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COMPUTATIONAL THINKING ABILITY IN MATHEMATICS LEARNING OF EXPONENTS IN GRADE IX

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ABSTRACT

In the PISA 2021 framework, Computational Thinking (CT) is described as a detailed mathematical solution to the problem to be solved. However, CT-based learning still needs to be widely applied in Indonesia. This study aims to describe the CT ability of students in grade IX of junior high school based on CT indicators on the material of signed numbers. The data collection techniques in this study were test questions and interviews. Students who obtained high categories with scores above 45.76 were six students with a percentage of 21%, students who received medium categories with scores between 11.94 and 45.76 were 19 students with a rate of 66%, and students who obtained low categories with scores below 11.94 were four people with a percentage of 13%. The results of the study state that as many as 39% of students can decompose the problems given, 17% of students can recognize patterns in the problem, 24% of students can sort out the information in the situation or abstract, and 26% of students can solve problems well according to algorithm indicators.

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1. INTRODUCTION

The presence of Indonesia as one of the countries that adopt devices connected to the internet makes this country on the challenge to adapt to existing advances (Kresnadi et al., 2023). These advances provide competency demands in the world of work (Dimyati et al., 2023). There are also other challenges in the form of an increasingly dynamic education curriculum so that sensitivity is needed in designing an educational framework (Litia et al., 2023). Education in the 5.0 era requires education in Indonesia to be able to produce students who have skills in things that are directly related to real life, not just good at reading and writing (Noviyanti et al., 2023). One of the skills to meet these demands is the ability of computational thinking that helps individuals solve everyday problems (Aisy & Hakim, 2023).

As explained earlier, in today's digital era, computational thinking is an indispensable skill (Ariesandi et al., 2021). Computational thinking has significant potential to improve students' ability to solve problems (Kresnadi et al., 2023). In addition, Zahid (2020), stated that the OECD also drastically changed the definition of ability in the PISA 2021 framework by taking into account the rapid technological advances in current technological developments. The ability to think computationally is a skill that helps individuals develop ways of thinking to solve complex problems in every context that exists both in computing and everyday life (Manullang & Simanjuntak, 2023; Wijaya et al., 2024). This shows that computational thinking can be an approach that can be used to solve a problem (Jamna et al., 2022).

Computational thinking is a new concept in educational research that was first introduced by Papert in 1996 and reintroduced by Jeannette Wing in 2006 (Bråting & Kilhamn, 2021). Computational thinking (CT) is a problem-solving ability that is a fundamental skill for everyone, not just for computer scientists (Wing, 2006). Grover and Pea (2018) argue that CT is basically thinking about problem-solving using concepts and strategies that are most closely related to computer science. It does not mean that the CT way of thinking is like a computer but rather by formulating problems into the form of computational problems and compiling good computational indicators (Chahyadi et al., 2021). The stages or indicators contained in CT consist of decomposition, pattern recognition, abstraction, and algorithm (Fajri & Utomo, 2019).

With the presence of CT and looking at the essential competencies in the form of personal solutions that require decomposition, abstraction, representation, and patterning, there is an opportunity to integrate CT with other subjects, one of which is mathematics. (Munirah, 2022). In this case, CT becomes a crucial skill with the use of mathematical concepts and programming in complex problem-solving, which can improve students' conceptual mathematics (Maharani et al., 2019). In problem-solving, CT is generally concerned with the structure of processes involving symbolization and understanding of representations that are similar to mathematical thinking (Bråting & Kilhamn, 2021). The view of CT as a tool and object of learning is also evident from some further research that recognizes CT's ability to help students learn mathematics efficiently (Kynigos & Grizioti, 2018).

Exponential numbers are one of the mathematical materials that require problem-solving and logical thinking. In addition, this exponents material is material that becomes a prerequisite in some of the following materials and is even found in lessons other than mathematics, such as biology, physics, and chemistry (Sumirat et al., 2023). However, in reality there are still many students who need help with this material due to not understanding the concept of the material, being too lazy to write down the steps, and not solving the problem until the end (Lagalante et al., 2022). This is also supported by the fact that the ability to understand mathematical concepts in Indonesia seen from the PISA results in 2018 shows an understanding that is still below the international average (Amalia et al., 2021). According to Mulyono and Hapizah (2018), language errors in exponents that are sometimes not realized by teachers can also affect students' learning process in the future. This is in line with research conducted by Nurkamilah and Afriansyah (2021), which states that in this material students can experience misconceptions of generalization, perspecialization, notation, and language.

It is not only about the material of exponential numbers but also about the application of CT in Indonesia, which, in reality, is still constrained. The lack of application in Indonesia is due to the low CT skills of teachers and also students as prospective teachers (Angraini et al., 2022). Students' lack of understanding of teaching materials is also influenced by teachers' understanding of CT, as seen from the results of research for perceptions of programming skills showing that students (pre-service teachers) think that they have successfully learned how to program but lack understanding of what they are actually learning in relation to CT (Lamprou & Repenning, 2018). Several other studies have also shown that the thinking skills possessed by students in Indonesia are still not well implemented (Aisy & Hakim, 2023).

Research related to the importance of CT skills has been conducted by Munirah (2022), the learning outcomes using the computational thinking-based self-learning activity unit that has been developed are adequate. In addition, the learning activities were carried out, namely solving problems by applying aspects of CT skills, obtaining solutions, and making simple programs from scratch. Setyawan and Astuti (2021) have implemented CT-based learning in calculus material by obtaining results that show 73.3% of students can understand the concepts given through the problems given. Research conducted by Kadarwati et al. (2020), showed the effectiveness of computational thinking in increasing student creativity.

