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Students' Computational Thinking Ability on Learning of Integers

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Abstract. Computational thinking is one of the most important skills in the 21st century; it is a thinking ability related to a set of mindsets that includes understanding problem-solving, reasoning at the level of abstraction, and developing problem-solving. This research is descriptive qualitative research that aims to determine the students' computational thinking ability and describe the computational thinking ability of 3 research subjects. The subjects of this study were 3 students selected from 28 students of class VII. The research instruments were test questions and interview guidelines. The results showed that out of 25 students, 14% were low-ability students, 75% were medium-ability students, and 11% were high-ability students. Students in class VII.1 were mostly able to fulfill the indicators of decomposition, pattern recognition, algorithmic thinking and abstraction, but only a few students who raised these indicators correctly

***Keyword**: Computational Thinking, Integers, Modern Students, Qualitative*

INTRODUCTION

Entering the 21st century, which is called the digital century, where the development of technology is increasingly advanced and growing very quickly. In the 21st century, almost all humans use devices that can integrate with computers and the internet (Kamil, Imami, & Abadi, 2021). This requires the world of education to be able to equip and prepare students with knowledge that is adequate to become a strong foundation to participate in the era of global competition (Sofyan, 2019). One of the skills that support the development of technology and information is computational thinking (Mubarokh, 2023). Computational thinking is considered a skill that 21st-century individuals must acquire and use to solve the problems they face in everyday life (Kuo & Hsu, 2020). As stated by Monalisa (2023) students need computational thinking skills in everyday life. In recent years, computational thinking has become popular and has become a fundamental skill that everyone in this digital era should possess (Hidayat, Affandy, & Pertiwi, 2020).

Computational thinking skills are a series of patterns in a person's thinking in solving problems with the use of systematic processes based on data that has been obtained to achieve the goal of getting maximum problem-solving (Nuraini, Agustiani, & Mulyanti, 2023). Computational thinking is a thinking ability related to a set of mindsets that include understanding problem-solving, reasoning at the level of abstraction and developing problem solving (Maharani, Nusantara, As'ari, & Qohar, 2021). In computational thinking there are four skills, namely 1) decomposition where the student's ability to identify the information needed or what is known from the problem given 2) Algorithmic thinking is the ability of students to recognize patterns or characteristics that are the same or different in the given problem to build a solution 3) pattern recognition, namely the ability of students to mention the logical steps used to compile solutions to the problems given 4) abstraction related to making meaning from the data that has been found and its implications (Cahdriyana & Richardo, 2020).

However in reality, the learning process of mathematics in Indonesia has not been oriented towards computational thinking skills (Veronica, Siswono, & Wiryanto, 2022). In line with what Sa'diyyah found (2021) that students' computational thinking skills are still low and need to be improved. Computational thinking can be measured by giving problem-solving problems (Sa'adah, Faridah, Ichwan, Nurwiani, & Tristanti, 2023). The same is expressed by Nasiba (2022) computational thinking is an approach to problem solving. The research conducted by Setiana (2018) also shows that computational thinking skills can be developed with problem solving. Then the results of Supiarmo et al. research (2021) which shows that the optimal computational thinking process can be used in solving problems through the steps of statements, hints, reminders, directions and encouragement.

One of the materials at the secondary school level that is still a concern for problem solving is integers. Integers are still one of the materials that students find difficult to learn due to their abstract nature (Arifuddin & Arrosyid, 2017). Another cause that makes students struggle is that students do not understand the concept of integers contextually (Mulyani, Suarjana, & Renda, 2018). According to Rahayu and Aini's research (2021) that students still have difficulty working on problem solving problems of whole number material. In addition, integers are suitable for us to use because integer material is very close to students' lives and almost all subjects in mathematics have a relationship with integer operations (Hamapinda, Ngaba, & Nuhamara, 2021). So that researchers are interested in using integers material to see students to get used to computational thinking skills. This ability is also an ability that needs to be instilled in students so that they can solve problems that will be present in their lives (Maulidasari & Novianti, 2022). This is in line with what was stated by Jamna et al. (2022) that computational thinking is a necessary skill to help solve problems that individuals face in everyday life.

