Vol. 12, No. 3, pp. 189 – 202 e-ISSN: 2715–856X p-ISSN:2338-1183

Jurnal Pendidikan Matematika

Universitas Lampung

http://jurnal.fkip.unila.ac.id/index.php/MTK

The Influence Of Self-Efficacy On Computational Thinking Ability : Meta Synthesis

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Received: 17 Jul, 2024 | Revised: 10 Oct, 2024 | Accepted: 30 Oct, 2024 | Published Online: 31 Oct, 2024.

Abstract

This study aims to describe the effect of self-efficacy on computational thinking skills, especially in mathematics learning. The method used in this research is meta synthesis as a qualitative systematic review by analyzing 4 journals that are relevant to the research title. The first step is to formulate a research problem, then proceed by tracing existing studies that are relevant to the research title which is then analyzed in depth. The data collection technique uses non-testing by reviewing previous research with similar problems so that the results and conclusions are obtained. The results of the analysis obtained the conclusion that self-efficacy affects the ability to think computationally. The higher the level of self-efficacy, the better the ability to describe important information from the problem, the ability to determine the problem pattern, the ability to mention the problem pattern, and the ability to solve problems with mathematical concepts that need to be used.

Keywords: *self-efficacy; computational thinking; mathematics education*

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan pengaruh self – efficacy terhadap kemampuan berpikir komputasional khususnya pada pembelajaran matematika. Metode yang digunakan dalam penelitian ini ialah meta sintesis sebagai systematic review kualitatif yakni dengan menganalisis 4 jurnal yang relevan dengan judul penelitian. Langkah pertama ialah merumuskan masalah penelitian, kemudian dilanjutkan dengan menelusuri penelitian-penelitian yang sudah ada dan relevan dengan judul penelitian yang selanjutnya dianalisis secara mendalam. Adapun teknik pengumpulan data menggunakan non-tes dengan cara mengkaji penelitian terdahulu dengan masalah yang serupa sehingga diperoleh hasil dan kesimpulannya. Hasil analisis diperoleh kesimpulan self-efficacy berpengaruh terhadap kemampuan berpikir komputasional. Semakin tinggi tingkat self efficacy maka semakin baik pula kemampuan mendeskripsikan informasi penting dari masalah, kemampuan menentukan pola masalah, kemampuan menyebutkan pola masalah, dan kemampuan memecahkan masalah. masalah dengan konsep matematika yang perlu digunakan.

Kata Kunci: Self-efficacy; berpikir komputasional; pembelajaran matematika

INTRODUCTION

The 21st century provides global competence in technological developments, this creates a challenge for the world of education to prepare students who can compete globally (Cahdriyana & Richardo, 2020). Therefore, we should be able to apply ways of thinking such as computer science techniques. In the life we live, we must be able to think like a computer which is able to understand something or a problem quickly so that we can find a solution to a problem quickly. This pattern of thinking is known as computational thinking. Computational thinking is a method for exploring problem-solving techniques for everyone, not just those who work in the computing field, and represents attitudes and skills in that field (Pewkam & Chamrat, 2022). According to Marcia Linn's explanation (Aho, 2012), the capacity for computational thinking is the fundamental basis of all science, including mathematics.

In mathematics, computational thinking is a type of higher order thinking or high order thinking skill (HOTS) that helps facilitate problem solving and improve students' mathematical performance (OECD, 2013). In solving problems using computational thinking, students will be directed to have critical, creative, communicative and collaborative thinking skills (Ansori, 2020; Litia et al., 2023; Sartina et al., 2023). Kalelioğlu (2018), said that the foundations of computational thinking in the process of understanding and solving problems include: decomposition, pattern recognition, abstraction, and algorithms. In line with this, Bocconi et al (2016), explained further that the problem solving process using computational thinking abilities can be seen from a person's ability in (1) decomposition, breaking down complex problems into problems that are easier to understand, (2) pattern recognition, identifying patterns that arise from the problem. has been solved, (3) abstraction, simplifying to find a general concept that can be used to solve the problem at hand, and (4) algorithm, developing gradual solution steps to overcome the problem. The level of computational thinking skills demonstrated by students with high mathematical activity and students with low mathematical activity is significantly different (Orton et al., 2016). In addition, students experience difficulties in integrating computational thinking skills into the mathematics learning process (Weintrop et al., 2016). The process of formulating problems and learning to find and solve them with or without the help of event processing agents (computers or humans) to produce practical and efficient solutions is included in the category of computational thinking (Wing, 2017).