2. METHOD

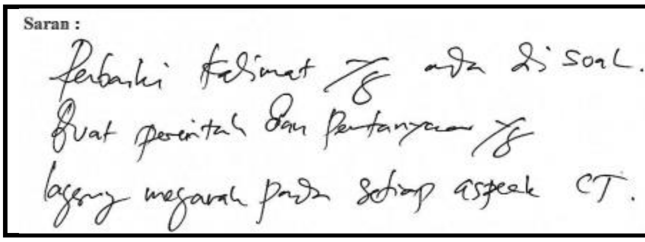
This research is descriptive. This research aims to see how students' CT abilities are based on CT indicators in the form of decomposition, pattern recognition, abstraction, and algorithm, which can be seen in Table 1. This research was conducted through three stages, namely the preparation stage (reviewing theories about CT, selecting learning materials, selecting places and research subjects, validating instruments, and taking care of research permits), the implementation stage (carrying out learning, giving tests to students, and selecting subjects to be interviewed), and the analysis stage (analyzing data and making conclusions).

Table 1. Indicators and aspects of computational thinking (Fajri & Utomo, 2019)

Skill Elements	Indicator	Aspects
Decomposition	Learners describe how a complex problem context can be made simpler.	Identifying existing information Simplify the information found.
Pattern Recognition	Learners can look for patterns, similarities, and connections that become quick ways of solving new problems.	Identify patterns, similarities, and connections. Formulate how to solve the problem
Abstraction	Learners can understand and generalize pattern formation, see its essential characteristics, and remove unnecessary details.	Analyze information that is not needed.
Algorithms	Learners can understand the solution flow through clear definitions.	Solve the problem according to the working steps.

This research was conducted at SMPN 54 Palembang in the odd semester of the 2023/2024 academic year, with the research subject being class IX.10 as many as 29 people. The selection of the subject was based on the consideration that the students had learned the material of exponents at this level. The data sources that will be used in this study are test results and interview data. The selection of subjects to be interviewed was carried out on students who represented each high, medium, and low category in the test results obtained.

The test instruments used were validated first by expert validators. Based on the validation results given by the validator, the instrument used is feasible to use with some revisions according to the suggestions given. The suggestions can be seen in Figure 1.


Saran :
Perbaiki kalimat yg ada di soal.
Buat perintah dan pertanyaan yg
langsung mengarah pada setiap aspek CT.

Translate:
Suggest:
Improve the sentences in the question.
Create commands and questions that directly lead to each aspect of Computational thinking.

Figure 1. Suggested improvements

The test results that have been carried out are used to see the CT abilities of students, which are then categorized based on the classification guidelines (Lestari & Annizar, 2020) (see Table 2).

Table 2. Category guidelines for students' computational thinking ability

Category Achievement Score	Category
$N \geq (\bar{x} + SD)$	High
$(\bar{x} - SD) < N < (\bar{x} + SD)$	Medium
$N \leq (\bar{x} - SD)$	Low

Description:
N = Student score
$\bar{x}$ = Ideal Average
SD = Standard Deviation

To support the test results that have been carried out by students, the interview guidelines used in this study are semi-structured with the aim of being an additional instrument in seeing the work of the subject based on the questions given. Meanwhile, the questionnaire was used to see students' responses to the application of learning and problem-solving using indicators in CT.

The data obtained during the research were then analyzed with reference to CT indicators. The focus of this study are: (1) the emergence of students' ability to simplify the problems given (decomposition); (2) students can associate concepts and materials that they can use to solve problems (pattern recognition); (3) students are able to sort out the information to be used so that other information that is not related to problem solving does not need to be written (abstraction); (4) students solve problems systematically. The analysis will be conducted based on Miles and Huberman (1994) data reduction, data presentation, and conclusion drawing.

3. RESULT AND DISCUSSION

3.1. Results

The subjects of this research were 9^{th}-grade students of SMP Negeri 54 Palembang. The selection of the subjects was based on the fact that the students had received teaching materials about exponents. The selected subjects came from class IX.10, which amounted to

29 people. After obtaining the subject that will be the subject of research, the next activity will be data collection.

The data collection technique begins with the application of CT-based learning. The application of learning carried out uses the Problem-Based Learning (PBL) learning model, and the approach taken uses CT so that the syntax to be implemented will follow the PBL model while the problems given follow the indicators in CT. In this learning, students are divided into 6 groups and given a student worksheet. The problem in the student worksheets consists of 1 problem and 5 sub-questions that will direct students to solve the problem following the CT indicators. The five sub-questions consist of introduction, decomposition, pattern recognition, abstraction, and algorithm. The implementation of learning was carried out in as many as two meetings with the time allocation for each meeting as much as 2×40 minutes.

The process carried out after the application of learning is in the form of taking test data. All research subjects worked on the test questions given based on the solution steps in each CT indicator for 100 minutes. Working on math test questions with solutions based on CT is done online through Google Meet with procedures in the form of students activating the camera during the test. The researcher will display the test questions on the Google Meet screen. After the allotted time runs out, students then collect the answers they have done on the Google Forms link provided by the researcher.