Research that has been conducted related to computational thinking using indicators of decomposition, algorithm, pattern recognition and abstracion by Danoebroto and Listiani (2020) who researched computational thinking skills on scale material. Then the research that has been done by Supiarmo et al. (2021) who conducted research on computational thinking skills on plane figure material. Then the research that has been done by Nuraini et al. (2023) who conducted research on computational thinking ability on the material of the system of linear equations of two variables. But have not found research on the ability of computational thinking on the material of integers. so the researcher is interested in doing a description of the ability of computational thinking students on the material of integers.

METHOD

This research is a descriptive study with a qualitative approach with the aim of seeing student's computational thinking skills on whole number material. The subjects in this study were 28 students of class VII.1 SMP Negeri 1 Martapura. According to Fadli (2021) Descriptive research is a study used to describe or describe data with the hope that the data obtained is original data that can be accountable for its truth. The method used in this research is the test method and interviews with 3 students selected by looking at the test results and represent each level of computational thinking ability.

Table 1. Indicators of Computational Thinking Ability

No	Indicators	Deskriptor
1	Dekomposition	- Explaining the steps to solve the problem - Identify what is asked in the problem
2	Pattern Recognition	- Find out what method to use to solve the problem
3	Abstraction	- Determine important information used to solve the problem - Write down what is known and asked

4	Algorithm	- Create a mathematical model of the given problem - Find the number of Marbles in the problem

The research instruments were in the form of integer problem solving test questions, interview guidelines and validation sheets. Based on data analysis, both instruments are valid according to Akbar's criteri (2013) that have been validated by validators.

The process of analyzing the data from the test results was carried out to select research subjects with the steps of collecting data from the results of written tests given to students in an electronic worksheet that has one problem and several questions developed by researchers, giving scores based on the scoring rubric as in Table 2 below

Table 2. Scoring Table

No	Indicators	Descriptor	Score
1	Decomposition	Simplify the problem given by dividing it into several parts including what is known and what is asked	20
2	Pattern Recognition	Recognize siilar or different patterns or characteristics in problems to find solutions	30
3	Abstraction	Filter important information used and state summarize patterns found to solve problems	10
4	Algorithm	Mention the logical steps that will be used to find a solution	40

Then recapitulating the scores into the recapitulation table, calculating and determining the research subjects. Triangulation used in this study was carried out by comparing the results of data obtained through test results and interview results.

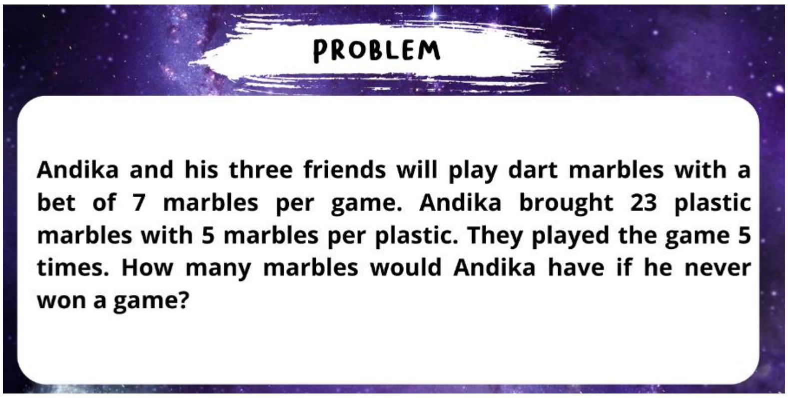

Figure 1. Problem Used

FINDINGS

Data on students computational thinking ability obtained from each subject includes the results of written test answers and interviews. After giving the written test, the researcher grouped students who had high, medium and low computational abilities based on the score of the written results and then carried out the interview process, the results of which were converted into interview transcripts.. The grouping of students' computational ability categories can be seen in Table 3 below.

Table 3. Grouping of Student's Computational Thinking Ability

Computational Thinking Ability Category	Interval (n)	
High	$x \geq M + 1SD$	$n \geq 91{,}7682$
Medium	$M - 1SD < x < M + 1SD$	$44{,}44608 < n < 91{,}7681$
Low	$x \leq M - 1SD$	$x \leq 44{,}44608$

Based on the results of the research data that has been carried out, of the 28 students in class VII.1 SMP Negeri 1 Martapura, there are 4 students (14%) whose computational thinking ability is categorized as low, 21 students (75%) whose computational thinking ability is categorized as moderate and 3 students (11%) whose computational thinking ability is categorized as high, it can be concluded that class VII.1 SMP Negeri 1 Martapura is more dominant in achieving moderate computational thinking ability, with details in Table 4 below.