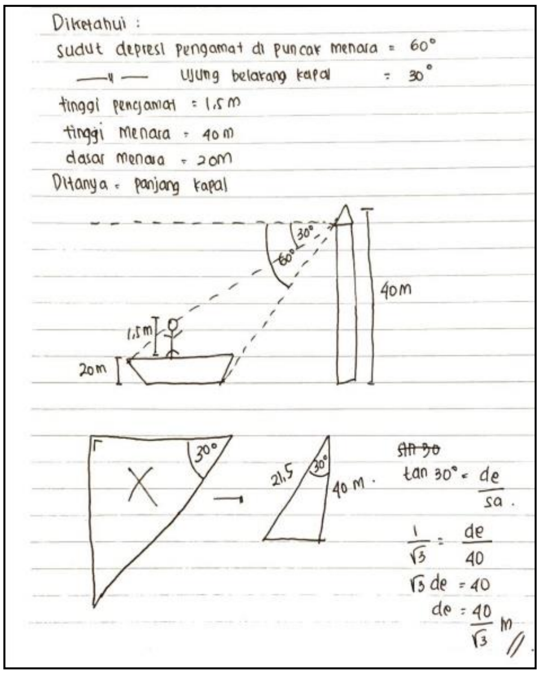

Figure 1. Answer Student

In Figure 1 above, the results of observations on Friday, 03 November 2023 in class In this question, students can only identify information that is known and asked in the question correctly, but students cannot plan a solution using the concepts that have been given to solve it so that students cannot find a pattern to solve the problem. This is in accordance with the computational thinking indicators that students have not met the pattern recognition indicators. that is, students have not been able to understand existing patterns and then relate them to patterns that have been studied previously. Then the researcher asked why the students were unable to solve the problem. Because students view mathematics as a difficult subject, and students are not interested in mathematics, especially when they encounter difficult questions and students do not have strong confidence in answering.

Computational thinking abilities are closely related to real-world problem solving which has a strong relationship with affective mastery, including self-efficacy (Begum et al., 2021). Self-efficacy functions as a predictor of success in solving mathematical problems (Kusmaryono, 2018). Self-efficacy is a belief in one's abilities, factors that influence a person's performance in achieving a goal, and a person's actions in dealing with a problem (Novianti et al., 2018). Therefore, students' lack of self-confidence in their own a bilities results in their inability to solve problems or solve them correctly (Kusmaryono, 2018).

Self-efficacy serves as a tool for predicting computational thinking (Tsai et al., 2019), facilitating the integration of computational thinking skills into students' learning

(Jaipal-Jamani & Angeli, 2017). Consequently, there exists an intertwined relationship between computational thinking proficiency and self-efficacy. Previous studies indicate that self-efficacy plays a vital role in evaluating and forecasting students' computational thinking capabilities (Kukul & Karatas, 2019). Those with high self-efficacy demonstrate superior performance in algorithmic processes and simulations related to computational thinking compared to peers with moderate or low self-efficacy levels (Tsai et al., 2019). Hence, self-efficacy becomes imperative in the context of mathematics education (Bjerke & Solomon, 2020). Bandura & Cherry (2020), suggests that individuals with heightened self-efficacy exhibit resilience in confronting challenges, demonstrate enthusiasm for problem-solving (OECD, 2018), and develop effective strategies for tackling mathematical modeling issues (Kukul & Karatas, 2019). Bandura's work (1997) also outlines three dimensions of self-efficacy: level, strength, and generality. Level pertains to an individual's confidence in resolving mathematical modeling problems, strength denotes confidence in handling diverse problem scenarios, and generality involves confidence in predicting optimization outcomes when applying mathematical models. Drawing from these insights, it becomes apparent that computational thinking skills are indispensable for addressing real-world challenges, while understanding the influence of self-efficacy on the computational thinking process is crucial. Motivated by these considerations, researchers aim to delve into exploring self-efficacy in the context of computational thinking abilities, particularly within mathematics education.

