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IDENTIFICATION OF HIGH SCHOOL STUDENTS' COMPUTATIONAL THINKING SKILLS IN SOLVING BINOMIAL PROBABILITY PROBLEMS

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Abstract

This study aims to identify the computational thinking skills of high school students in solving binomial probability problems. This research uses a case study method with a descriptive qualitative approach. The subjects of this study were three students of class XI, where each student represented each category of mathematical ability in general, namely: low, medium, and high. Data collection using test and interview methods. Based on the results of data analysis using computational thinking stages, that found: 1) Students with high mathematical abilities can fulfill the stages of computational thinking skills in each given problem. 2) Students with medium mathematical abilities can't always fulfill the stages of computational thinking. When unable to solve problems, students with medium mathematical abilities have problem formulation and abstraction skills. 3) Students with low mathematical abilities are not as good as students with medium or high mathematical abilities. Students with low mathematical ability cannot fulfill all stages of computational thinking when they cannot solve problems.

Keywords: Binomial probability; computational thinking; mathematical ability.

Abstrak

Penelitian ini bertujuan untuk mengidentifikasi kemampuan berpikir komputasi siswa SMA dalam menyelesaikan masalah peluang binomial. Penelitian ini menggunakan metode studi kasus dengan pendekatan kualitatif deskriptif. Subjek penelitian ini adalah tiga siswa kelas XI, dimana setiap siswa mewakili setiap kategori kemampuan matematika secara umum yaitu: rendah, sedang, dan tinggi. Pengumpulan data menggunakan metode tes dan wawancara. Berdasarkan hasil analisis data dengan menggunakan tahapan berpikir komputasi, ditemukan: 1) Siswa dengan kemampuan matematika tinggi dapat memenuhi tahapan kemampuan berpikir komputasi pada setiap masalah yang diberikan. 2) Siswa dengan kemampuan matematika sedang tidak selalu dapat memenuhi tahapan berpikir komputasi. Ketika tidak mampu menyelesaikan masalah, siswa dengan kemampuan matematika sedang memiliki keterampilan merumuskan masalah dan abstraksi. 3) Siswa dengan kemampuan matematika rendah, memiliki kemampuan berpikir komputasi tidak sebaik siswa dengan kemampuan matematika sedang atau tinggi. Siswa dengan kemampuan matematika rendah tidak dapat memenuhi semua tahapan berpikir komputasi ketika mereka tidak dapat menyelesaikan masalah.

***Kata kunci**: Berpikir komputasi; kemampuan matematika; peluang binomial.*

INTRODUCTION

In the 21st century, information technology is developing rapidly and affecting every area of human life, including education. With the development of technology, teaching and learning also change. Today, the learning process can be done online through social media or other media that support the online learning process. So that learning can be held without face to face directly like before (Nastiti et al.,

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2020). Therefore, a curriculum that can help students develop their skills is needed. All students must be prepared with appropriate technical knowledge and communication skills to compete in this era (Tsai & Tsai, 2018). Computational thinking is one of the skills that students must have in the 21st century (Selby, 2015).

Computational thinking means forming problems and composing solutions in the form of computational problems and computational solutions, rather than thinking like a computer (Wing, 2017). According to (Selby, 2013), computational thinking is the way to solve problems better through the systematic application of abstraction, decomposition, algorithmic design, generalization, and evaluation that can be carried out by digital devices or by humans. In line with this opinion, a study conducted by (Voskoglou & Buckley, 2012) concluded that computational thinking is a new method for solving the problem.

Based on several opinions about computational thinking, computational thinking is not only needed by computer scientists, not only related to programming, but also about formulating problems. (Wing, 2006) states that computational thinking skills include abstraction, problem decomposition, problem reformulation, automation, and systematic testing. Based on Wing's ideas, (ISTE & CSTA, 2011) divide computational thinking into six components: formulating problems, analyzing data, abstracting, algorithmic thinking, evaluating, and generalizing. (Selby, 2013), define computational thinking skills, namely skills that include the following terms: abstraction, decomposition, algorithmic thinking, generalization, and evaluation.