Researchers also conducted interviews with three students who became research subjects. The selection of the three subjects was based on the CT ability category of each subject. The subjects to be interviewed consisted of 1 person with high ability, one person with medium ability, and one person with low ability. Interviews were conducted using Google Meet with an allocation of 15-45 minutes on different days for each subject.

The data collection process lasted for approximately one month. The data was taken in the form of test results based on CT indicators, questionnaires, and interviews. The schedule for data collection in this study can be seen in Table 3.

Table 3. Data collection schedule

No	Activities	Implementation Date
1	Learning Activity I	September 27, 2023
2	Learning Activity II	October 4, 2023
3	Test	October 9, 2023
4	Conducting Interviews	October 16-22, 2023

After the data is collected, then the researcher begins to analyze the existing data starting with reducing. Data reduction is done from test result data, questionnaire data, and interview data. Based on the data reduction that has been done, it is known that the CT ability of students after implementation is still relatively low. The minimum and maximum values obtained from the test are presented in Table 4.

Table 4. Maximum and minimum values obtained by learners

Number of Learners	Minimum Value	Maximum Value	Mean	Standard Deviation
29	0	66.67	28.85	16.91

The results listed in Table 4 are obtained from tests that have been carried out with details in the form of an average of 28.85 with 29 students. The highest score obtained during the test was 66.67, with the lowest score being 0. The details in Table 3 then become data for calculating and categorizing student abilities in Table 5.

Table 5. Percentage of students for each category on computational thinking ability

Category Achievement Score	Category	Number of Learners	Percentage
N ≥ (45.76)	High	6	21%
(11.94) < N < (45.76)	Medium	19	66%
N ≤ (11.94)	Low	4	13%

Table 5 shows the percentage of each category of students' computational thinking ability in solving problems as a whole. Students who obtained high categories with scores above 45.76 were six students with a percentage of 21%, students who obtained medium categories with scores between 11.94 and 45.76 were 19 students with a percentage of 66%, and students who obtained low categories with scores below 11.94 were four people with a percentage of 13%. In addition to the percentage of students in each ability category, there is also data on the number of students who bring up CT indicators in the three questions, which can be seen in Figure 2.

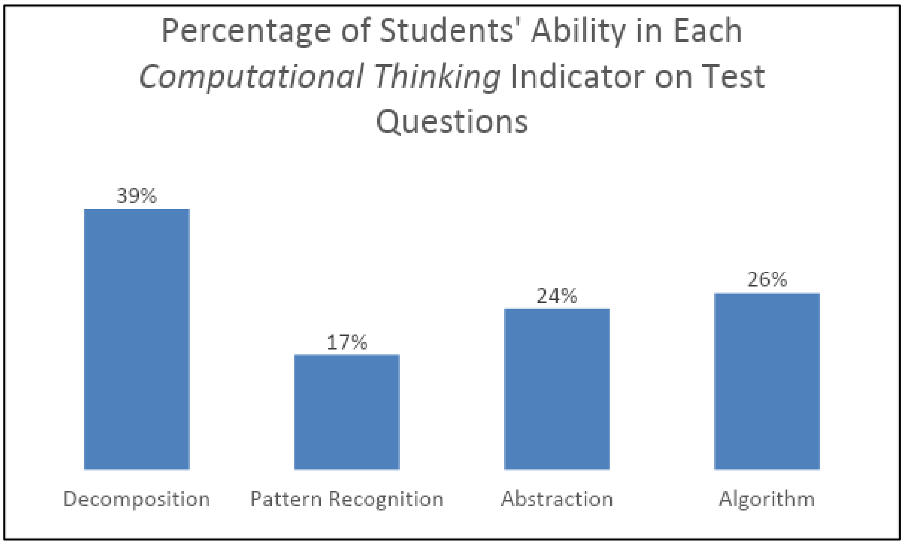


Figure 2. Percentage of Learners' CT Ability in each Indicator

Based on Figure 2, the percentage obtained for each CT ability indicator on the decomposition indicator the percentage obtained is 39%, the percentage obtained on the pattern recognition indicator is 17%, the percentage obtained on the abstraction indicator is 24%, and the percentage obtained on the algorithm indicator is 26%.

The description of students' computational thinking ability in solving problems on the material of exponents per indicator is as follows:

a. Decomposition

In this indicator, students are directed to identify problems to be more straightforward. So in this indicator, students are asked to write down what things they need to look for to solve existing problems. The problem given is about the multiplication and division of exponents, with the problem given being knowing the reproduction of viruses. The following are the answers of students who represent the decomposition indicator.

Kita menggunakan perpangkatan	**Translation**: We are using multiplication

Figure 3. Learners' answers on the decomposition indicator

In Figure 3, the answers given by students have not described the simplification steps of the problems given. In these answers, students describe things that are included in the aspects assessed in the pattern recognition indicator in the form of linking problems with concepts or material that has been learned to solve the problems given.

Menghitung berapa jumlah Virus dalam tubuh Seorang warga Setelah 4 Jam.	**Translation**: Counting the number of viruses in the citizen's body after 4 hours

Figure 4. Learners' answers on the decomposition indicator

In Figure 4, the answers given by students have described the decomposition indicator with the simplification of the problems given so that there are several steps that students need to complete later.

