in improving computational thinking skills. Elementary school students.
Google Scholar	Marbun et al., (2023)	Jurnal Analisa	Differences in computational thinking ability were seen between students taught using problem-based learning rooted in Batak culture, and students taught through direct teaching. Descriptive analysis showed a variation in the mean post-test scores between the two experimental groups. The N-Gain value of the computational thinking test results in the first experimental class was higher than the second experimental class, indicating a more significant improvement in computational thinking skills in the first group compared to the second group.
Google Scholar	Batul et al., (2022)	AKSIOMA: Jurnal Program Studi Pendidikan Matematika	The t-test results of the experimental research showed that the SSCS model learning tool integrated with the RME approach significantly improved students' computational thinking ability. Students' active participation shows the effectiveness of the learning tool, students' positive response to the learning process, and a high level of task completion among students.
Google Scholar	Pranata et al., (2024)	Pendas: Jurnal Ilmiah Pendidikan Dasar	The Project Based Learning learning model affects the ability to think computationally in learning flat buildings of grade V, even semester students of SDN Parakansalak 01 in the 2023/2024 school year.
Google Scholar	Syahputra & Sinaga, (2024)	Jurnal Riset HOTS Pendidikan Matematika	The application of a project-based learning model improves students' computational thinking ability. The increase can be seen in the average student's computational thinking ability starting from the initial test, which is in the very low category. In cycle I, it increased even though it was in the low

			category, and cycle II increased to the high category.
Google Scholar	Pratiwi & Akbar, (2022)	Didaktik : Jurnal Ilmiah PGSD FKIP Universitas Mandiri	The mathematical computational thinking skills of students using the Problem-Based Learning Model are higher than those using the conventional learning model. There is an effect of the problem-based learning model on mathematical computational thinking skills.
Google Scholar	Hidayat et al., (2023)	Caruban: Jurnal Ilmiah Pendidikan Dasar	The mind mapping learning model affects students' computational thinking ability in mathematics learning on data presentation material in class V of SD Negeri 01 Gunung Jati.

The following is the research data on mathematical disposition in the reviewed articles.

Table 3. Research Results of Mathematical Disposition Articles

Source	Author & Year	Journal	Research result
Google Scholar	Hidayatsyah et al (2023)	Jurnal Cendekia: Jurnal Pendidikan Matematika S4	The study found that students who took part in learning using a problem-based mathematics learning model assisted by GeoGebra software showed a significant increase in mathematical disposition ability.
Scopus	Silalahi et al., (2020)	International Journal of Scientific and Technology Research	Students' mathematical disposition after using the RME model in the good category.
Google Scholar	Rahmalia et al., (2020)	Jurnal Numeracy	The mathematical disposition of students who received problem-based learning was better than that of conventional learning students.
Google Scholar	Rahlan & Sofyan, (2021)	PLUSMINUS: Jurnal Pendidikan Matematika	Students' mathematical disposition in both classes that received treatment with CTL and SAVI learning models increased in the sufficient category.
Google Scholar	Femisha & Madio, (2021)	PLUSMINUS: Jurnal Pendidikan Matematika	The improvement of students' mathematical disposition ability between those who get CTL and BBL learning models is classified in the moderate category.
Google Scholar	Irham, (2020)	AlphaMath,	The mathematical disposition of students receiving RME learning is better than that of those following direct learning. Thus, it

	can be concluded that RME learning positively affects mathematical disposition.

Research Question 1. What research designs are used in articles from 2019-2024 related to computational thinking skills and mathematical disposition?

Based on the results of identifying articles related to the type and design of research used from 2019-2024, the types of research obtained from 9 articles on computational thinking ability and six articles on mathematical disposition can be seen in Figure 1.