METHODS

This research employs meta-synthesis, a qualitative systematic review method with two approaches: meta-aggregation and meta-ethnography (Lewin, 2008). Here, the meta-aggregation approach is utilized, which involves summarizing validated research findings into specific themes to form an analytical framework (Walsh & Downe, 2005). Through this approach, relevant research articles are collected, compared, and synthesized based on thematic relevance (Siswanto, 2010). Meta-synthesis aims to comprehensively summarize prior research developments, serving as a means to understand the evolving landscape of studies (Krisnawwati et al., 2022).

The research topic chosen is self-efficacy on students' mathematical computational thinking abilities. Data were gathered from scientific journals using keywords "Self-efficacy" and "computational thinking skills" on Google Scholar and Scopus, resulting in the analysis of four relevant articles. The analysis focused on key components such as the significance of computational thinking skills, the relationship between self-efficacy and computational thinking skills, and the research outcomes.

The qualitative analysis produced in this study is structured following the steps outlined by Francis & Baldesari (2006):

1. Formulating the research question, which explores the influence of self-efficacy on computational thinking abilities.
2. Developing a protocol by conducting a systematic literature search within the timeframe of 2020-2024.
3. Screening and selecting appropriate research articles based on qualitative criteria related to self-efficacy and computational thinking skills.
4. Analyzing and synthesizing qualitative findings from the selected articles.
5. Implementing quality control to ensure adherence to qualitative meta-synthesis standards.
6. Summarizing and drawing conclusions from the prepared results and discussions.

RESULTS AND DISCUSSION

The following 4 articles have been selected for analysis regarding the influence of self-efficacy on computational thinking abilities. The selection of these four articles was based on their relevance to the relationship between self-efficacy and computational thinking skills. The four articles selected provide the necessary variety and depth for this study, both from the perspective of specific mathematical materials, technology use, and the perspective of future educators. These articles consistently present relevant and in-depth research on the role of self-efficacy in the context of computational thinking, thus providing a stronger and more focused contribution to the meta-synthesis analysis. Some articles may discuss computational thinking or self-efficacy separately, but do not connect the two directly in the context of mathematics education. In addition, some articles may not offer rich perspectives or specific findings on how self-efficacy affects computational thinking. Therefore, these four articles were selected because they were the most relevant to the research title.

Table 1. Articles Have Been Selected For Analysis

No	Title	Author, Year	Journal/Proceedings
1	Students' Computational Thinking Process in Solving PISA Problems of Change and Relationship Content Reviewed from Students' Self Efficacy	Azizia et al. (2023)	EduMa: Mathematics education learning and teaching
2	Kemampuan Computational Thinking Siswa Pada Materi Garis Dan Sudut Ditinjau Dari *Self-Efficacy*	Mukhibin et al. (2024).	JPMI (Jurnal Pembelajaran Matematika Inovatif),
3.	Kemampuan komputasional siswa dalam memecahkan masalah	Rahmadhani & Mariani (2021).	PRISMA, Prosiding Seminar Nasional Matematika

	matematika SMP melalui digital project based learning ditinjau dari self efficacy		
4.	Computational Thinking Patterns In The Mathematical Modeling Process: Self-Efficacy Preservice Mathematics Teacher	Marom et al (2023)	The Seybold Report

The analysis of the 4 selected articles will be described one by one according to the components to be analyzed in each journal. The important components that will be analyzed in each journal are the research objectives, research methods used, and the research results obtained. Journal data is processed according to meta-synthesis steps.