Table 4. Result of CT Ability Grouping

Computational Ability	Number of Students	Percentage
Low	4	14%
Medium	21	75%
High	3	11%

At the interview stage, only one subject from each level of students' computational thinking ability was taken, with details in Table 5 below:

Table 5. Research Subject Data

Subject Code	Score	Computational Ability	Subject Characteristics (from observations and interviews)
ST	100	High	Does not give up easily
SS	85	Medium	Working calmly
SR	36	Low	Give up easily

ST brought up the four indicators of computational thinking ability on the test questions given as shown in Figure 2 below.

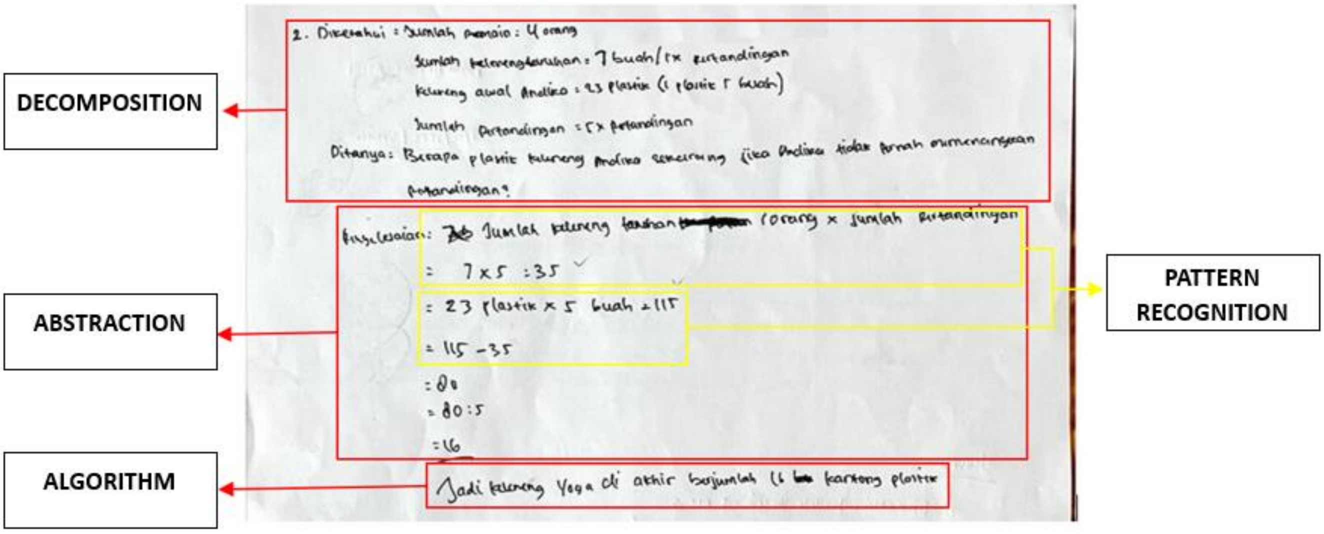

Figure 2. ST Subject Answer

On the decomposition indicator ST can simplify the given problem by dividing it into several parts, including what is asked and what is known completely. On the pattern recognition indicator ST can find similar or different patterns or characteristics to solve the problem as in the following interview excerpt:

P : *Did ST find a pattern to answer the question?*
ST : *Yes, first find how many marbles Andika lost.*
P : *Then what else are you looking for?*
ST : *Looking for the marbles that Andika brought*
P : *Why look for it that way?*
ST : *Because to find the plastic number of Andika's marbles we have to find how many marbles Andika has at the end so we first find how many Andika lost and then subtract the marbles that Andika brought.*

On the algorithm indicator ST can mention the steps to find what is asked in the problem and answer the problem correctly. Then on the abstraction indicator ST can filter out important information used and mention and conclude the patterns found to solve the problem.