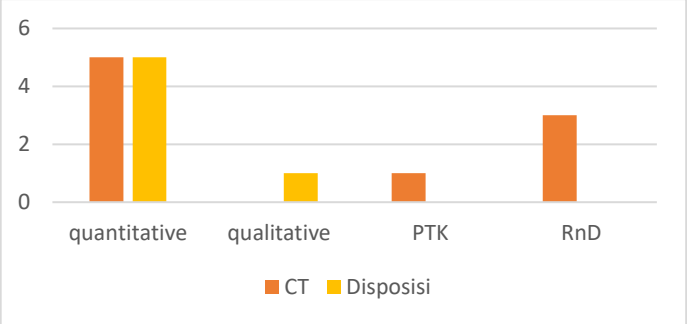

Figure 1. Types of Research Methods for Computational Thinking Ability and Mathematical Disposition

The results of Figure 1 show that of the nine articles related to computational thinking skills in 2019-2024, there are five types of quantitative research: 1 class action research and three research RnD. Meanwhile, mathematical disposition shows six articles from 2019-2024, illustrating the types of quantitative research, five research, and one qualitative research.

After going through the selection of the type of research, then the researcher determines the chosen research design. The research design related to computational thinking ability and mathematical disposition in 2019-2024 is obtained in Figure 2 as follows.

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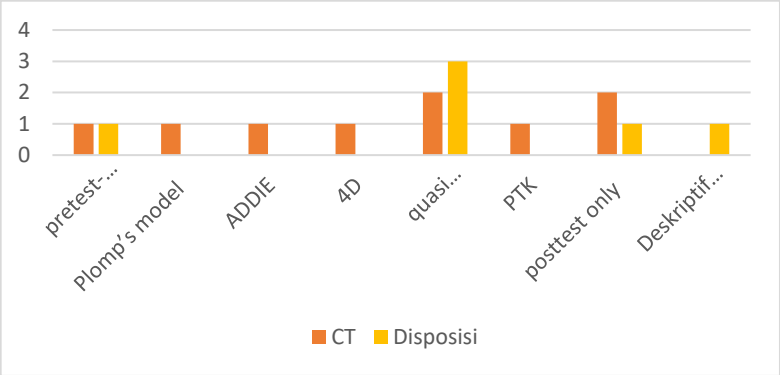

Figure 2. Research Design of Computational Thinking Ability and Mathematical Disposition

Figure 2 shows that of the nine articles related to computational thinking skills in 2019-2024, it illustrates that there are two types of quantitative research with quasi-experimental research designs, one pretest-postest research design, and two post-test-only research. On the other hand, other types of RnD research used are 4D design, ADDIE, and Plomp's model - 1 study each. Moreover, there is also classroom action research with two cycles. Meanwhile, six articles related to mathematical disposition in 2019-2024 illustrate that research using quantitative methods with quasi-experimental design research designs is more widely used; 3 studies use quasi-experimental design. 1 research pretests-posttest design, one post-test only research. And one qualitative research with descriptive qualitative.

Research Question 2. What are the selected models and lessons in articles related to computational thinking and mathematical disposition from 2019-2024?