According to (Palts & Pedaste, 2020), computational thinking is divided into three stages, namely: 1) defining the problem, 2) solving the problem, and 3) analyzing the solution. Based on the skills in computational thinking, the ability to think computationnally is good if every individual owns it because computational thinking can be used to formulate problems. Although computational thinking is based on computer science, computational thinking can be applied to other disciplines (Yadav et al., 2017). That is, computational thinking can be used in solving problems related to mathematics.

Although it is good to have computational thinking skills, the computational thinking skills of equivalent high school students in Indonesia are still lacking. It can be seen from the results of the Bebras Competition in 2021, where less than 1% of participants scored above 80, and 73% of the 317 participants scored less than 60 (Bebras Indonesia, 2021). It is in line with the observations of (Sa'diyyah et al., 2021) that students have low computational thinking skills and need to be improved. In addition, based on the results of the 2018 Program International Student Assessment (PISA) study, Indonesia is ranked 73 out of 79 in the mathematics category. The 2018 PISA results had decreased from 2015, when 2015 it scored 386, while in 2018, it was 379 (OECD, 2019). PISA measures problem-solving and reasoning skills (Asdarina & Ridha, 2020). It means that when PISA results are not good, computational thinking skills are also not good because computational thinking skills can be seen in how someone solves mathematical problems (Cahdriyana & Richardo, 2020).

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When solving mathematical problems, students are trained to think logically critically, systematically formulating problems and formulating issues related to computational thinking. The mathematical problem in question is not just a common problem that can be done directly using a formula with known elements but a problem that requires thought at the time of execution. Many problems in mathematics require a strategy in solving the problem, one of which is the material of probability.

Probability is one of the materials studied in school. Students learn from elementary school to high school and even study it again in college for specific majors. Given this, it is an essential material to be mastered by students. In probability, especially those related to binomial probabilities, there are many problems related to everyday life. Students also sometimes need to think about problem-solving strategies to solve binomial probability. Students who use computational thinking on solving mathematics problem, especially to solve binomial probability, would be easy to solve any problem in mathematics (Maharani et al., 2019).

Since 2014 the UK government has introduced computational thinking to students to make decisions and solve problems (Syaeful et al., 2017). However, in Indonesia, there is still little research on computational thinking skills (Ansori, 2020). Based on this explanation, it is necessary to identify the computational thinking ability of high school students through solving problems; in this case, the problem used is binomial probability. It is hoped that the results of this research can later be used to design learning that can improve computational thinking skills.

METHOD

This research uses a case study method with a qualitative approach. This study aims to obtain a detailed description and information about the computational thinking ability of high school students seen through solving mathematical problems.

This research was conducted in one of the high schools in Sukabumi City with the subjects of this study were three 12th-grade high school students, who were selected using a purposive sampling technique, namely the subject-taking technique based on specific considerations. The research subjects consist of students with high mathematical abilities, students with medium mathematical skills, and students with low mathematical skills, which are selected based on the consideration of the teacher.

The data collection technique used in this research is the test and interview method. The test instrument used consists of 3 questions about binomial probability. Before being given to students, the test instrument was validated first by three experts. Furthermore, after being given to students, the test results of the three research subjects were then analyzed using the stages of computational thinking skills adapted from (Palts & Pedaste, 2020).

This research was used computational thinking's indicators to determine the category of student's mathematical computational thinking ability. There are three categories of students computational thinking ability in solving problems. It was high, medium, and low category. After solving the given problem, subjects were interviewed to confirm the stages of computational thinking they had gone through in the problem-solving

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process. Furthermore, the results of the tests and interviews were compared to conclude. The indicators of student's mathematical computational ability was explained in Table 1.