P : *How to find the loss of Andika's marbles?*
ST : *Multiplying the bet amount by the number of matches*
P : *How to find the marbles that Andika brought?*
ST : *Multiply plastic marbles by the number of marbles in each plastic.*

In the problem, information that is not needed to answer the problem is also given, it seems that the ST subject is able to recognize this information so that it can be said that ST can fulfill the abstraction indicator of filtering important information used to solve problems. As in the following interview excerpt:

P : *Is the information in the problem enough to answer the problem?*
ST : *Already*
P : *Is there any information that is not important?*
ST : *Yes, sir*
P : *What is that?*
ST : *The number of players*

In subject SS all four indicators of computational thinking can be seen but only the decomposition indicator appears correctly. In the decomposition indicator SS can simplify the given problem by dividing it into several parts, including what is asked and what is known completely as in the following Figure 3 below.

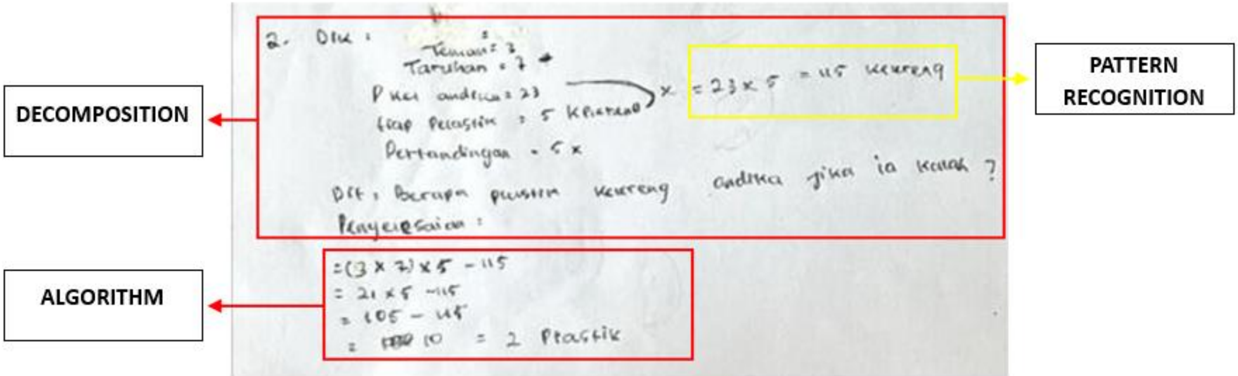

Figure 3. SS Subject Answer

In the pattern recognition indicator, it can be seen from the answer that SS has not found the same or different patterns or characteristics to solve the problem. Then supported from interview data as in the following interview excerpt:

P	:	*Did SS find a pattern to answer the question?*
SS	:	*Yes, find how much their total bet is*
P	:	*Then what else are you looking for?*
SS	:	*After that, find how much plastic the bet is*
P	:	*Why look for it that way?*
SS	:	*Because to find the plastic marbles Andika must first find how much Andika lost sir*

In the algorithm indicator SS has not been able to mention the steps to find what is asked in the problem and answer the problem correctly. Then on the abstraction indicator SS has not been able to filter out important information used and mention and conclude the patterns found to solve the problem.

P	:	*How to find the loss of Andika's marbles?*
SS	:	*The bet is multiplied by three of your friends and then multiplied by five*
P	:	*How to find the marbles that Andika brought?*
SS	:	*Andika's plastic marbles multiplied by five sir*

The problem is also given information that is not needed to answer the problem at hand, it seems that the SS subject has not been able to recognize this information. As in the following interview excerpt:

P	:	*Is the information in the problem enough to answer the problem?*
SS	:	*Yes*
P	:	*Is there any information that is not important?*
SS	:	*No sir*

Then for the SR subject there are no indicators that appear correctly as shown in Figure 4 below.