The first article analyzed was Students' Computational Thinking Process in Solving PISA Problems of Change and Relationship Content Reviewed from Students' Self Efficacy. This research aims to describe students' computational thinking processes in solving PISA change and relationship content questions in terms of self-efficacy. The subjects of this research consisted of 3 students, namely one each at high, medium and low levels of self-efficacy. Subject selection was carried out after administering a self-efficacy questionnaire. The self-efficacy questionnaire consists of 15 statements with questions that ask respondents to choose one appropriate answer from several answers provided. The computational thinking test instrument takes PISA level 2-5 questions in the form of descriptions related to change and reality content. The data analysis technique begins with analysis of data from self-efficacy questionnaires, followed by analysis of data from computational thinking tests which are useful as a guide in preparing questions for interviews. Final data analysis was carried out on the interview results which included data reduction, data presentation, and data withdrawal or verification. The following research results have been analyzed based on computational thinking criteria in terms of self-efficacy. students who have high and moderate self-efficacy at levels 2 - 3 do not have a significant difference, both can meet the indicators of computational thinking. The difference is only in the problem solving steps applied. At level 4, students who have high self-efficacy can fulfill the computational thinking indicators, while those who have moderate self-efficacy are limited to pattern recognition. At level 5 students are limited to the decomposition stage. Meanwhile, the computational thinking process of students who have low levels of self-efficacy at levels 2 - 3 is only limited to the pattern recognition stage. Meanwhile, at level 4 - 5 students are limited to the decomposition stage.

The second article analyzed was students' computational thinking abilities regarding lines and angles in terms of self-efficacy. This research aims to comprehensively examine students' computational thinking abilities from different levels of self-efficacy. The subjects of this research consisted of 3 class VII students at SMP Bumi Usaha for the 2022/2023 academic year, medium and low. The instruments used are tests, questionnaires and interviews. Data analysis was carried out using qualitative data analysis which includes data reduction, data presentation, verification and conclusion stages. The research results show that students with a low level of self-efficacy are only able to fulfill 2 indicators of computational thinking ability, students with a moderate level of self-efficacy fulfill 3 indicators of computational thinking ability. Meanwhile, students with a high level of self-efficacy have excellent computational thinking abilities by being able to fulfill 4 indicators of computational thinking ability.

The third article analyzes students' computational abilities in solving junior high school mathematics problems through digital project based learning in terms of self-efficacy. This research aims to test whether Digital PjBL is effective on students' computational abilities in solving mathematical problems, and to describe students' computational abilities in solving junior high school mathematics problems through Digital PjBL in terms of self-efficacy. The research subjects were 6 grade 8 students at SMP Negeri 3 Semarang consisting of students from 2 high self-efficacy groups, 2 students from the medium self-efficacy group, and 2 students from the low self-efficacy group. The data collection techniques used in this research are (1) tests consisting of self-efficacy tests and tests of students' computational abilities in solving mathematical problems; (2) the interview aims to obtain answers from the subject by means of questions and answers about the subject's answers on tests of students' computational abilities in solving mathematical problems; (3) documentation is used to obtain related data in research. The results of digital PjBL research are effective in achieving students' computational abilities in solving mathematical problems. A description of students' computational abilities in solving junior high school mathematics problems through Digital Project Based Learning in terms of Self Efficacy is as follows.

1) Students' computational abilities in solving mathematical problems with high Self Efficacy are able to fulfill the four indicators of students' computational abilities in solving mathematical problems. Students are able to complete assignments, understand and choose strategies in completing assignments.

2) Students' computational abilities in solving mathematical problems with moderate Self Efficacy are able to fulfill three indicators of students' computational abilities in solving mathematical problems. Students are able to complete assignments, understand and choose strategies in completing assignments. However, there are students who hesitate and lack confidence when they have to be in unusual situations.

3) Students' computational abilities in solving mathematical problems with low Self Efficacy are able to fulfill two indicators of students' computational abilities in solving mathematical problems. Students are less able to complete assignments, understand and choose strategies in completing assignments (magtitude dimension), this can be seen from some students who are still not able to answer the questions given completely and are able to do several questions but are not doing their work optimally.