Table 1. Stages of computational thinking

Stages of Computational Thinking	Computational Thinking Skill	Description
Defining The Problem	Problem Formulation	Formulate the problem.
	Abstraction	Identify the appropriate information to solve the problem.
	Problem Reformulation	Re-formulate or model the problem into a solvable problem.
	Decomposition	Breaking the problem into smaller parts so that complex problems are easier to understand.
Solving The Problem	Data collection and analysis	Evaluating data sets to ensure that the data obtained can facilitate the discovery of patterns and relationships.
	Algorithmic design	Make a series of sequential steps to solve a problem or achieve a goal.
	Parallelization and iteration	
	Automation	
Analyzing The Solution	Generalization	Re-checking the solution, and formulating it into a general form that can be applied to other problems.
	Testing and evaluation	

RESULT AND DISCUSSION

Based on the answers and interviews of the three subjects, there were differences in the achievement of computational thinking skills in students with low, medium and high mathematical abilities. The recap of the results of the analysis of answers and interviews based on the stages of computational thinking can be seen in Table 2.

Table 2. Differences in students' computational thinking skills based on mathematical ability

Stages of Computational Thinking	Computational Thinking Skill	Mathematical Abilities								
		High			Medium			Low		
		1	2	3	1	2	3	1	2	3
Defining The Problem	Problem Formulation	✓	✓	✓	✓	✓	✓	✓	×	×
	Abstraction	✓	✓	✓	✓	✓	✓	✓	×	×
	Problem Reformulation	✓	✓	✓	✓	✓	×	✓	×	×
	Decomposition	✓	✓	✓	✓	✓	×	✓	×	×
Solving The Problem	Data collection and analysis	✓	✓	✓	×	✓	×	✓	×	×
	Algorithmic design	✓	✓	✓	×	✓	×	✓	×	×
	Parallelization and iteration									
	Automation									
Analyzing The Solution	Generalization	✓	✓	✓	×	✓	×	✓	×	×
	Testing and evaluation									

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Based on Table 2, it can be seen that a subject with high mathematical abilities can fulfil all stages of computational thinking in any given problem. It means that a subject with high mathematical abilities can define problems, solve problems, and analyze solutions. A subject with medium mathematical abilities fulfils all stages of computational thinking in problem two. However, it does not fulfil all stages of computational thinking for problems one and three. In problem one, a subject with medium mathematical abilities cannot fulfil the stages of solving problems and analyzing solutions. While in problem three, in addition to being unable to solve problems and analyze solutions, students with medium mathematical abilities can also not reformulate problems and perform decomposition at the stage of defining the problem. A subject with low mathematical abilities can fulfil the stages of computational thinking in problem one but does not fulfil all stages of computational thinking for problems two and three. Following are the results of the analysis of answers from the three subjects.

Student with high mathematical ability (S01)

As seen from Table 2, students with high mathematical ability can solve problems by going through the stages of computational thinking. Here are the answers of students with high math abilities for problem number one. The answer from S01 can be seen in Figure 1.

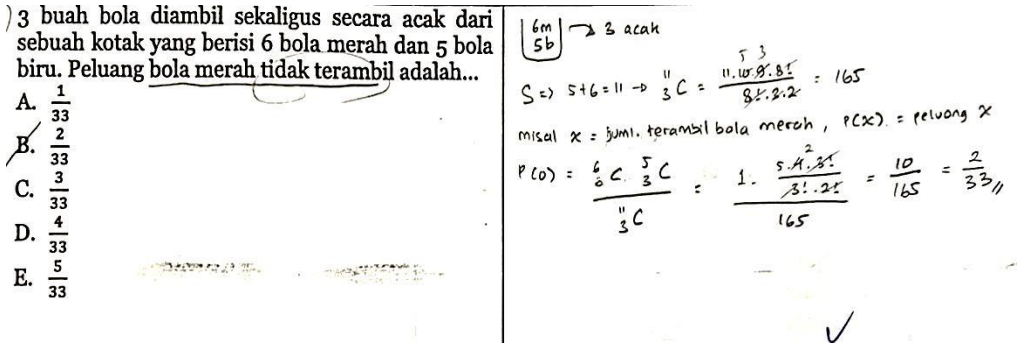

Figure 1. S01's answer No.1

Based on Figure 1, it is known that S01 has defined the problem. S01 describes the situation's information and assumes the ball is drawn with x. S01 also wrote that what would be determined was the value of $x = 0$. Furthermore, S01 also goes through the second stage, solving the problem, where S01 determines the number of ways to take three balls from all balls or ${}_{3}^{11}C$. In addition, S01 determines how many ways to pick three red balls and means that no blue balls are drawn or ${}_{0}^{6}C.{}_{3}^{5}C$. Finally, using the information that has, S01 can analyze the solution. S01 can determine the probability that the red ball is not drawn or $p(0)$, the ratio between the number of ways to pick three red balls and the number of ways to get three balls in total. It shows that students have fulfilled the three stages of computational thinking: defining the problem, solving the problem, and analyzing the solution.