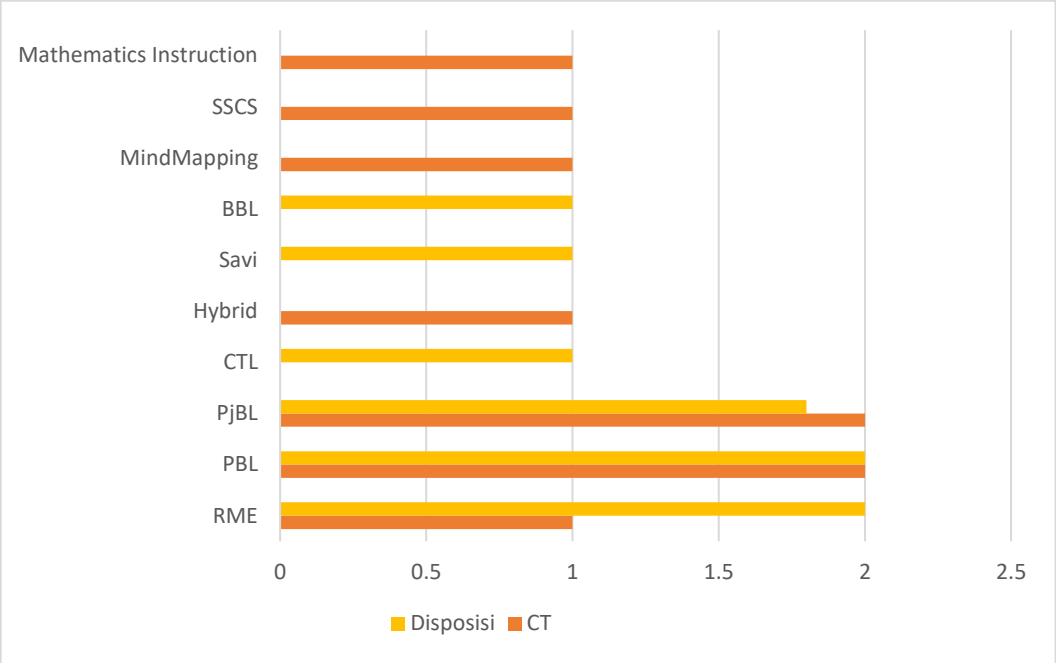

Figure 3. Learning Model on Computational Thinking Ability and Mathematical Disposition

Figure 3 shows that out of 15 articles related to computational thinking skills and dispositions in 2019-2024, the PBL model was chosen more. Learning models that encourage students to be directly involved positively impact affective attitudes and student learning outcomes. This finding is supported by the research (2020) that improved the mathematical disposition of students who received problem-based learning. On the other hand, students' mathematical computational thinking ability using the Problem-Based Learning Model is higher than that of those using conventional learning models. A problem-based learning model affects mathematical computational thinking skills (Pratiwi & Akbar, 2022).

Research Question 3. What are the trends related to computational thinking skills and mathematical disposition from 2019 to 2024?

Based on the results of identifying articles related to trends from 2019-2024, 15 articles on computational thinking skills and mathematical disposition are obtained as follows.

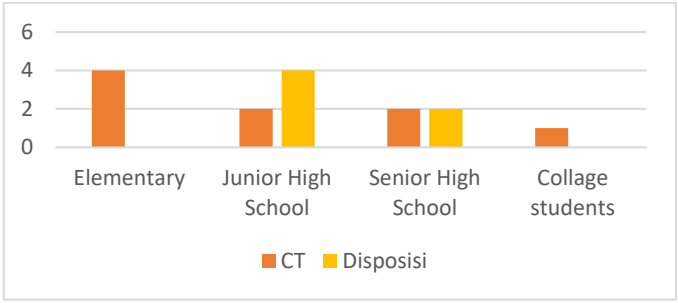

Figure 4. Research Levels of Computational Thinking Ability and Mathematical Disposition

Figure 4 shows that of the 14 articles related to computational thinking ability and mathematical disposition in 2019-2024, it illustrates that the level of education chosen for research related to computational thinking ability is four elementary school studies, while for junior and senior high school levels, two studies. Meanwhile, the level of education chosen for research related to mathematical dispositions is the junior high school level in as many as four studies. Therefore, it can be concluded that there are still few studies related to research on algebraic thinking ability and mathematical disposition at higher levels.