Overall, students who have raised the decomposition indicator answer the problems given by making steps or detailing what they need to do to solve the problems given. Learners who have not raised this indicator answer the problems given directly to the last step of problem-solving, and some students perform arithmetic operations directly.

b. Pattern Recognition

In this indicator, students are directed to identify patterns, similarities, or concepts from the problems given. In this indicator, students are asked to write down strategies or patterns that they can use to solve problems. The following are students' answers that represent pattern recognition indicators.

Membuat perhitungan perkembangan jumlah Virus setiap ½ Jam dan menghitung jumlah virus setelah 4 jam	**Translation**: Make a calculation of the development of the number of viruses every ½ hour. Counting the number of viruses after 4 hours

Figure 5. Learners' answers on the pattern recognition indicator

In Figure 5, the answers given by students are included in the decomposition indicator because they only detail the steps taken without linking to the concepts or materials they have learned.

Menggunakan Perkalian / Penambahan berulang	**Translation**: Using repeated multiplication/addition

Figure 6. Learners' answers on the pattern recognition indicator

In Figure 6, the answers given by students are related to concepts or material that they have learned before. In this indicator, the percentage obtained for students can bring this indicator to the smallest percentage because most students only answer the steps of work without linking to the materials and concepts they have learned. This makes the answers they give include the aspects measured in the decomposition indicator.

c. Abstraction

In this indicator, learners are directed to identify important things that are useful for solving problems. In this indicator, the researcher made an introductory question to see the difference in the information they provided. In the introductory question, the researcher wanted to write down all the information listed in the problem, such as the number of residents, the time it takes for the virus to divide, and the number of divisions that occur in the virus in one division. Whereas in the abstraction question, the researcher only wants students to sort out the information they have written before so that they only write down the essential things that are used to solve existing problems. Here are the answers of learners who represent abstraction indicators.

Melakukan perkalian setiap pembelahan virus selama 4 jam	**Translation**: Multiplied each virus lesson for 4 hours

Figure 7. Learners' answers on the abstraction indicator

In Figure 7, the answers given by learners are not yet included in the abstraction indicator where learners need to sort out important information that they previously wrote in the introductory question. In the answer given by the learner, the thing that is highlighted is the steps he needs to complete.

Informasi Jumlah Virus awal dan faktor Pembelahan Setiap ½ Jam	**Translation**: Initial virus count and cleavage factor information every ½ hour

Figure 8. Learners' answers on the abstraction indicator

Whereas in Figure 8, the answers given by learners are included in the abstraction indicator which can sort out information so that information about the total number of residents does not need to be included in the question items regarding abstraction.

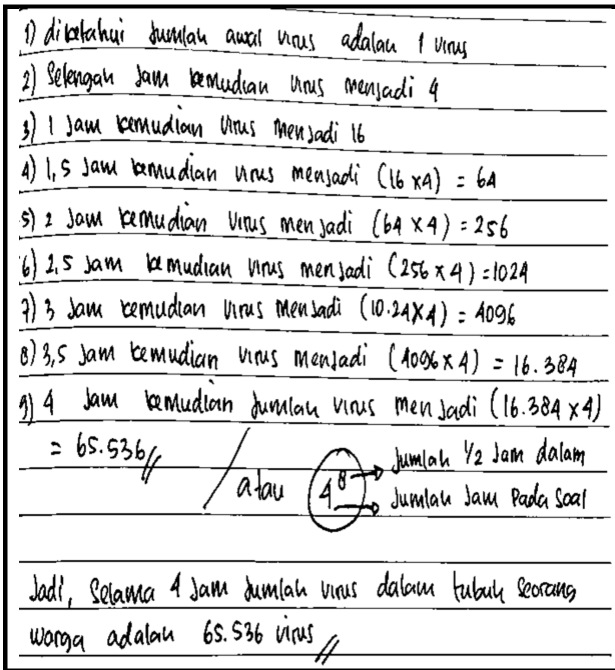
d. Algorithm

In this indicator, students are directed to solve problems using all the things they get in the previous steps of the work. The following are students' answers that represent indicators of algorithm ability.

Ulangi proses pembelahan virus setiap ½ jam selama 4 jam lalu hitung dan catat jumlahnya misalnya (1) Jumlah virus awal adalah satu (2) setelah ½ jam virus mengalami pembelahan menjadi empat setiap ½ jam (3) lama waktu virus membelah adalah selama 8 kali dalam 4 jam. (4) 4x8 =16 jumlah virus	**Translation**: Repeat the virus division process every ½ hour for 4 hours, then count and record the number. For example (1) The initial virus count is one. (2) After ½ hour the virus divides into four every ½ hour. (3) The length of time the virus divides is 8 times in 4 hours. (4) 4×8=16 number of viruses

Figure 9. Learners' answers on the algorithm indicator

In Figure 9, students solve the problem according to the steps they have chosen. However, in this solution, students experience errors in understanding the problems given, so students only multiply the number of divisions that occur by the number of virus divisions in the first period, namely 4. Meanwhile, for each division that occurs, each virus will continue to divide. Therefore, students cannot understand the question at hand. In working on question number 2, they were able to write the information correctly but the subject in Figure 8 still made an error in the final result.