Apart from S01's answer, the S01's computational thinking skills were also confirmed through interviews. From the interview results, it was found

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that S01 went through three stages of computational thinking to get the final result. Although a series of computational thinking skills at each stage is not outlined in detail to obtain these results, S01 has carried out the stages of computational thinking.

As for the answer problem number two, S01 has been completed correctly through the stages of computational thinking. The answer from S01 for problem number two can be seen in Figure 2.

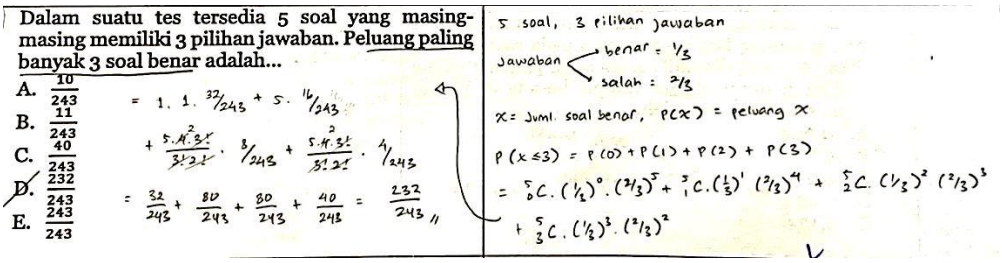

Figure 2. S01's Answer No.2

Based on Figure 2, S01 has been able to define and solve the problem. As for the stage of analyzing the solution, it is not stated in the answer. However, after being confirmed, S01 has tested and evaluated the problem-solving process. It means S01 has undergone three computational thinking stages for problem number two. Likewise, S01 has gone through the stages of computational thinking for the answer to problem number three.

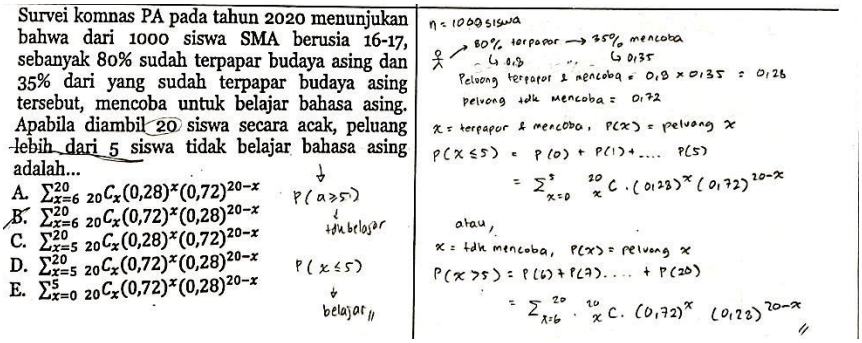

Figure 3. S01's answer No.3

Figure 3 shows that S01 has been able to define and solve the problem. As for the stage of analyzing the solution, it is not stated in the answer. However, after being confirmed, S01 has tested and evaluated the problem-solving process. Even for problem number two, S01 has undergone three computational thinking stages. Likewise, S01 has gone through the stages of computational thinking for the answer to problem number three.

The results of the analysis of answers and interviews show that the subject of S01 has good computational thinking skills. The students who have high mathematical abilities can solve problems well. It is in line with the research results of (Syaeful et al., 2017) that after being given learning with a realistic mathematical approach, students with high mathematical abilities have better mathematical problem-solving abilities than students with medium and low abilities.

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Student with medium mathematical ability (S02)

Based on the the S02's answer sheet, it can be seen that S02 cannot always fulfill all the skills at the computational thinking stage. Subject S02 solved problem no. 2 with the stages of computational thinking ability but for problems number one and three, S02 could not solve them. The answer from S02's to problem number one can be seen in Figure 3.