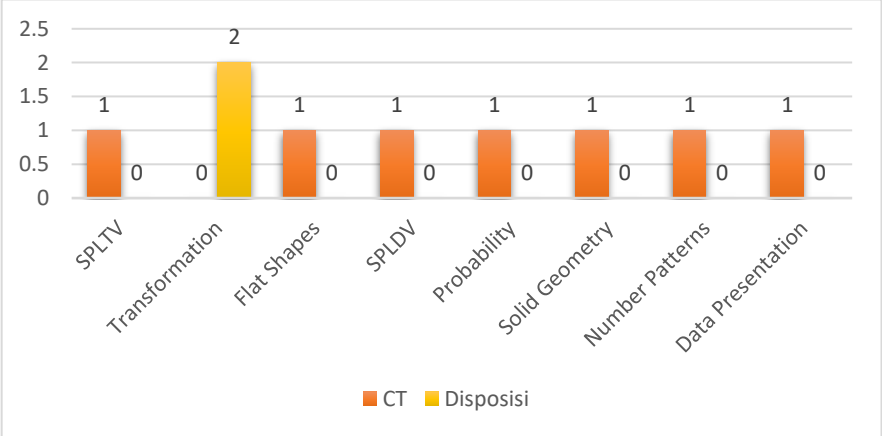

Figure 5. Mathematics Materials Of Computational Thinking Ability And Mathematical Disposition

The results of Figure 5 show that of the nine articles related to computational thinking skills and six articles related to mathematical disposition from 2019-2024 identified, it illustrates that the mathematics materials selected for research related to computational thinking skills and mathematical disposition are SPLDV, SPLTV, Transformation, Flat shape, Probability, Data presentation, and Number Patterns. So, the most common materials chosen for research are algebra, geometry, and

statistics. Geometry learning in mathematics requires sound reasoning to understand it. (Fitria & Maarif, 2021). Students' errors in solving geometry problems include concept, calculation, and information errors that often occur. Information errors are often found in story problems involving geometry. These errors impact student inhibitions so that students will avoid them and be reluctant to encounter geometry problem-solving problems. In learning mathematics, it is not only the ability to understand concepts that students need, but it is necessary to instill mathematical resilience attitudes in students, such as being tenacious, persevering, confident in their abilities, and not giving up easily (Sulistyowati, 2013).

Algebra is difficult to learn mathematics (Lestari & Suryadi, 2020; Maskur et al., 2020; Nada, 2023). One factor that hinders students from learning algebraic material is their difficulty performing algebraic form operations and their lack of understanding of the problems they face. Cahyani et al. (2022) state that most students cannot use their abilities optimally and cannot analyze and communicate their solutions because they still struggle with algebraic operations. For example, students only remember the definitions of variables, coefficients, and constants. Students only understand algebraic forms and can distinguish similar and non-similar terms, as well as the principle of addition and subtraction of algebraic fractions with different denominators. (Zaelani et al., 2020).

In addition, students consider statistical material difficult. This perception is evidenced by the research results by Mediyani & Mahtuum (2020). In addition, students also have difficulty determining what principles or formulas to use and difficulties in terms of academic ability, namely understanding the concept of the problem because it is more related to numbers and logic. It can be seen from the overall average test results that students can solve statistics problems by 69%, reflecting that the difficulties or mistakes experienced by students are due to a lack of mathematical understanding of statistics material. Geometry, algebra, and statistics are the most researched materials because students struggle to solve problems. Research Question 4: Is there a relationship between computational thinking ability and mathematical disposition? Computational thinking and

mathematical disposition are two important aspects of mathematics education that are interrelated and influence each other. Computational thinking is understanding and formulating problems to conceive and implement practical solutions. Computational thinking is understanding and formulating problems to organize and implement effective solutions through computational processes. Wing (2017) defines computational thinking as a way of thinking that involves problem decomposition, pattern recognition, abstraction, and algorithms. Computational thinking is relevant not only in computer science but also in various disciplines, including mathematics. Mathematical disposition refers to attitudes, habits of mind, and tendencies to act mathematically. According to NCTM (1989), mathematical disposition includes aspects such as confidence in using mathematics, a desire to discover and use new strategies, and an appreciation of the role of mathematics in everyday life. The relationship between computational thinking and mathematical disposition can be seen from several problem-solving perspectives. Computational thinking involves the process of problem decomposition and algorithmic thinking, which are important skills in mathematical problem solving. Students who are skilled in computational thinking tend to be more confident in solving mathematical problems, which improves their mathematical disposition.