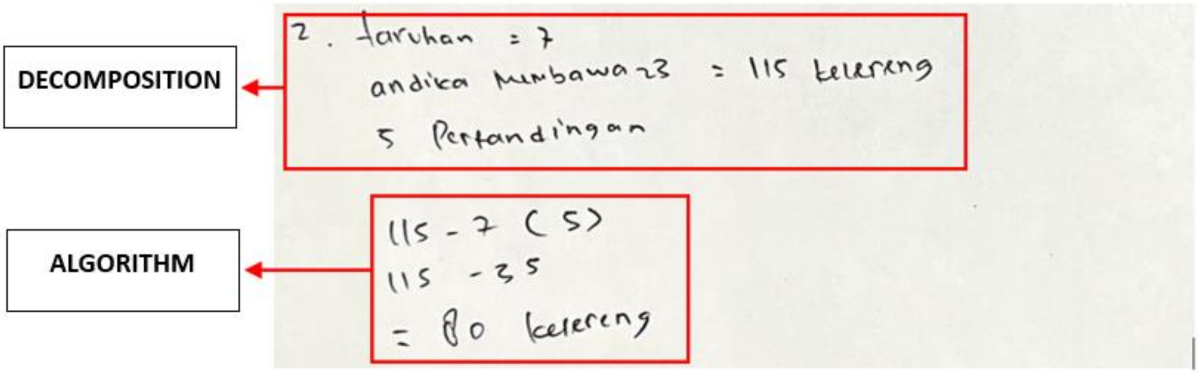

Figure 4. SR Subject Answer

On the decomposition indicator, SR can simplify the given problem by dividing it into several parts, including what is asked and what is known but not yet complete but during the interview SR was able to mention the known things completely.

P : *For this second problem, do you know what information is known from the problem?*
SR : *The bet was 7 marbles and then Andika brought 23 plastic marbles so the marbles were 115 and they played 5 games.*
P : *Anything else?*
SR : *That's all, sir*
P : *What does the question ask?*
SR : *Plastic Andika marbles if Andika never wins a game*
P : *Why isn't it written?*
SR : *Hurry up sir, the time is running out*

On the pattern recognition indicator SR has not been able to find the same or different patterns or characteristics to solve the problem as in the following interview excerpt:

P : *Did SR find a pattern to answer the question?*
SR : *Yes sir, find how many marbles Andika*
P : *What else are you looking for?*
SR : *Andika's loss*
P : *Then what else?*
SR : *The result will be subtracted from your initial marbles*
P : *Why is that the way to look for it?*
SR : *To know how many marbles you have left*

On the algorithm indicator SR can mention the steps to find what is asked in the problem and answer the problem correctly but incomplete as in the picture above. Then on the abstraction indicator SR has not been able to filter out important information used and mention and conclude the pattern found to solve the problem completely.

P : *How to find the loss of Andika's marbles?*
SR : *The amount of the previous bet times the number of matches*
P : *How to find the marbles that Andika brought?*
SR : *Andika's plastic marbles multiplied by 5*
P : *Is the information in the problem enough to answer the problem?*
SR : *Yes*
P : *Is there any information that is not important?*

SR : No sir

To make it easier to see the difference of ability between high, medium and low ability students can be seen in table 6 below.

Table 6. Comparison of Computational Thinking Ability of the Three Subjects

Computational Thinking Ability Indicator	High Subject	Medium Subject	Low Subject
Dekompositon	ST has been able to write what is asked and known correctly	SS has been able to write what is asked and known correctly	SR has been able to write what is known in the problem but is incomplete
Pattern Recognition	ST can find similar or different patterns or characteristics to solve problems	SS has not been able to find the same or different patterns or characteristics to solve the problem	SR has not been able to find the same or different patterns or characteristics to solve the problem.
Algorithm	ST can mention the steps to find what is asked and answer the problem correctly	SS can mention the steps to find what is asked and answer the problem but there are a few mistakes	SR can mention the steps to find what is asked and answer the problem but not yet correct.
Abstraction	ST can filter the information contained in the problem	SS can filter the information contained in the problem but not yet correct	SR has not been able to filter out important information contained in the problem

From the table above, it can be seen that high-ability students fulfill all indicators of computational thinking, medium-ability students have not fulfilled the pattern recognition indicator, and low-ability students only fulfill the ability of decomposition and algorithm.

DISCUSSION

Based on the findings that have been presented above, the results obtained are that students with high abilities have raised all indicators of computational thinking seen from student answers and the results of interviews that have been conducted. Indicators that appear in high ability students ranging from decomposition, pattern recognition, algorithms and abstraction have appeared correctly. High ability students are also able to find information that is not needed in the problem to solve the problem. This is in line with the results of research conducted by Lestari and Annizar. (2020) which says that students with high computational thinking ability are able to fulfill all indicators of computational thinking correctly.

