p-ISSN: 2086-4280
e-ISSN: 2527-8827

Computational Thinking in Polyhedron: Student Analysis

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Article received: 18-02-2025, revision: 23-03-2025, published: 30-04-2025

Abstrak

Computational Thinking (CT) penting dalam Pembelajaran bangun ruang sisi datar karena membantu siswa memahami masalah kompleks melalui berpikir matematis. Penelitian ini bertujuan menganalisis kemampuan CT siswa kelas VIII berdasarkan empat indikator: dekomposisi, pengenalan pola, abstraksi, dan algoritma. Metode yang digunakan adalah deskriptif kualitatif dan kuantitatif dengan tes berbasis konteks Tabot Bengkulu. Hasil menunjukkan siswa berada pada Kategori sedang, dengan capaian tertinggi pada abstraksi 73,75 dan terendah pada pengenalan pola 55,00. Temuan ini mengimplikasikan perlunya integrasi CT dalam evaluasi dan Pembelajaran Matematika untuk memperkuat kemampuan berpikir lagis siswa.
Kata Kunci: Computational Thinking; Matematika; Bangun Ruang Sisi Datar

Abstract

Computational Thinking (CT) is important in learning polyhedron because it helps students understand complex problems through mathematical thinking. This study aims to analyze the CT abilities of eighth-grade students based on four indicators: decomposition, pattern recognition, abstraction, and algorithms. The methods used are descriptive qualitative and quantitative with context-based tests from Tabot Bengkulu. The results show that students are in the moderate category, with the highest achievement in abstraction at 73.75 and the lowest in pattern recognition at 55.00. These findings imply the need to integrate CT into mathematics evaluation and learning to strengthen students' logical thinking skills.
Keywords: Computational Thinking; Mathematics; Polyhedron

I. Introduction

Flat shapes are an important topic in mathematics, covering the introduction of shapes, measurement of length, perimeter, and area. This topic is closely related to everyday problems, such as the local wisdom of Bengkulu's tabot, whose shape contains geometric elements (Budiarti et al., 2022). Therefore, students' understanding of flat shapes is very important. Through this material, students can be trained to have a good thinking process in solving problems related to everyday life.

Previous studies have shown that student achievement is still unsatisfactory, with students still experiencing difficulties in identifying relevant mathematical concepts (Amaliyah et al., 2022; Annisa et al., 2021; Elsa et al., 2022; Al-Qonuni & Afriansyah, 2023; Fitriyani et al., 2023; Noviyla et al., 2023), and difficulty in creating mathematical models (Annisa et al., 2021). According to (Fitriyani et al., 2023), students who scored above the minimum passing grade still had misconceptions in solving problems and were weak in connection and reasoning. According to (Oktaliana & Haerudin, 2023), students experience difficulties in performing simple calculations and calculations according to algorithms in flat shape material. Students still make mistakes in reading, understanding, and transforming plane geometry problems (Ardianzah & Wijayanti, 2020; Zulhamma, 2020).

Judging from the difficulties students have in solving problems related to flat shapes above, it can be said that students do not yet have good problem-solving skills, starting with a weak understanding of the concepts of flat shapes. The ability to read, understand, and transform problems is closely related to the thinking process, especially computational thinking (Junaeti et al., 2023; Harmini & Suprihatiningsih, 2024). Computational thinking is a thinking process needed to formulate problems and their solutions, so that these solutions can become effective agents of information processing in solving problems (Wing, 2010; Islami, Fatra, & Diwidian, 2023; Suwanto et al., 2025). Computational thinking skills have four components, namely problem decomposition, pattern recognition, abstraction, and algorithmic thinking (Junpho et al., 2022; Junpho et al., 2022; Nurlaelah, Usdiyana, & Fadilah, 2024; Mukhibin et al., 2024).

Efforts to address these issues have been widely undertaken, including the use of technology, particularly Geogebra (Azis et al., 2023), the use of analytical-synthetic-based modules (Azis et al., 2023), the use of REACT learning (Sari & Kurniawati, 2020), the use of M -Apos learning (Naja et al., 2023), using a realistic mathematics approach (Adilaturrahmah, 2022), guided discoveryy learning model (Hardianti, Yusuf, & Koswara, 2025), and using interactive learning media (Khairunnisa et al., 2023). However, none of these studies have analyzed students' understanding of shapes from the aspect of computational thinking. This paper describes students' computational thinking abilities in solving problems related to flat shapes.