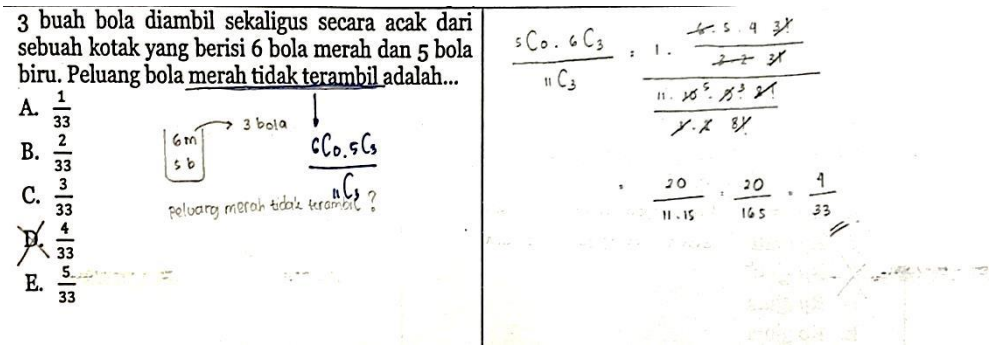

Figure 4. S02's Answer No.1

Based on Figure 4, it is known that S02 has defined the problem. S02 described the information contained in the problem and wrote down what was asked, namely determining the probability that the red ball is not drawn and supposing the ball is drawn with x. S02 has also gone through the second stage, solving the problem, where S02 determines the value of the number of ways to take three balls from all balls or ${}_{3}^{11}C$. In addition, S02 has also collected other data, namely determining the value of ${}_{0}^{5}C.{}_{3}^{6}C$. However, this value is not necessary for solving the problem. This value determines the number of ways to take three blue balls and means that no red balls are drawn. As a result, S02 does not get the final answer it deserves. After being confirmed through interviews, S02 understood the problems given and solved these problems. However, S02 does not evaluate and re-assure that the data obtained can facilitate solving the problem. Then after seeing the results of the answers in the options, S02 already felt that the answer was correct and did not re-check the answer. It means S02 does not fulfill the stages of solving problems and analyzing solutions.

For problem no.2, S02 passed the computational thinking stage well. The following are the results of S02's answers to the second problem.

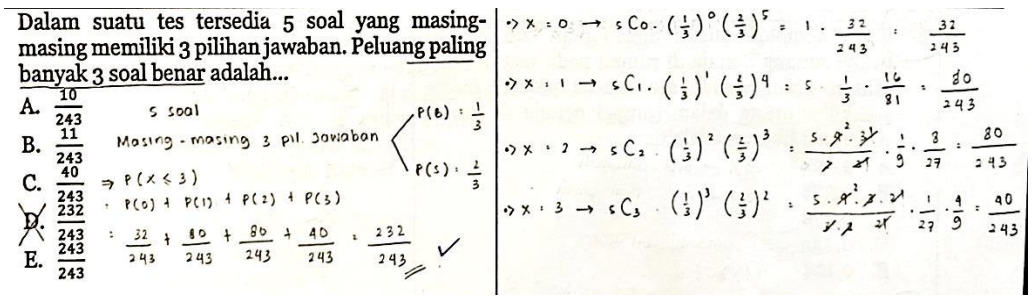

Figure 5. S02's Answer No.2

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Figure 5 shows S02 has passed the defining and solving the problem stages correctly. However, for the stage of analyzing the solution, it has not been seen in the answers. After being confirmed through the interview results, the subject of S02 performed all stages of computational thinking skills, including conducting a final evaluation. For the next is the answer from s02 for question number 3 can be seen in Figure 6.

