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Exploring Fourth Grade Students' Computational Thinking Skills in Mathematics Learning on Number Concepts

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Abstract. This study aims to analyze the Computational Thinking (CT) skills of grade IV students in mathematics learning with number materials. Based on the CT skill test conducted on 37 students at SDN Sepanjang Jaya III, the results showed that students' ability in the indicators of decomposition (53.12%) and pattern recognition (54.68%) was still in the poor category, which indicated the difficulty of students in breaking down problems into simpler parts and recognizing patterns in numbers. Meanwhile, the indicators of abstraction (60.41%) and algorithmic thinking (77.34%) showed better achievements, although still in the sufficient category. These results reveal that students have begun to be able to sift through relevant information and follow problem-solving steps systematically, but still struggle in developing algorithms for more complex problems. This study suggests that mathematics learning in elementary school needs to place more emphasis on pattern exploration, problem-based learning, and unplugged activities to strengthen students' CT skills, especially in the aspects of decomposition and pattern recognition, as well as to encourage the development of logical and algorithmic thinking skills in a more in-depth manner.

Keywords: Computational Thinking, Mathematics Learning, Problem Solving, Elementary School.

INTRODUCTION

The rapid development of technology and digital transformation has made Computational Thinking (CT) skills one of the key competencies in the 21st century. CT, which includes skills such as decomposition, pattern recognition, abstraction, and algorithms, is considered an intellectual foundation for students to be able to solve complex problems in a systematic and logical way. (Wing, 2006). Given that mathematics is abstract and demands logic, the development of CT in mathematics learning is very strategic. Some studies have shown that the integration of CT into mathematics learning can strengthen students' high-level thinking skills as well as problem-solving skills. (Suarsana et al., 2024). However, practically, there are still weaknesses in the understanding and application of CT, especially in elementary school students. For example, research (Fitriyah et al., 2024) Through data from the Indonesian Bebras Competition noted that 87% of Indonesian students were below the CT ability threshold score, showing that, in general, students' CT skills are still very low. In addition, mathematics teachers in Indonesia still show an uneven understanding of CT and difficulties in integrating it into the learning process. (Djidu & Retnawati, 2025).

In the context of elementary school, research on CT tends to be limited. One study in the field of 3D geometry showed that a problem-based learning approach can significantly improve the CT scores of elementary school students (Widodo et al., 2023). On the other hand, bibliometric studies of CT in primary schools show that the integration of CT into curriculum and learning strategies is still in its development, and there has not been much research linking CT directly to specific material, such as numbers (Maharani et al., 2024). Especially in Indonesia, research on teachers' perceptions of CT in the new curriculum revealed that although teachers recognize the importance of CT, many of them have not yet understood CT indicators in depth or have not been able to design questions and learning activities that actually lead to CT (Abidin et al., 2023). This indicates that the implementation of CT has not been optimal despite policies that have encouraged the integration of CT in mathematics learning since 2022 (Suarsana et al., 2024).

The OECD (Organization for Economic Cooperation and Development), through PISA (Programme for International Student Assessment), has assessed the ability of students from various countries in the aspects of literacy, reading, mathematics, science, finance, and CT as measured in PISA 2022 (OECD, 2018). Within such frameworks, computational thinking is seen as the ability to dynamically represent mathematical concepts and relationships, which helps students solve problems systematically and logically. Furthermore, PISA 2022 affirms the importance of CT as part of mathematical literacy in the digital era by emphasizing abstraction, algorithmic thinking, and complex problem-solving skills that involve identifying, analyzing, and evaluating solution strategies. PISA 2022 results show that Indonesian students are still below the OECD average in mathematics literacy (OECD, 2023). These low results show that computational thinking skills have not been optimally developed at the elementary school level. Research Fitriyah et al., (2024) Emphasized that the majority of Indonesian students still have difficulties in decomposition and abstraction of problems, which are the basis of CT skills. Similar findings were also put forward by. Nuvitalia et al., (2022) That mathematics learning in elementary school has not fully fostered algorithmic thinking processes and the ability to formulate systematic problem-solving steps.