II. Method

This study is a quantitative and qualitative descriptive study. The purpose of this study is to examine the computational thinking abilities of students based on indicators consisting of decomposition, pattern recognition, abstraction, and algorithms. The study was conducted in the second semester of the 2024/2025 academic year. The research subjects were 40 eighth-grade students at a junior high school in Mukomuko Regency. The selection of subjects was based on the consideration that flat-sided shapes are studied at this level. The data collection technique used was a test. The test used has been validated by three expert validators consisting of content, language, and construct validation. Based on the test results obtained, they will be categorized into three categories, namely high, medium, and low. The test questions given to students consisted of two questions. The questions used to measure students' CT abilities were:

1. Every year, Acha and her family vacation in Bengkulu City to watch the Tabot Festival. Acha buys souvenirs in the form of Tabot miniatures. Acha notices that these miniatures come in various shapes, including pentagons and cubes. Then, Acha studies the geometric shapes that make up the Tabot miniature and finds that the height of the pyramid is equal to the height of the cube. Is the difference between the volume of the cube and the volume of the square pyramid equal to twice the volume of the square pyramid?
   a. What steps should be taken before resolving the issue?
   b. What questions should be asked regarding the issue?
   c. What methods can be used to resolve each part of the issue?
   d. What important information can be used to resolve the issue?
   e. What is the difference between the volume of a cub and the volume of a square pyramid that is equal to twice the volume of a square pyramid?
2. The Bengkulu Tabot has a prismatic structure measuring 4 meters in length and 2 meters in width. If the height of the tabut is 3 meters and it will be covered with a pyramid-shaped decoration on top, design a pyramid cover with a maximum volume of 25% of the prism's volume.
   a. What steps must be taken before solving the problem?
   b. What questions are asked in the problem?
   c. What methods can be used to solve parts of the problem?
   d. What important information can be used to solve the problem?
   e. What is the difference between the volume of a cube and the volume of a square pyramid that is equal to twice the volume of a square pyramid?

This study focuses on the results of computational thinking-based mathematics tests based on four computational thinking indicators, namely decomposition, pattern exploration, abstraction, and algorithms, using a CT ability test scoring guideline on a scale of 1-4 (Yasmin & Negara, 2024). Table 1 shows the CT indicators used in this study.

Table 1.
CT Indicator and Aspect

Indicator	Aspect
Decomposition	

Indicator	Aspect
Students describe how a complex problem context can be simplified.	Students can identify what is being asked in the problem.
	Explaining the steps to solve the problem
Pattern Recognition	
Students can identify patterns, similarities, and connections, which are quick ways to solve new problems.	Students can discover the methods used to solve problems.
Abstraction	
Participants can understand and generalize pattern formation, seeing unnecessary details.	Students can design effective and efficient procedures or algorithms to solve problems.
Algorithm	
Students can understand the solution process through clear definitions.	Students can design effective and efficient procedures or algorithms to solve problems, then test and evaluate the results.

(Nizarudin et al., 2022)

The analyzed test results were then categorized based on the classification guidelines presented in Table 2, which consists of three categories.

Table 2.
Computational Thinking Category Guidelines for Students

Category Acquisition Value	Category
$N \geq (\bar{x} + SD)$	High
$(\bar{x} - SD) < N < (\bar{x} + SD)$	Moderate
$N \leq (\bar{x} - SD)$	Low

(Lestari & Annizar, 2020)

Description:

N: Student score

$\bar{x}$: Ideal average

SD: Standard deviation

After the test results are obtained, they will be categorized based on the score and the appearance of CT indicators.

III. Result and Discussion

Test data from two questions given to students obtained overall results shown in Table 3.

Table 3.
Maimum and Minimum Score that Achieved by Students

Total Students	40
Minimum Score	27,5
Maximum Score	90
Mean	63,81
Standard Deviation	16,34

Test results data based on high, medium, and low ability categories are presented in Table 4.

Table 4.
Students Percentage for Each CT Category

Achievement Category Score	Category	Total Students	Percentage (%)
N ≥ 80,15	High	7	17,5
80,15< N < 47,47	Moderate	25	62,5
N ≤ 47,47	Low	8	20

The Android-based test data for the material on building a tabot bengkului context for each computational thinking component as a whole is shown in Figure 1.

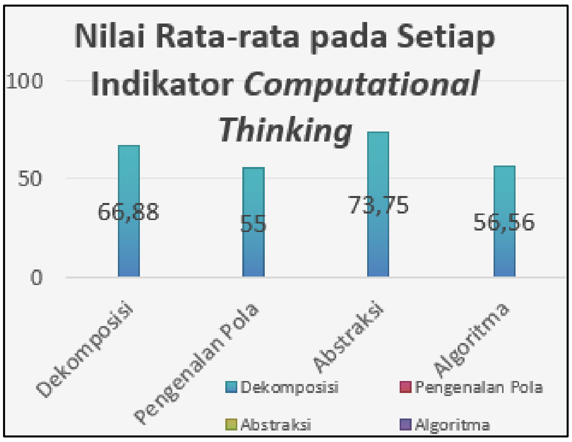

Figure 1. Mean Score for Each CT Indicator

Based on Figure 1, calculated from the test results of students with a decomposition indicator occurrence rate of 66.88%, a pattern recognition indicator occurrence rate of 55%, an abstraction indicator occurrence rate of 73.75%, and an algorithm indicator occurrence rate of 56.56%.