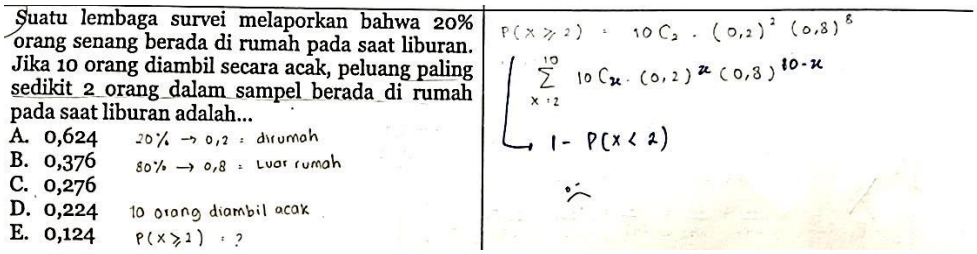

Figure 6. S02's Answer No.3

As for problem no.3, based on figure 6, subject S02 has formulated the problem and identified the information needed. However, subject S02 cannot reformulate and decompose the problem. S02 writes that the probability of people who like to be at home on vacation is 0.2, and the probability of leaving the house is 0.8. In addition, S02 wrote that ten people took randomly and what was asked was $P(x \geq 2)$. After finding out, S02 knows the information needed to solve the problem. S02 also explains that what was asked in this problem was the probability that at least two people in the sample are happy at home; therefore, S02 wrote $P(x \geq 2)$. It means that the stage of defining the problem is not carried out entirely. As a result, S02 cannot solve the problem and analyze the solution.

The analysis of answers and interviews shows that S02 has computational thinking skills that are not as good as S01. It means that in solving the problems, S02 is not better than S01. Following the results of Rianti's research, students with medium mathematical problem-solving abilities are in the lower category. In contrast to students with high mathematical ability, problem-solving abilities are medium (Rianti, 2018).

Student with low mathematical ability (S03)

As seen from table 2, the students with low mathematical ability can solve the problem through computational thinking only for the first problem. However, when defining the first problem, S03 collected redundant data. Nonetheless, S03 can solve problems and analyze solutions. Here is S03's answer to the first problem.

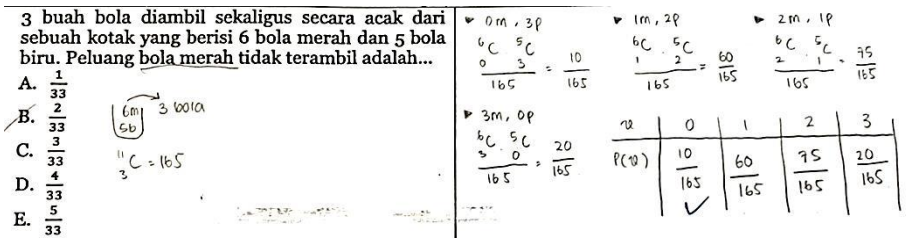

Figure 7. S03's Answer No.1

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Based on Figure 7, the subject of S03 has been able to define and solve the problem. However, S03 has not shown capable of analyzing solutions. After being confirmed through interviews, in determining the results, S03 evaluates the results that have been determined.

For the second and third problems, the subject of S03 could not solve them, which means that S03 did not fulfil the computational thinking stage. Subject S03's answer to the second problem like the Figure 8.

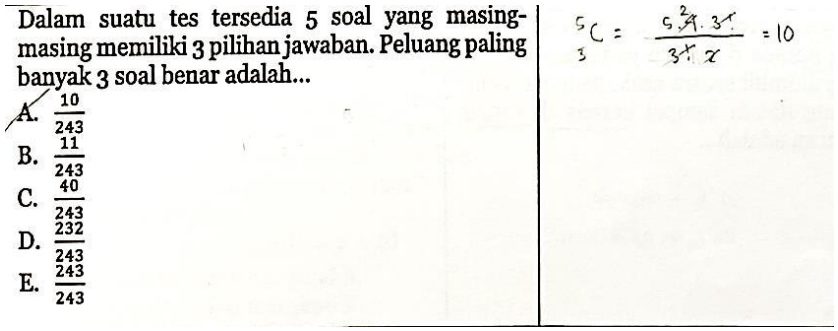

Figure 8. S03's Answer No.2

For the second problem, based on figure 8, subject S03 only wrote ${}_3^5C$. Subject S03 did not define and solve problems also analyzes solutions. After being asked at the interview, it turned out that S03 did not understand the problem, so S03 could not solve the problem. As a result, S03 does not fulfill the stages of computational thinking. S03 only thought that the probability problem was related to combinations, and there was information in the problem that there are five questions and three answer choices, so write ${}_3^5C$.

