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MATHEMATICAL COMPUTATIONAL THINKING SKILLS IN THE CONTEXT OF CRITICAL THINKING BASED ON GENDER

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ABSTRACT

Computational thinking is related to critical thinking skills. The purpose of this research is to find out how students' ability in mathematical computational thinking in the context of critical thinking and the differences in the abilities of women and men. This research is a qualitative research. Data collection techniques used written tests, interviews, and documentation. The subjects of this study were selected through purposive sampling technique and totaled 34 students. After that they did a written test with 7 questions on the material of the system of linear equations of two variables and obtained 6 students with the category of 2 high ability students, 2 medium ability students, and 2 low ability students. The data were analyzed by using Triangulation technique. The results showed that female students are superior in solving problems according to the indicators of computational thinking because they pay more attention to accuracy in the work. So it must often work on problems to train students' abilities so that all students can do it better and become balanced for each student's ability. So it is hoped that students will get used to thinking in a stepped, systematic and logical manner.

Keywords: Critical Thinking, Gender, Mathematical Computational Thinking

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PRELIMINARY

As we already know, math is an important component in education. Not only counting, math also demands other skills such as logical and critical reasoning in solving problems. These skills will be essential for their success in the world of work and outside of work (Fauji et al., 2022). According to (Barr & Stephenson, 2011), in addition to math skills, students will be influenced by computing throughout their lives, and many will work in fields that involve or are influenced by computing.

Computational Thinking (CT) first emerged around 1950, but the concept of computational thinking both in terms of ideas and concepts actually existed long before the 1950s. In the past, there were terms such as algorithm, algorithmic thinking, and computer literacy, developed by Alan Perlis and Donald Knuth. So in this century, the ability to think computationally is needed, also identified as Computational Thinking (CT). Not only needed by computer experts, the ability to think computationally is a basic ability that every

individual wants to read, write, and count (Kamil et al., 2021). Computational thinking is a cognitive stage in which learners adopt regular patterns in solving certain problems because it is a technique that helps learners in facilitating and enhancing learners' creativity (Città et al., 2019; Supiarmo et al., 2022). Computational thinking is needed because it helps a person to solve problems in everyday life so that they become more creative and more critical (Lisa et al., 2024).

According to (Sa'diyyah et al., 2021) showed that students failed to describe the problem and find the right pattern of solving the exercise, which indicates that they have poor computational thinking skills and need to be improved. Some skills are interconnected and can benefit each other, such as computational thinking and critical thinking. Critical thinking ability is an important ability for a person in dealing with various problems in social and personal life (Nuryanti et al., 2016) Critical thinking and computational thinking are needed to create human resources who can think with high patterns (Setyautami, 2020). According to Rudinau and Barry, (Hardika, 2020) critical thinking is a process that emphasizes the rational and scientific basis for beliefs and sets standards and procedures for analysis, testing, and evaluation.

Basically, humans have differences that were created for them, one example is the gender differences between women and men. Teachers must realize and pay attention that each gender has unique characteristics (Davita & Pujiastuti, 2020). Gender refers to the way male and female students behave towards society regarding gender differences (Rosania et al., 2019).

According to (MZ, 2013), gender differences inevitably cause physiological and psychological differences in learning. According to the results of research (Khodashenas, 2023), male and female students differ in critical thinking ability, although this difference is not significant. Based on previous research on computational thinking and critical thinking, research (Lee et al., 2023) on Exploring the multifaceted roles of mathematics learning in predicting students' computational thinking competency that enjoyment and self-efficacy are important for effective learning in computational thinking. However, more research is needed to explore how these affective factors influence learning outcomes across gender, particularly in non-STEM contexts. Research (Widyatiningtyas et al., 2015) on the impact of problem-based learning approach to senior high school students' mathematics critical thinking ability showed that there was no significant relationship between the learning methods used by students and their school level and mathematics ability. The purpose of this study was to find out (1) how the ability of mathematical computational thinking in the

context of students' critical thinking and (2) differences in the ability of male and female students in mathematical computational thinking in the context of critical thinking.