The fourth analyzed article explores Computational Thinking Patterns in the Process of Mathematical Modeling: A Study on Self-Efficacy among Pre-Service Mathematics Teachers. Its objective is to identify computational thinking patterns based on the self-efficacy levels of pre-service teachers. The study involved six fifth-semester students from Salatiga State Islamic University, with two students representing each of the high, medium, and low self-efficacy categories. Data collection relied on self-efficacy questionnaires categorized into high, medium, and low levels. Subsequently, participants were presented with a mathematical modeling problem. The data obtained from the test and subsequent in-depth interviews were analyzed to classify, summarize, interpret, and formulate hypotheses. The researchers cross-referenced the data by comparing test results with the insights gained from the interviews. The findings revealed that participants with high self-efficacy tended to articulate crucial information, discern patterns, adopt systematic problem-solving approaches, and generate optimal solutions. Those with moderate self-efficacy could typically identify patterns and essential information but often struggled to devise comprehensive solutions. Conversely, participants with low self-efficacy encountered challenges in recognizing and labeling relevant patterns, leading to errors in problem-solving attempts.Based on the results of the 4 articles, several similarities and differences can be obtained which can become new findings. First, what is discussed is several similarities, namely that each article discusses computational thinking skills and self-efficacy.

The results of 4 articles show that self-efficacy influences computational thinking abilities. The following description can be concluded regarding the influence of self-efficacy on computational thinking abilities.

a) Students with High Self-Efficacy in Computational Thinking Abilities.

Students with high self-efficacy in computational thinking skills can achieve 4 indicators of computational thinking, namely decomposition, pattern recognition, abstraction and algorithmic thinking. At the decomposition stage students can understand the questions well so they are able to describe important information from what is known and what is asked very well. At the pattern recognition stage students can formulate real problems into mathematical problems and can solve problems using mathematical solutions. At the abstraction stage, students are able to name mathematical problem patterns that are appropriate to the problem so that they can interpret conclusions from mathematical solutions to real solutions. At the algorithmic thinking stage, students can solve problems and then state logical steps in solving the problem given the concept of understanding they have. So that students with high self-efficacy in solving mathematical problems, students are able to complete assignments, understand and choose strategies in completing assignments (magtitude dimension), students are able to persist and are confident in facing tasks and challenges (strength dimension), students have confidence in completing assignments in diverse contexts (generality dimension).

b) Students with Medium Self-Efficacy in Computational Thinking Abilities.

Students with moderate self-efficacy in computational thinking ability can achieve 3 indicators of computational thinking ability, namely decomposition, pattern recognition, abstraction. At the decomposition stage students can understand the questions well so they are able to describe important information from what is known and what is asked very well. At the pattern recognition stage students can find patterns by formulating real problems using logic. At the abstraction stage, students are able to name mathematical problem patterns that are appropriate to the problem but cannot solve the problem given so they do not provide conclusions on the problem given. Students with moderate self-efficacy are able to understand and choose strategies in the problems given. Students are able to persist and be confident in facing tasks and challenges (strength dimension). Students have confidence in completing assignments in diverse contexts (generality dimension), but there are students who hesitate and lack confidence when they have to be in unfamiliar situations.

c) Students with Low Self-Efficacy in Computational Thinking Abilities.

Students with low self-efficacy in computational thinking abilities can achieve 2 indicators of computational thinking abilities, namely decomposition and pattern recognition. At the decomposition stage students can understand the question so they are able to describe important information from what is known and what is asked well. At the pattern recognition stage students can find patterns by formulating real problems using logic. However, at the stage of abstraction and algorithmic thinking, students have not been able to reach this stage so they cannot name mathematical problem patterns that are appropriate to the problem and cannot solve the problem so they cannot provide conclusions on the problems given. Students with low self-efficacy are able to understand and choose strategies in the problems given. Students are able to persist and be confident in facing tasks and challenges (strength dimension). Students have confidence in completing assignments in diverse contexts (generality dimension), but there are students who hesitate and lack confidence when they have to be in unusual situations. Students with low self-efficacy Students are less able to persist and less confident in facing tasks and challenges (strength dimension), there are still some students who are hesitant in working on questions because they have previously experienced failure. Students are less confident in completing tasks in diverse contexts (generality dimension), there are students who hesitate and lack confidence when they have to be in unfamiliar situations.