1) diketahui jumlah awal virus adalah 1 virus
2) Setengah jam kemudian virus menjadi 4
3) 1 jam kemudian virus menjadi 16
4) 1,5 jam kemudian virus menjadi (16 x 4) = 64
5) 2 jam kemudian virus menjadi (64 x 4) = 256
6) 2,5 jam kemudian virus menjadi (256 x 4) = 1024
7) 3 jam kemudian virus menjadi (10.24 x 4) = 4096
8) 3,5 jam kemudian virus menjadi (4096 x 4) = 16.384
9) 4 jam kemudian jumlah virus menjadi (16.384 x 4) = 65.536 // atau 4^8
8 → jumlah ½ jam dalam
4 → jumlah jam pada soal
Jadi, selama 4 jam jumlah virus dalam tubuh seorang warga adalah 65.536 virus //

Translation:
(1) It is known that the initial number of viruses is one virus.
(2) Half an hour later the virus became 4.
(3) One hour later the virus count was 16
(4) 1 ½ hours later the number of viruses became (16×4=64)
(5) 2 hours later, the virus became (64×4=256)
(6) 2½ hours later the number of viruses became (256×4=1024)
(7) 3 hours later the virus became (1024×4=4096)
(8) 3½ hours later the number of viruses became (4096×4=16.384)
(9) 4 hours later the virus became (16.384×4=65.536) or 4^8=65.536

So, for 4 hours the number of viruses in a citizen's body is 65.536

Figure 10. Learners' answers on the algorithm indicator

In Figure 10, the answer given can be said to be correct where for each division time each virus. In the process, these students provide two ways of solving: the first way, to detail for each period of division, and the second way, which directly relates to the concept of exponents. Due to the results of the answers given by students vary. Therefore, the researcher took three subjects with the selection of subjects as described in the research method. Of the three subjects, 2 students answered all questions and sub-problems from the high ability and low-ability groups. However, the work of students who are classified as low a high-ability all correct, which causes the categorization results obtained by the subject to fall into the low category. While 1 other student who came from moderate ability, the work he did on question number 3 only answered the introductory sub-question item. The details of the indicators that appear from the work of the three subjects can be seen in Table 6.

Table 6. Summary of emerging computational thinking indicators of each subject

No	Name	Question No. 1				Question No. 2				Question No. 3			
		D	PR	A	AL	D	PR	A	AL	D	PR	A	AL
1	Subject NA	✓	-	-	-	✓	-	-	-	-	-	-	-
2	Subject Z	✓	-	-	✓	✓	✓	-	-	-	-	-	-
3	Subject ND	✓	✓	✓	✓	✓	-	✓	✓	✓	-	-	-

In addition to the student test data that has been obtained, interviews were also conducted to get a clearer picture of the computational thinking indicators from the test data results that students have done. Based on the results of the interview, students provided a number of statements and explanations regarding the work they had done. This is evidenced by the following student statement:

P : *Did you have any difficulty understanding the question and how to solve it?*
NA : *The questions are not too complicated because I have been guided before.*
P : *For the answer to question b, what did you answer? If you see there is an answer to understand the problem, can you please explain what that means?*
NA : *After NA read it the first time, Mrs. Siska needed to divide the two tiles equally. So before the division, NA needs to know how many tiles will be installed on the terrace. So that's the process of understanding the problem, maybe it should be understood at the beginning.*
P : *From the whole process of NA's answer, how to solve the problem?*
NA : *NA is also a bit confused. For example, at the beginning, NA already understood what to do and what information was there, but when it was already in the completion section, NA was confused about how to start.*

Based on the results of interviews conducted with NA subjects, it is known that the guidance given during the application of learning makes it easier for NA Subjects to understand the problems given. However, after simplifying the problem, the NA subject had problems solving the problem as a whole.

P : *I want to ask about question number 1 first. in each problem there are 5 questions, do you understand the questions yourself?*
Z : *in part C, I still don't understand what is meant by the strategy in the question, what is the strategy, sis? Is the strategy affecting the answer to part D and E, sis?*
P : *Yes, the strategy is more about the concept of material or formulas that can be used to solve the problem.*
Z : *Does that mean that part C is the core of the solution? Still don't understand sis.*

Based on the results of the interview conducted with subject Z, it is known that subject Z still does not understand the question items of the pattern recognition indicator. If you look at the test answers given by subject Z, it can be seen that subject Z can only answer 1 question for the pattern recognition indicator question items.

P : *Do you think there will be any formulas or material concepts to solve it?*
Z : *According to Z, you can use multiplication and addition, Z doesn't understand if you use other formulas.*

In addition, in the process of solving problems on exponents. Subject Z seemed to have not mastered the material on exponents so that the concept he used about the problem of dividing the virus was solved using multiplication which made the solution he made was not correct.

P : *The d part is important. From ND's point of view, did you think more about the formula, the value, or the result?*
ND : *It is more about the result.*
P : *Okay ND. So, after going through the whole process, how did you solve number 1?*
ND : *Calculate the area of the terrace and one ceramic first. If it is already later, their units are equalized first, and then the area of the terrace is divided by the area of 1 ceramic. Later, the result will be 100 ceramics.*

Based on the results of interviews conducted with Subject ND, it is known that the ND subject raises abstraction indicators orally. However, at the time of writing, the answers given by subject ND referred more to the pattern recognition indicator.

3.2. Discussion

The application of CT-based learning helps to direct learners to understand how to solve the problem of the given problem about exponents. According to Lewis Presser et al. (2023), this happens because the facts show that CT-based learning objectives have alignment with mathematics learning objectives. In addition, CT is one of the things that helps students identify and analyze problems to assess the effectiveness of the solutions that have been designed (Wu et al., 2024). According to Lee et al. (2023), CT and mathematics become formative constructs that can positively assess CT and likewise CT will positively assess mathematics as well.