Moreover Suryaningsih & Yarmi, (2023) Explained that mathematics learning at the elementary level needs to be directed to foster systematic thinking through the use of models and contextual media, as this can help students understand the relationship between concepts and practice logical thinking skills. This approach is in line with the results of the research. Suarsana et al., (2024) Which suggests that the integration of CT in mathematics learning

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through a problem-based approach can significantly improve students' level-level thinking skills.

Based on the description above, an in-depth analysis of the CT skills of elementary school students is needed, especially in learning mathematics with number materials. This analysis is important to see how students can decompose, recognize patterns, abstract, and compile algorithms when solving mathematical problems. The results of the analysis are expected to be a reference and foothold for teachers, researchers, and education policy makers in designing a more contextual mathematics learning strategy, oriented towards the development of systematic, logical, and algorithmic ways of thinking. Thus, mathematics learning in elementary schools does not only focus on the final result, but also on the computational thinking process that grows students' cognitive abilities and problem-solving sustainably.

METHODOLOGY

This study is a descriptive qualitative research that aims to analyze the CT skills of elementary school students in mathematics learning. The main focus of this study is to describe the forms of CT skills that students demonstrate as well as the difficulties they experience in each CT indicator, i.e., decomposition, pattern recognition, abstraction, and algorithms. The subjects of this study are 37 students in grade IV B of SDN Sepanjang Jaya III. Data collection was carried out through two main techniques, namely CT skills tests and in-depth interviews. The test is used to measure students' ability to solve mathematical problems that contain elements of computational thinking, while interviews are conducted to explore students' thinking processes in facing and solving these problems.

Data analysis using interactive analysis models Miles (2014) Which consists of three main components, namely data reduction, data presentation, and conclusion drawing or verification. At the data reduction stage, the researcher selects, concentrates, simplifies, and transforms the raw data of test and interview results into data relevant to the focus of the research. The data presentation stage is carried out by systematically compiling information in the form of tables, graphs, and narrative descriptions so that patterns and relationships between data can be easily understood. Furthermore, the conclusion and verification stage is carried out by interpreting the meaning of the data that has been presented to produce accurate conclusions related to students' CT abilities.

In qualitative research, the truth of data reality is plural and depends on the social constructs of individuals. (Creswell & Creswell, 2017). Therefore, to maintain the validity of the data, credibility tests are used through triangulation of techniques and sources, and the use of supporting reference materials such as observation notes and documentation of student learning outcomes. Technique triangulation is done by comparing CT test results and interview results, while source triangulation is done by confirming data from several students with different abilities.

RESULTS AND DISCUSSION

The results of the CT skill test in grade V elementary school students showed significant variation in ability between individuals. Based on test scores obtained from 36 students with a score range between 42 to 88, CT ability was then grouped into three categories, namely good, adequate, and poor. An overview of the percentage of results of students' computational thinking skills as a whole is presented in Figure 1 below.

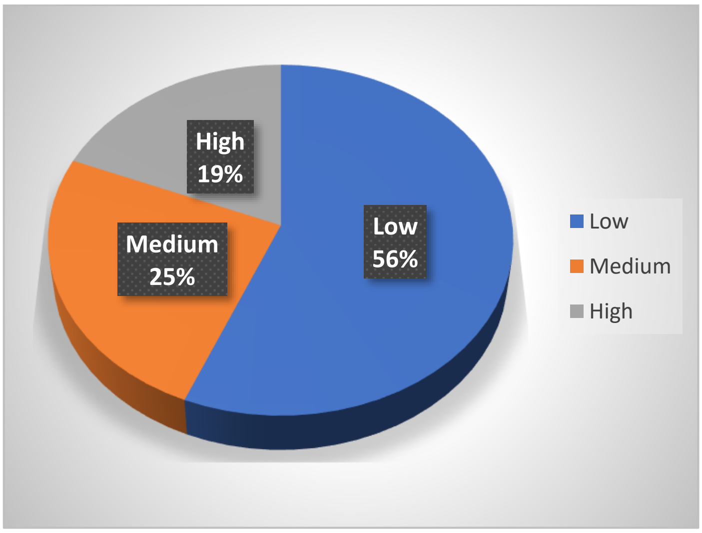

Figure 1. Percentage of CT Skills Results of Elementary School Students

The results of the grouping showed that 18.75% (7 students) were in the good category, 25% (9 students) in the fair category, and 56.25% (20 students) in the poor category. This proportion illustrates that most students still have low computational thinking skills. Furthermore, the test results were further analyzed based on four main indicators of CT skills, namely (1) decomposition, (2) pattern recognition, (3) abstraction, and (4) algorithmic thinking, as summarized in Picture 1 below.