Students' computational thinking skills in solving problems on flat-sided shapes based on CT components still contain many errors, as described below.

a. Decomposition

In this component, the answers given by participants that are in line with CT indicators and those that are not in line with CT indicators are presented in Table 5.

Table 5.
Decomposition Indicator Result

Question Number	Result
1	Answers in accordance with the indicators • Calculate the volume of a pyramid. • Calculate the volume of a cube. • Calculate the difference between the volume of a cube and the volume of a pyramid. Student answers that do not meet the indicators • Investigate the spatial structures that make up the miniature. • Find the height of the pyramid in the miniature.
	Answer According to Indicators • Is the difference between the volume of a cube and the volume of a square pyramid equal to twice the volume of a square pyramid? Student Answers Not According to Indicators • Calculate the difference in height between the pyramids.
2	Answers in accordance with the indicators • Separate the calculation of the volume and surface area of the prism. • Design a pyramid cover with volume restrictions. Student answers that do not meet the indicators • Calculate the volume of the pyramid. • Calculate the surface area of the pyramid.
	Answer According to Indicators • Design a pyramid cover with a maximum volume of 25% of the prism volume. Student Answers Not According to Indicators • Determine the surface area of the pyramid to design the cover.

b. Pattern Recognition

In this component, the answers given by students that are in line with the CT indicators and those that are not in line with the CT indicators are presented in Table 6.

Table 6.
Pattern Recognition Indicator Result

Question Number	Result
1	Answers that meet the indicators • From the decomposition, a pattern or formula can be obtained using the volume of a cube. • Using the formula for the volume of a pyramid. Student answers that do not meet the indicators • Solving with the volume of a square pyramid with the volume of a cube.
2	Answers According to Indicators • Calculate the volume of a prism. • Calculate the surface area of a prism. • Calculate the sides of a flat-sided prism. • Calculate the volume of a pyramid.

Question Number	Result
	Student Answers Not in Line with Indicators • Solving problems with a maximum volume of 25% of the pyramid

c. Abstraction

In this component, the answers given by participants that are in line with CT indicators and those that are not in line with CT indicators are presented in Table 7.

Table 7.
Abstraction Indicator Result

Question Number	Result
1	Answers According to Indicators Important information: • s = t = r • Acha bought souvenirs in the form of miniature Tabot • Acha observed that there were various shapes of the miniature's structure • The height of the pyramid is equal to 2 times the volume of the square pyramid Unimportant information: • Acha went on vacation with her family to Bengkulu City to watch the Tabot Festival. Student Answers that do not match the indicators • s = t • Calculating the volume of a pyramid • Calculating the difference between the volume of a cube and the volume of a pyramid
2	Answers According to Indicators Important information: • The length of the prism is 4 meters. • The width of the prism is 2 meters. • The height of the prism is 3 meters. • It is covered with pyramid-shaped decorations on the top. Student Answers Not According to the Indicators • The length of the pyramid is 4 meters. • The width of the pyramid is 2 meters. • The height of the pyramid is 3 meters. • The volume of the prism is 25% of the volume of the pyramid.

d. Algorithm

In this component, students are directed to solve problems using everything they have learned from the previous steps. The mistakes made by students in the algorithm component are presented in Table 8.

Table 8.
Misconception in Algorithm Indicator

Question Number	Student Responses that Do Not Meet the Indicators
1	• Some students only answered the difference between the volume of a cube and the volume of a pyramid. • Some students still made mistakes in the calculation process, namely when comparing, multiplying, and dividing. • Some students only rewrote the information contained in the question and did not perform any calculations.
2	• Some students only wrote down the information contained in the question and did not perform any calculations. • Some students only answered questions about the volume of prisms. • Some students still made mistakes in their calculations, namely when multiplying and dividing.

Computational thinking of students in solving problems in flat space using the context of Tabot Bengkulu to answer Android-based mathematics evaluation

p-ISSN: 2086-4280
e-ISSN: 2527-8827

questions as a whole is categorized as moderate. Of the 40 students, 17.5% were in the high category, 62.5% were in the moderate category, and 20% were in the low category. The lowest score was 27.5 and the highest score was 9- with a standard deviation of 16.34. The fact that some students scored 27.5 indicates that there are still students who do not understand the problems and some indicators of computational thinking appear, although there are also students who are able to provide perfect answers. The high standard deviation indicates that there is still variation in the Computational Thinking abilities of students in the subject of flat shapes in the context of Tabot Bengkulu, with the majority at a moderate level.