Judging from the test results that have been carried out, out of 29 people who took the test. There were 6 students with a percentage of 21% who obtained a high category, 19 students who obtained a medium category with a percentage of 66%, and 4 students who obtained a low category with a percentage of 13% so it can be concluded that students are in the medium category. Meanwhile, the calculation of students' abilities in the decomposition indicator is 39%, pattern recognition is 17%, abstraction is 24%, and algorithm is 26%. According to Kamil (2021), mathematical computational thinking skills still need to be considered again even though the results of student categorization are in the moderate category.

As stated earlier, the ability to think mathematically computationally still needs to be considered again by looking at the results of each indicator which are still below 50%. According to Kamil (2021), the difficulty in achieving CT indicators is due to students' lack of familiarity with CT-based problems. If students start to get used to doing CT-based questions, it is possible that the results obtained will be in the high category. Apart from habituation, age can also improve students' algorithm skills (Piatti et al., 2022). Based on the results of research by Montuori et al. (2024), it was found that students who had an older age obtained an increase in problem solving which became a skill in the algorithm.

In addition to the lack of familiarity of students with CT-based problems, giving story problems that are rarely solved by students also affects the results on the indicators of pattern recognition and abstraction of students. Based on research by Kresnadi et al. (2023), students' difficulties in understanding story problems indicate difficulties in understanding patterns and abstraction because they need to involve the ability to recognize patterns and draw more complex conclusions. This can also be seen from the results of research by Bilbao et al. (2021) which states that the percentage of students getting scores below 4 out of a maximum score of 5 is 86%. In addition, the results of this study stated that there was a relationship between abstraction and algorithms which obtained a percentage of 52.6% below 4.

In this algorithm problem, students also experience errors in the calculations they make. Sunardiningsih et al. (2019) argued that the errors made by the research subjects were included in the understanding error in Newman's error analysis. In this error, the research subject was unable to understand the known information completely and did not understand what was asked completely. This is in line with Lestari and Annizar (2020) research which states that the subject has been able to write down the stages correctly, it's just that they don't proofread the answers so that the final results given are wrong. This is also supported by the results of research by Chytas et al. (2024) which states the most common mistakes made so that they often use the wrong formula. According to Nurkamilah and Afriansyah (2021), the mistakes made by the subject in Figure 9 are included in experiencing perspecialization misconceptions so that they equate the concept of multiplication with the concept of multiplication. Based on research conducted by Kamil (2021) students who still cannot sort out the information provided are students who are in the very low category.

4. CONCLUSION

Computational Thinking ability of students based on indicators of decomposition, pattern recognition, abstraction, and algorithm as follows: Decomposition, in answering questions about this indicator, the steps that students write down are used as guidelines in calculations carried out on algorithm indicators later. Based on the results obtained, the percentage of students with the ability to decompose indicators is 39%, which is the largest percentage of indicators that many students appear.

Pattern Recognition Based on the results obtained, the percentage of students who raised this indicator was only 17%, and it became the lowest percentage indicator when compared to other indicators. The desired aspect of this indicator is students who can relate concepts or material they have learned to solve problems. In solving questions in the algorithm indicator item, it is not uncommon for students to bring up material or concepts that can help solve problems that do not appear in answering questions about pattern recognition.

Abstraction, the answers of most students who are still wrong about this indicator are usually in the form of steps they have to take, such as those in the decomposition indicator. Based on the results obtained, the percentage of students who can bring up this indicator is 24%. Algorithm, in answering this question item, students start from the steps they have compiled in the decomposition indicator. In each of these steps, students relate the problem to material that allows them to simplify the existing problems. In addition, not infrequently, students experience errors in solving these problems even though they have compiled the steps they need to do. One of the errors experienced by students is in the form of misconceptions in the perception of the concept of exponents so that students equate the concept of multiplication with the concept of multiplication. Based on the results obtained, the percentage of students who raised this indicator was 26%.

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REFERENCES

Aisy, A. R., & Hakim, D. L. (2023). Kemampuan berfikir komputasi matematis siswa SMP pada materi pola bilangan [Mathematical computational thinking abilities of junior high school students in number pattern material]. *Didactical Mathematics*, *5*(2), 348-360.

Amalia, A. R., Rusdi, R., & Kamid, K. (2021). Pengembangan soal matematika bermuatan HOTS setara PISA berkonteks pancasila [Development of mathematics questions containing HOTS equivalent to PISA in the Pancasila context]. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *5*(1), 1-19. https://doi.org/10.31004/cendekia.v5i1.386

Angraini, L. M., Arcat, A., & Sohibun, S. (2022). Pengaruh bahan ajar berbasis multimedia interaktif terhadap kemampuan computational thinking matematis mahasiswa [The influence of interactive multimedia-based teaching materials on students' mathematical computational thinking abilities]. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *6*(2), 370-383. https://doi.org/10.33603/jnpm.v6i2.6937

Ariesandi, I., Syamsuri, S., Yuhana, Y., & Fatah, A. (2021). Analisis kebutuhan pengembangan modul elektronik berbasis inkuiri untuk meningkatkan kemampuan berpikir komputasi pada materi barisan dan deret siswa SMA [Analysis of the need for developing inquiry-based electronic modules to improve computational thinking skills in high school students' sequence and series material]. *AKSIOMA: Jurnal Matematika dan Pendidikan Matematika*, *12*(2), 178-190.