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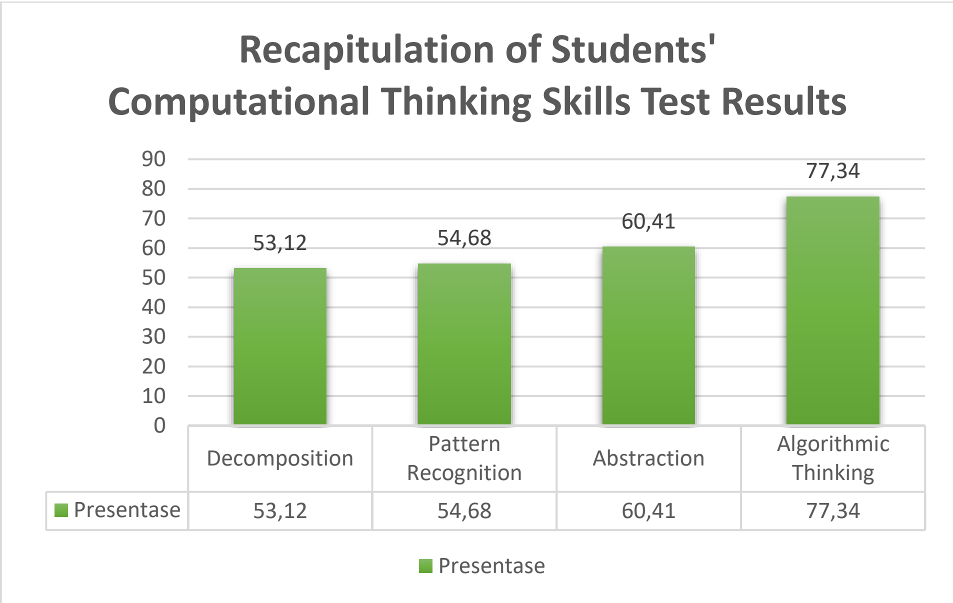

Picture 1. Recapitulation of Students' Computational Thinking Skills Test Results

In the decomposition indicator, students showed difficulty in breaking down the problem into smaller, simpler parts. As many as 53.12% of students have not been able to identify important elements of number math problems, such as determining place values or understanding basic operating patterns. This shows that some students still think as a whole without first analyzing the components of the problem. In the pattern recognition indicator, students' ability to recognize patterns and relationships between numbers is also relatively low (54.68%). Many students have not been able to find the regularity of repetitive sequences or operations. Common mistakes occur because students are used to using memorization methods and not patterned logic. The abstraction indicator obtained a sufficient category (60.41%). Some students are already able to simplify information by ignoring irrelevant data and focusing on important aspects of the problem. However, there are still students who have difficulty selecting information and tend to work on problems procedurally without understanding the concept of abstraction behind it. In the algorithmic thinking indicator, the results were relatively better with an average of 77.34% (sufficient category). Students can follow the completion steps systematically, especially in familiar questions. However, some students are not able to develop their own algorithms when faced with new or non-routine situations.

In the decomposition indicator, it was found that 53.12% of students were not able to break down math problems into simpler parts. This illustrates a major challenge in math learning, where students often focus only on the final result without analyzing the components of the problem first. Research by Grover & Pea (2013) Shows that skills in decomposition are a major foundation in CT, as they allow individuals to break down complex problems into smaller, more manageable pieces. Effective problem-solving requires these skills to analyze the elements in a problem and devise more structured solution steps. Wing (2006). On the other hand, education that places too much emphasis on the result and ignores the critical thinking process can lead to limitations in the development of students' analytical abilities Papert & Harel (1991). Therefore, to overcome these difficulties, teachers need to facilitate exercises that focus on gradual problem-solving through problem-based learning or more exploratory activities.