Then in medium ability students, from the test results that have been carried out, indicators of decomposition, pattern recognition and algorithms have appeared. But of the three indicators that appeared, only the decomposition indicator appeared correctly. This is in line with the results of research from Nuraini et al. (2023) which says that students with moderate ability are able to fulfill the decomposition indicator. As for students with low ability, it can be seen from the test results that they only bring up indicators of decomposition and algorithms but both indicators have not appeared correctly. Starting from decomposition where students with low ability have not completely written what is known in the problem and when interviews are also conducted students with low ability cannot provide complete answers. This is in line with the research results of Mubarokh (2023) who said that students with low ability did not complete writing the steps to find a solution and could not explain the pattern formed to solve the problem.

Overall, all subjects still have difficulties in the abstraction and pattern recognition indicators even though the ST subject can fulfill all indicators of computational thinking ability. This is because students rarely work on problem solving problems so it takes more time to understand the problems in the problem. To work on problems that are rarely encountered, students need more time than routine problems (Fauziah, Roza, & Maimunah, 2022). So from this research it can be suggested that teachers more often train students to work on non-routine problems so that students are more familiar with these problems acccording to the results of interviews conducted that students only work on routine problems considering the importance of computational thinking skills for students to face challenges in the 21st century.

The impact of computational thinking (CT) skills on students is profound, enhancing their problem-solving abilities and academic performance across various educational contexts. Studies indicate that cooperative learning approaches significantly improve CT skills and academic outcomes among middle school students, with no notable differences between individual and group learning methods (Çelik & Bati, 2024). Additionally, tangible programming tools have been shown to foster CT, spatial reasoning, and executive function skills in early childhood, particularly benefiting beginners in programming (Pellas, 2024). Game-based learning platforms that incorporate student-generated questions also enhance CT skills, motivation, and confidence in primary school students (Cheng et al., 2023). Furthermore, project-based learning has been identified as a powerful method to elevate CT competencies across different educational levels, emphasizing the need for age-appropriate strategies (Zhang et al., 2024). Lastly, the effectiveness of in-person training over online methods for developing CT skills highlights the importance of engaging teaching methodologies, especially in engineering education (Herrero-Álvarez et al., 2024). Collectively, these findings underscore the critical role of CT in preparing students for future challenges.

The development of computational thinking (CT) skills can be significantly enhanced by utilizing diverse materials and instructional strategies, providing students with broader opportunities to refine their problem-solving abilities. For instance, Gupta and Tiwari emphasize the need for holistic educational approaches that integrate CT into various subjects, while Lehtimäki et al. present an unplugged CT obstacle course based on Bebras tasks, which promotes teamwork and communication among students without requiring formal computer science training (Gupta & Tiwari, 2022; Lehtimäki et al., 2023). Additionally, Ma et al. demonstrate that an interdisciplinary approach using Scratch can effectively improve students' CT skills and self-efficacy, particularly among girls, highlighting the importance of tailored instructional methods (Ma et al., 2021). Furthermore, Juškevičienė et al. advocate for physical computing activities within STEAM education, showing significant gains in CT literacy through hands-on learning experiences (Juškevičienė et al., 2021). Lastly, Pelánek and Effenberger provide a taxonomy of CT problems that can guide educators in creating varied and comprehensive learning environments, ensuring that students engage with a wide range of problem-solving scenarios (Pelánek & Effenberger, 2023).

CONCLUSION

The computational thinking ability of students in class VII.1 SMP Negeri 1 Martapura has three categories with 4 students (14%) of low ability, 21 students (75%) of medium ability and 3 students (11%) of high ability. High ability students were able to fulfill all indicators ranging from decomposition, pattern recognition, algorithms and abstraction. Medium ability students were able to fulfill the decomposition indicator correctly then for pattern recognition, algorithms and abstraction skills had appeared but still had errors. Then low ability students have no computational thinking ability that appears correctly. Future researchers are recommended to research computational thinking skills using other materials so that students will be able to see more problems that support computational thinking skills.

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