Bilbao, J., Bravo, E., García, O., Rebollar, C., & Varela, C. (2021). Study to find out the perception that first year students in engineering have about the computational thinking skills, and to identify possible factors related to the ability of abstraction. *Heliyon*, *7*(2), e06135. https://doi.org/10.1016/j.heliyon.2021.e06135

Bråting, K., & Kilhamn, C. (2021). Exploring the intersection of algebraic and computational thinking. *Mathematical thinking and learning*, *23*(2), 170-185. https://doi.org/10.1080/10986065.2020.1779012

Chahyadi, F., Bettiza, M., Ritha, N., Rathomi, M. R., & Hayaty, N. (2021). Peningkatan high order thinking skill siswa melalui pendampingan computational thinking [Improvement of students' high-order thinking skills through computational thinking assistance]. *Jurnal Anugerah*, *3*(1), 25-36.

Chytas, C., van Borkulo, S. P., Drijvers, P., Barendsen, E., & Tolboom, J. L. J. (2024). Computational thinking in secondary mathematics education with GeoGebra: Insights from an intervention in calculus lessons. *Digital Experiences in Mathematics Education*, 1-32. https://doi.org/10.1007/s40751-024-00141-0

Dimyati, A., Fatra, M., Sobirudin, D., & Hafiz, M. (2023). Pengembangan media motion graphic pada mata kuliah aplikasi matematika komputer [Development of motion graphic media in computer mathematics applications courses]. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(1), 67-79. https://doi.org/10.24127/ajpm.v12i1.6444

Fajri, M., & Utomo, E. (2019). Computational thinking, mathematical thinking berorientasi gaya kognitif pada pembelajaran matematika di sekolah dasar [Computational thinking, mathematical thinking is cognitive style oriented in mathematics learning in elementary schools]. *Dinamika Sekolah Dasar*, *1*(1), 1-18.

Grover, S., & Pea, R. (2018). Computational thinking: A competency whose time has come. *Computer science education: Perspectives on teaching and learning in school*, *19*(1), 19-38. https://doi.org/10.5040/9781350057142.ch-003

Jamna, N. D., Hamid, H., & Bakar, M. T. (2022). Analisis kemampuan berpikir komputasi matematis siswa smp pada materi persamaan kuadrat [Analysis of junior high school students' mathematical computational thinking abilities on quadratic equations]. *Jurnal Pendidikan Guru Matematika*, *2*(3), 278-288. https://doi.org/10.33387/jpgm.v2i3.5149

Kadarwati, S., Suparman, S., & Astutik, K. (2020). Keefektifan Computational Thingking (CT) Dan Problem Based Learning (PBL) Dalam Meningkatkan Kreativitas Siswa

Terhadap Penyelesaian Soal-Soal Cerita Materi Perbandingan (Skala Pada Peta) Di Sekolah Dasar [The effectiveness of computational thinking (CT) and problem-based learning (PBL) in increasing students' creativity in solving comparative material story problems (scales on maps) in elementary schools]. *Jurnal Karya Pendidikan Matematika*, *7*(1), 63-68. https://doi.org/10.26714/jkpm.7.1.2020.63-68

Kamil, M. R. (2021). Analisis kemampuan berpikir komputasional matematis Siswa Kelas IX SMP Negeri 1 Cikampek pada materi pola bilangan [Analysis of mathematical computational thinking abilities of Class IX Students of SMP Negeri 1 Cikampek on number pattern material]. *AKSIOMA: Jurnal Matematika dan Pendidikan Matematika*, *12*(2), 259-270.

Kresnadi, H., Ghasya, D. A. V., & Pranata, R. (2023). Analisis kemampuan computational thinking berdasarkan tahap generalisasi pola dan desain algoritma siswa di kelas III SDN 03 Toho [Analysis of computational thinking abilities based on the pattern generalization and algorithm design stages of students in class III at SDN 03 Toho]. *Jurnal Review Pendidikan dan Pengajaran (JRPP)*, *6*(4), 1660-1666.

Kynigos, C., & Grizioti, M. (2018). Programming approaches to computational thinking: Integrating turtle geometry, dynamic manipulation and 3D space. *Informatics in Education*, *17*(2), 321-340. https://doi.org/10.15388/infedu.2018.17

Lagalante, R., Suharna, H., & Tonra, W. S. (2022). Analisis kesalahan siswa dalam menyelesaikan masalah matematika pada bilangan berpangkat dan bentuk akar [Analysis of student errors in solving mathematical problems on exponent numbers and root forms]. *Jurnal Pendidikan Guru Matematika*, *2*(2), 184-192. https://doi.org/10.33387/jpgm.v2i2.4633

Lamprou, A., & Repenning, A. (2018). Teaching how to teach computational thinking In Proceedings of the 23rd Annual ACM Conference on Innovation and Technology in Computer Science Education, Larnaca, Cyprus (pp. 69–74). https://doi.org/10.1145/3197091.3197120

Lee, S. W.-Y., Tu, H.-Y., Chen, G.-L., & Lin, H.-M. (2023). Exploring the multifaceted roles of mathematics learning in predicting students' computational thinking competency. *International journal of STEM education*, *10*(1), 64. https://doi.org/10.1186/s40594-023-00455-2

Lestari, A. C., & Annizar, A. M. r. (2020). Proses berpikir kritis siswa dalam menyelesaikan masalah PISA ditinjau dari kemampuan berpikir komputasi [Students' critical thinking processes in solving PISA problems are viewed from computational thinking skills]. *Jurnal Kiprah*, *8*(1), 46-55.