The computational thinking skills of students in each component averaged 66.88 for the decomposition component, 55.00 for the pattern recognition component, 73.75 for the abstraction component, and 56.56 for the algorithm component. Of the four components, the lowest average was in the pattern recognition component. The expected pattern in this problem is what strategies can be used to solve the problem. Some of the errors in the students' answers are related to the real problems of flat-sided spatial figures, such as in question number 1, where the students' answer is “calculate the difference in height between the pyramid and the spatial figure.” This answer is a mathematical strategy for solving the problem, but it should have been written as a strategy for calculating the difference between the volume of a cube and the volume of a pyramid. Based on the results of this study, it is necessary to develop problem-solving stages that can help students recognize the solution patterns for flat-sided spatial problems. This is in line with Widana's (2021) research, which states that there needs to be a bridge between one stage and the next so that students can solve problems.

Although pattern recognition is the component in which students achieved the lowest scores, errors were also found in other components. In the decomposition component, students were expected to be able to describe the operational steps required to solve the problem. These errors mostly occur in terms of language that is not operational and does not show that students understand the stages of problem solving. This also indicates that students do not sufficiently understand the stages of solving flat-sided spatial problems, which is in line with the results of research (Syaifar et al., 2022). The findings regarding the language used by students in conveying their ideas are in line with the results of research by Yunitasar et al. (2019), which revealed that one of the difficulties students face in solving flat-sided spatial problems is a weakness in language comprehension.

Furthermore, the abstraction component, with an average achievement of 73.75, appears to be satisfactory. The answers given by students related to abstraction questions were generally unstructured and unable to distinguish between important and unimportant information. Based on these answers, it indicates that students are accustomed to computational thinking. The findings of this study, which state that the abstraction component is something that students can achieve, are in line with the opinion (Amelia et al., 2024) that students' abstraction abilities are quite good. However, according to research (Fitriyani et al., 2023), abstraction ability is not among the components with the lowest achievement after learning through video media; rather, the lowest components are decomposition and algorithms. The results of the study (Hapizah et al., 2024) state that the lowest component is not abstraction but rather the pattern recognition component for addition and subtraction of integers. This abstraction ability is the main key in computational thinking.

The students' performance in the algorithm component was unsatisfactory, with an average score of only 56.56. The algorithm component, as presented in Table 8, shows that these errors are operational errors and errors in solving flat-sided spatial problems. This finding is in line with Suprayo et al. (2023), who stated that one of the difficulties students face in solving flat-sided spatial problems is difficulty in the solution steps. Similarly, the results of research revealed by Dila & Zanthy (2020) state that students experience difficulties in the applied aspect, namely not being able to perform calculations accurately. The results of the research by Yunitasar et al. (2019) reveal that students are not consistent in solving flat-sided geometric problems and lack an understanding of concepts related to flat-sided geometric shapes.

The mistakes made by these students stem from a lack of understanding of the problems at hand. Several previous studies have generally stated that students do not understand the problems well, as revealed by (Dila & Zanthy, 2020; Yunitasar et al., 2019). Understanding these problems is the key to solving them. In terms of characteristics, problems in flat-sided spatial figures can take the form of story problems with fairly long narratives, requiring steps to help students solve them.

These stages can be translated into mathematical evaluation instruments with reference to the components of computational thinking. The mathematical evaluation instruments used by teachers must keep up with the times, as stated by R. M. Sari & Hapizah (2020), which in this case is the digital age, so that computational thinking skills are in line with the stages of solving flat-sided spatial problems using computational thinking stages.

IV. Conclusion

Based on research related to students' computational thinking abilities in mathematics on the subject of flat-sided shapes, categorized as moderate, with the highest percentage in the aspect of abstraction at 73.75 and the lowest in pattern recognition at 55.00. This shows the need to strengthen mathematics problem-solving strategies. This study enriches the study of CT integration in mathematics learning, especially flat-sided shapes, and teachers can use these results to design learning and evaluation that fosters students' CT abilities.

This study targets junior high school mathematics teachers to identify student weaknesses and strengthen learning strategies. Furthermore, for future research, it is necessary to design more in-depth diagnostic instruments for each component of CT in order to identify specific student weaknesses.

ACKNOWLEDGEMENT

The research of this article was funded by Directorate of Research, Technology, and Community Service Directorate General of Higher Education, Research, and Technology in accordance with the contract for the implementation of the operational assistance program for state universities for the 2024 fiscal year research program with the number 090/E5/PG.02.00.PL/2024 with a Derivative contract 0018.033/UN9/SB1.LP2M.PT/2024 dated June 24, 2024.

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