After concluding the similarities between the four articles, we continued with the differences between the four articles, namely that there was one article that added a new variable in the form of PISA content change and reality questions. In this research, PISA questions were used as a reference to describe students' computational thinking processes. PISA questions were used in research at levels 2 to level 5. From the research results, the computational thinking abilities of students who have high and medium levels of self-efficacy at level 2 and level 3 can both meet the four indicators of computational thinking, the difference is in the completion steps, students with High self-efficacy can find answers using mathematical concepts that have been studied, while students with moderate self-efficacy solve problems using logic without using formulas. Meanwhile, students with low self-efficacy at level 2 can fulfill the computational thinking indicator stages, namely decomposition and pattern recognition, but at level 3 they can only fulfill the decomposition indicators. At level 4, students who have high self-efficacy can fulfill the computational thinking indicators, while those who have moderate self-efficacy are limited to pattern recognition. Meanwhile, students with low self-efficacy are limited to decomposition. At level 5 students with high, medium and low self-efficacy categories are limited to the decomposition stage. Apart from that, another article discusses the effectiveness of the Digital Project Based Learning learning model for improving computational thinking skills in solving mathematical problems.

Factors that can influence a person's low self-efficacy are usually influenced by factors outside the individual or factors external to the individual, namely support from relatives, support from teachers or mentors, and support from peers. who belong to a social support group. These three factors can increase students' learning self-efficacy. Apart from external factors, there are internal factors such as character and intelligence, as well as the social environment, in this case family and classmates (Nauvalia, 2021). To support students with low self-efficacy, teachers can implement a variety of strategies to help them develop stronger beliefs in their abilities and improve their academic performance. These strategies may include providing mastery experiences, offering vicarious experiences, using verbal persuasion, and creating a supportive and encouraging learning environment (Bandura & Cherry, 2020). By addressing these factors, educators can help students with low self-efficacy build self-confidence, increase motivation, and increase their academic success.

Additionally, a conducive learning atmosphere for nurturing self-efficacy involves the adoption of a problem-based learning approach. This method entails connecting mathematical content to real-world issues, enabling students to cultivate critical thinking skills necessary for extracting fundamental knowledge and concepts from the subject matter. As articulated by Mergendoller, Maxwell, & Belissimo, problem-based learning presents an engaging pedagogical strategy. Instead of passively absorbing facts and theories inherent to an academic discipline, students engage in solving authentic (albeit simulated) problems reflective of the challenges individuals encounter in their daily lives. In essence, problem-based learning represents an intriguing instructional approach wherein students tackle practical problems, even if only in simulated form, mirroring the decision-making processes and dilemmas prevalent in everyday situations, rather than solely focusing on theoretical readings or lectures about academic subjects (Susiani, 2021).

CONCLUSION

Based on the explanation of the description of self-efficacy for each level, it can be concluded that self-efficacy influences computational thinking abilities. At the decomposition stage, high, medium and low self-efficacy subjects can mention information that is known about the problem. At the pattern recognition stage, high, medium and low self-efficacy subjects can find patterns by formulating real problems into mathematical problems, but medium and low self-efficacy formulate problems using logic. At the abstraction stage, high, medium and low self-efficacy subjects were able to name patterns for solving problems. The higher the self-efficacy, the subject is able to connect problem information with concepts and ideas to solve the problem and is able to assess the information created. At the algorithmic thinking stage, the higher the self-efficacy the subject can solve the problem and then state the logical steps in solving the problem given the concept of understanding they have. The higher the level of self-efficacy, the better the ability to describe important information about the problem (what is known and asked), the ability to determine problem patterns, the ability to name problem patterns, and the ability to solve problems. problems with mathematical concepts that need to be used. This research recommends continuing and increasing the number of articles analyzed. The more articles there will be, the more results will be analyzed. The greater number of articles analyzed increases the possibility of obtaining new findings from the analysis of all related articles. To increase self-efficacy, teachers can provide motivation, learning experiences and create a meaningful learning environment that encourages students' self-efficacy, one of which is by implementing the Problem Based Learning learning model.

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