Lewis Presser, A. E., Young, J. M., Rosenfeld, D., Clements, L. J., Kook, J. F., Sherwood, H., & Cerrone, M. (2023). Data collection and analysis for preschoolers: An engaging context for integrating mathematics and computational thinking with digital tools. *Early Childhood Research Quarterly*, *65*, 42-56. https://doi.org/10.1016/j.ecresq.2023.05.012

Litia, N., Sinaga, B., & Mulyono, M. (2023). Profil berpikir komputasi siswa dengan menggunakan model pembelajaran problem based learning (PBL) ditinjau dari gaya belajar di SMA N 1 Langsa [Computational thinking profile of students using the problem based learning (PBL) learning model in terms of learning styles at SMA N 1 Langsa]. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *7*(2), 1508-1518. https://doi.org/10.31004/cendekia.v7i2.2270

Maharani, S., Kholid, M. N., Pradana, L. N., & Nusantara, T. (2019). Problem solving in the context of computational thinking. *Infinity Journal*, *8*(2), 109-116. https://doi.org/10.22460/infinity.v8i2.p109-116

Manullang, S. B., & Simanjuntak, E. (2023). Pengaruh model problem based learning terhadap kemampuan computational thinking berbantuan media Geogebra [The influence of the problem based learning model on computational thinking abilities assisted by Geogebra media]. *Journal on Education*, *6*(1), 7786-7796.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Sage Publications.

Montuori, C., Gambarota, F., Altoé, G., & Arfé, B. (2024). The cognitive effects of computational thinking: A systematic review and meta-analytic study. *Computers & Education*, *210*, 104961. https://doi.org/10.1016/j.compedu.2023.104961

Mulyono, B., & Hapizah, H. (2018). Pemahaman konsep dalam pembelajaran matematika [Understanding concepts in mathematics learning]. *Kalamatika: Jurnal Pendidikan Matematika*, *3*(2), 103-122. https://doi.org/10.22236/KALAMATIKA.vol3no2.2018pp103-122

Munirah, S. (2022). *Pengembangan bahan ajar matematika siswa SMA berorientasi computational thinking skills*. Doctoral dissertation. Universitas Pendidikan Indonesia. Retrieved from https://repository.upi.edu/71642

Noviyanti, N., Yuniarti, Y., & Lestari, T. (2023). Pengaruh pembelajaran berdiferensiasi terhadap kemampuan computational thinking siswa sekolah dasar [The effect of differentiated learning on elementary school students' computational thinking abilities]. *Prima Magistra: Jurnal Ilmiah Kependidikan*, *4*(3), 283-293. https://doi.org/10.37478/jpm.v4i3.2806

Nurkamilah, P., & Afriansyah, E. A. (2021). Analisis miskonsepsi siswa pada bilangan berpangkat [Analysis of students' misconceptions about exponent numbers]. *Mosharafa: Jurnal Pendidikan Matematika*, *10*(1), 49-60.

Piatti, A., Adorni, G., El-Hamamsy, L., Negrini, L., Assaf, D., Gambardella, L., & Mondada, F. (2022). The CT-cube: A framework for the design and the assessment of computational thinking activities. *Computers in Human Behavior Reports*, *5*, 100166. https://doi.org/10.1016/j.chbr.2021.100166

Setyawan, F., & Astuti, D. (2021). Pengembangan bahan ajar kalkulus integral berbasis pendekatan computational thinking [Development of integral calculus teaching materials based on a computational thinking approach]. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(4), 2000-2013. https://doi.org/10.24127/ajpm.v10i4.4308

Sumirat, S. F. P., Sudihartinih, E., & Sumiaty, E. (2023). Kajian learning obstacle pada topik bilangan berpangkat ditinjau dari literasi PISA 2021 [Study of learning obstacles on the topic of exponent numbers in terms of PISA 2021 literacy]. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *7*(1), 350-361.

Sunardiningsih, G. W., Hariyani, S., & Fayeldi, T. (2019). Analisis kesalahan siswa dalam menyelesaikan soal matematika berdasarkan analisis Newman [Analysis of student errors in solving mathematics problems based on Newman's analysis]. *RAINSTEK: Jurnal Terapan Sains & Teknologi*, *1*(2), 41-45.

Wijaya, T. T., Hidayat, W., Hermita, N., Alim, J. A., & Talib, C. A. (2024). Exploring contributing factors to PISA 2022 mathematics achievement: Insights from Indonesian teachers. *Infinity Journal*, *13*(1), 139-156. https://doi.org/10.22460/infinity.v13i1.p139-156

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

Wu, T.-T., Silitonga, L. M., & Murti, A. T. (2024). Enhancing English writing and higher-order thinking skills through computational thinking. *Computers & Education*, *213*, 105012. https://doi.org/10.1016/j.compedu.2024.105012

Zahid, M. Z. (2020). Telaah kerangka kerja PISA 2021: Era integrasi computational thinking dalam bidang matematika [Review the PISA 2021 framework: The era of the integration of computational thinking in the field of mathematics]. In PRISMA, Prosiding Seminar Nasional Matematika, Universitas Negeri Semarang (Vol. 3, pp. 706-713).