Likewise, subject S03 only wrote the answer directly for the third problem without defining and solving the problem. Based on the interview results, it turned out that S03 did not understand how to solve it and only wrote down the answer he chose from the options. The answer from S03 for the third problem can be seen in Figure 9.

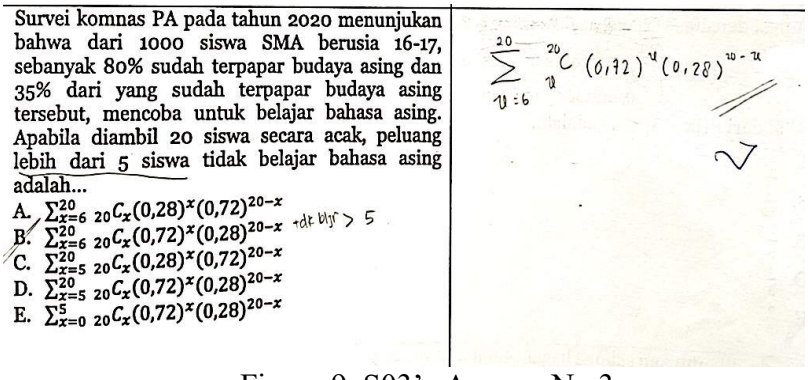

Figure 9. S03's Answer No.3

Based on the analysis of answers and interviews that S03 has computational thinking skills that are not as good as S02 and S01 subjects. It shows that the subject of S03 cannot solve the problem correctly. Following the results

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of (Pangesti & Soro, 2021), students who have a low mathematical disposition cannot fulfill all indicators of mathematical problem-solving ability.

Based on the explanations above, it can be seen that students with high mathematical abilities have fulfilled all the indicators of computational thinking skills, namely defining problems, solving problems, and analyzing solutions. Students with moderate mathematical ability cannot always fulfil all indicators of computational thinking skills. Students with moderate mathematical abilities may not go through the stages of solving problems and identifying solutions. Meanwhile, students with low mathematical abilities cannot go through the stages of computational thinking more often. Students with low math skills skip these stages, from defining the problem, solving the problem, and analyzing the solution. It is in line with (Novitasari & Wilujeng, 2018)that students with high abilities, both male and female, can understand the problem well, have a solution plan, complete problem-solving according to the plan, and re-check. Students who have low abilities, both male and female, cannot solve the problem completely. In addition, the results of (Achadiyah et al., 2022) also show the same result. Students with high mathematical ability in solving mathematical problems can solve all given problems, students with medium abilities can only solve some problems, and students with low abilities cannot solve problems.

So, it is obtained that students with high mathematical abilities have better computational thinking skills than those with moderate or low mathematical abilities. Meanwhile, students with moderate mathematical abilities have better computational thinking skills than students with low mathematical abilities.

CONCLUSION AND SUGGESTION

Based on the results of the research described above, it can be seen that students with high, medium and low mathematical abilities have different computational thinking skills. Students with high mathematical abilities have excellent mathematical skills because they can fulfill the stages of computational thinking skills in any given problem. Students with medium mathematical abilities have computational thinking skills that are not better than students with high mathematical abilities. Students with medium mathematical ability cannot always fulfill the stages of computational thinking. When unable to solve problems, students with moderate mathematical abilities have problem formulation and abstraction skills. Meanwhile, students with low mathematical abilities have computational thinking skills that are not better than students with medium mathematical abilities. When unable to solve problems, students with low mathematical abilities cannot fulfill all stages of computational thinking.

Furthermore, as a suggestion to identify future computational thinking, it can be viewed from other abilities, not only in terms of mathematical abilities. Research can also be carried out more deeply by looking at the influencing factors. The results of this study can also be used to design learning based on computational thinking.

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