The computational thinking process encourages students to look for different ways and approaches to solving problems. Creativity in creating algorithms and computational models can broaden students' mathematical horizons, making them more open to new strategies in mathematics. Implementing computational thinking in mathematics learning helps students understand mathematical concepts more deeply. For example, programming in mathematics allows students to see and manipulate abstract concepts to be more concrete, strengthening their understanding and appreciation of mathematics. Research shows a positive correlation between computational thinking skills and mathematical disposition. For example, research by Shute et al. (2017) found that students who engaged in computational-based learning showed significant improvements in mathematical problem-solving ability and positive attitudes towards mathematics. This result suggests that integrating computational thinking

into the mathematics curriculum can improve computational skills while strengthening students' mathematical dispositions.

The 15 articles identified and reviewed show that all researchers are from Indonesia because this research can further explore innovations in teaching methods that suit the characteristics and needs of students in Indonesia. The selection of local articles also enriches the understanding of educational resource development efforts that are more relevant to the conditions and dynamics in the country and provides a more applicable contribution to the improvement and development of mathematics learning in Indonesia. Learning models that encourage students as the center of the learning process are effective in computational thinking skills and provide positive results. Computational thinking skills have increased by using the following learning models Mathematics Instruction Design, SSCS, Mind Mapping, Hybrid TPACK approach, PjBL, PBL, RME (Supiarmo et al., 2022; Rahmawati et al., 2024; Marbun et al., 2023; Pranata et al., 2024; Syahputra & Sinaga, 2024; Pratiwi & Akbar, 2022; Batul et al., 2022; Hidayat et al., 2023; Helsa et al., 2023). Some studies use contextual problems so that students are active in solving problems that emphasize a solution in the form of problems commonly experienced by students, thus constructing students' ways of thinking, communicating mathematical ideas, and working in groups to obtain information in solving the problems given.

On the other hand, learning that involves dispositions encourages students to experience increased achievement in learning mathematics. Good mathematical dispositions, such as interest, creativity, accuracy, courage, and logical thinking skills, can be a substantial provision for students facing mathematical challenges in everyday life. (2023) state that learning models center students on learning, bringing out mathematical dispositions, and providing positive results. Students experiencing an increase in mathematical disposition tend to like challenges and have a high interest in learning mathematics because they believe that every mathematical problem given must have a solution to solve, so they cannot do it in a certain way. They will try to solve it differently (Rahmalia et al., 2020).

CONCLUSION

Based on the results and discussion of the review of 15 articles published in 2019-2024, it can be concluded that the methods and research designs that tend to be used for research on computational thinking ability and mathematical disposition tend to use quantitative research with quasi-experimental designs. Research on computational thinking ability and mathematical disposition uses the most popular problem-based learning model. Research on thinking ability is dominantly conducted on elementary school students but for mathematical disposition at the junior and senior high school levels with geometry, algebra, and mathematical statistics materials. In addition, computational thinking ability and mathematical disposition are two important aspects of mathematics education that are interrelated and influence each other. Integrating computational thinking and mathematical disposition in mathematics learning is increasingly becoming a concern in educational research. Computational thinking plays a role in improving logical, systematic, and creative problem-solving skills. At the same time, mathematical disposition supports the development of positive attitudes towards mathematics, such as self-confidence, perseverance, and interest in learning. Thus, integrating computational thinking and mathematical disposition has excellent potential to create a more meaningful and effective mathematics learning experience. The researcher recommends that further research be conducted related to computational thinking ability and mathematical disposition through the type and design of research or learning models that are still relevant, such as using mixed methods at the high school level with models other than PBL that can improve computational thinking ability and mathematical disposition.

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