In the pattern recognition indicator, students' ability to recognize patterns in numbers and mathematical operations is still low (54.68%). Patterns are one of the important aspects of CT that allow individuals to see the relationships between elements and predict the outcome of repeated operations. These results are in line with research by Bers (2018) Which shows that the skill of recognizing patterns is key to understanding more complex mathematical concepts. However, many students still rely on memorization rather than patterned logic. This indicates the need for a learning approach that emphasizes pattern recognition through active exploration. When students are directly involved in finding patterns in data or mathematical situations, they can develop a deeper understanding. (Wing, 2011). Therefore, teachers need to introduce exercises that invite students to find patterns in repetitive series of numbers or operations, as well as relate them to real-world applications.

The abstraction indicator showed better results with a percentage of 60.41%, but it was still in the sufficient category. Most students are already able to sift through relevant information and ignore unimportant data. However, there are still many students who work procedurally without understanding the concept of abstraction that underlies problem solving. Abstraction is the ability to sift through relevant information and focus on more important aspects, which is a fundamental skill in CT (Wing, 2006). This is in line with the view of Semenov (2017) that abstraction skills help individuals to work with more general concepts and solve problems in a more flexible way. Learning that emphasizes understanding abstraction concepts will help students not only memorize the procedure but also understand the essence of the given solution (Grover & Pea, 2021). In this case, teachers should introduce tasks that require students to sift through relevant information, as well as provide space for them to think more critically and reflectively.

In the algorithmic thinking indicator, the results were relatively better with an average score of 77.34%. Students are able to follow the steps to solve problems systematically, especially in familiar problems. However, there are still students who find it difficult to develop their own

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algorithms when faced with non-routine problems. This suggests that although students have a basic understanding of the completion procedure, they are not yet fully able to transfer these skills to more complex contexts. (Wing, 2006). Algorithmic thinking is one of the core skills in CT that involves the formulation of systematic steps to solve a problem, and this skill is essential to prepare students to deal with real-world problems that are often complex and unstructured. (Lodi & Martini, 2021). To address these shortcomings, teachers can use a more focused approach to the exploration and development of algorithms through unplugged activities that allow students to design their own algorithms in a more diverse and creative context.

The difficulties experienced by students on each CT indicator do not appear suddenly, but are closely related to the learning pattern that has so far emphasized procedures and final results rather than the thinking process (Suryaningsih, 2024). In the context of learning mathematics in elementary school, teachers often give examples of problems, explain the solution steps, and then ask students to imitate the steps (Weintrop et al., 2021). This pattern makes students accustomed to following instructions without understanding the structure of the problem. As a result, skills such as decomposition, pattern recognition, abstraction, and algorithmic thinking develop partially or even stagnantly. When students are faced with non-routine problems that demand analysis of problem components, the discovery of new patterns, or the development of their own algorithms, they become difficult because they are not used to carrying out these mental processes in daily learning activities (Agbo et al., 2024).

To overcome these problems, teachers need to change the learning approach from one that focuses on "drill and practice" to learning that is exploratory, reflective, and centered on the student's thinking process (Suryaningsih & Astuti, 2021). Teachers can apply scaffolding strategies, which are providing step-by-step help such as lighter questions ("What are the important information in this question?", "What patterns appear?", "What is the first step that can be taken?"), the use of visual representations, or unplugged CT activities that train students to solve problems, recognize patterns, and devise solution steps (Brackmann et al., 2017; Ticon et al., 2022). With teaching practices like this, students not only understand the procedure, but also build a deep mathematical thinking structure, thus being able to apply CT skills more flexibly in a variety of contexts.

CONCLUSION

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Overall, these results show that the CT ability of elementary school students in mathematics learning is still not optimal. The weakest aspects were in *the ability to decompose* and *pattern recognition*, while *algorithmic thinking* showed the highest results. These low results can be caused by learning that still focuses on the final result, not on the systematic and reflective thinking process. Students are accustomed to following the teacher's example of completion without being trained to explore patterns or design solutions on their own. This is in line with the opinion of Wing (2011) That *computational thinking* is not only about programming, but a way of thinking to solve problems with structured and logical strategies. As a follow-up, teachers can develop *problem-based learning* or *unplugged activities* that involve pattern exploration, step simulation, and simple algorithm modeling so that students can internalize CT skills in a more meaningful way. Strengthening learning through scaffolding strategies and guided discovery is also essential to help students gradually build their analytical abilities. In addition, involving students in exploratory and reflective activities allows them to practice CT processes naturally and consistently during mathematics learning.

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