METHODS

This research uses a qualitative method with a case study approach. Qualitative research according to (Sidiq & Choiri, 2019) is a type of research that is descriptive and usually uses analysis to produce findings that cannot be achieved through quantitative or statistical techniques. In this study, the researcher will focus on analyzing mathematical computational thinking ability in the context of critical thinking based on gender in senior high school. The data collected in this study came from test results and interviews. The instruments in this study involved the researcher himself, test and interview tools, and documentation. The test instrument used has gone through a validation test so that it can measure the indicators that have been made by asking experts' opinions. The test instrument used was in the form of eight mathematics essay test questions with the material of the system of linear equations of two variables. In qualitative research, data is analyzed when starting research until taking data in the field, namely: (1) Analyzing the material; (2) Developing instruments; (3) Analyzing the results of instrument tests obtained; (4) Making categories; (5) Interpreting stories; and (6) Presenting in the form of tables, pictures, and others are the steps of data analysis in this study.

The source of data in this study is class X students in one of the high schools in Jakarta totaling 34 students. Students were selected through a technique to prove students' mathematical computational ability in working on the problem of a system of linear equations of two variables based on critical thinking ability questions. Based on some indicators that have been proposed by Bocconi and adapted by (Veronica et al., 2022) listed in Table 1.
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Table 1. Computational Thinking Indicators

No.	Aspects	Indicators
1.	Abstraction	The process of identifying information about a problem to make it easier to understand by reducing unnecessary elements
2.	Decomposition	Solve math problems by dividing them into simple parts
3.	Algorithmic Thinking	Understand and design structured steps to solve mathematical problems

No.	Aspects	Indicators
4.	Generalization	Identify patterns or common properties of some mathematical concepts or situations and adapt them to similar problem situations

The procedure carried out by the researcher is to first make an instrument in accordance with critical thinking skills with eight questions about the linear equation system, then validate the expert to submit the research instrument that has been made and revise the instrument according to the will of the validator. After that, validate the X grade high school students in one of the schools in Jakarta and obtained using the Rasch model with the Winstep application so as to get the results of valid questions totaling seven questions. Then the researcher will take the research data to the school that has been determined. Researchers made initial observations of the school and also determined the class and date for conducting research.

On the appointed day, researchers conducted a written test to 34 students in class X using seven questions on the material of the system of linear equations of two variables. After students took the written test, the researcher processed the data from the students' work by using winstep and determined six students, namely one male student and one female student with a high rank, one male student and one female student with a medium rank, and also one male student and one female student with a low rank seen from WrightMap. After that, the researcher processed the work of the six students according to the indicators of computational thinking ability and conducted interviews.

RESULT AND DISCUSSION

The subjects consisted of 34 students to take a test consisting of 7 questions on the material of the system of linear equations of two variables. Then 6 students will be selected, namely one male student and one female student with high rank, one male student and one female student with medium rank, and one male student and one female student with low rank to conduct this research. Students selected through the data processing stage with high, medium, and low ranking criteria based on Figure 1.

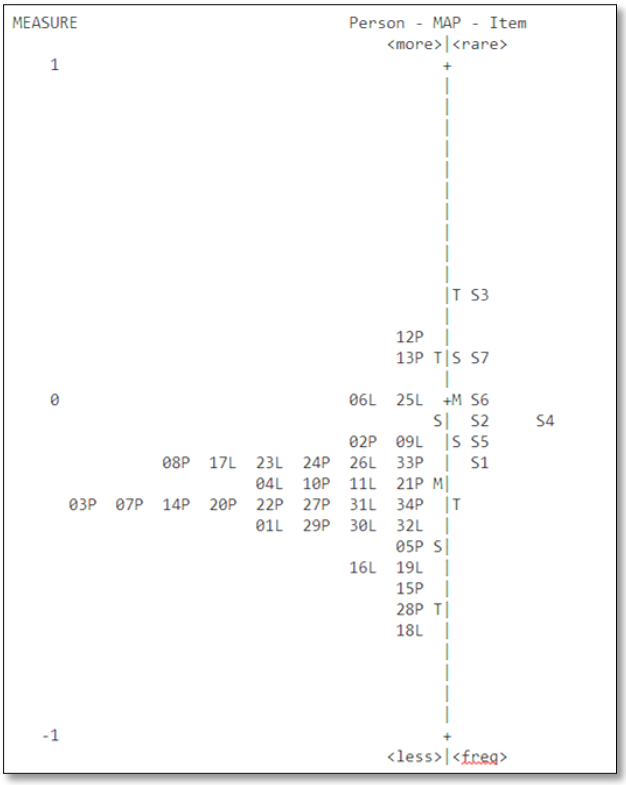


Figure 1. WrightMap

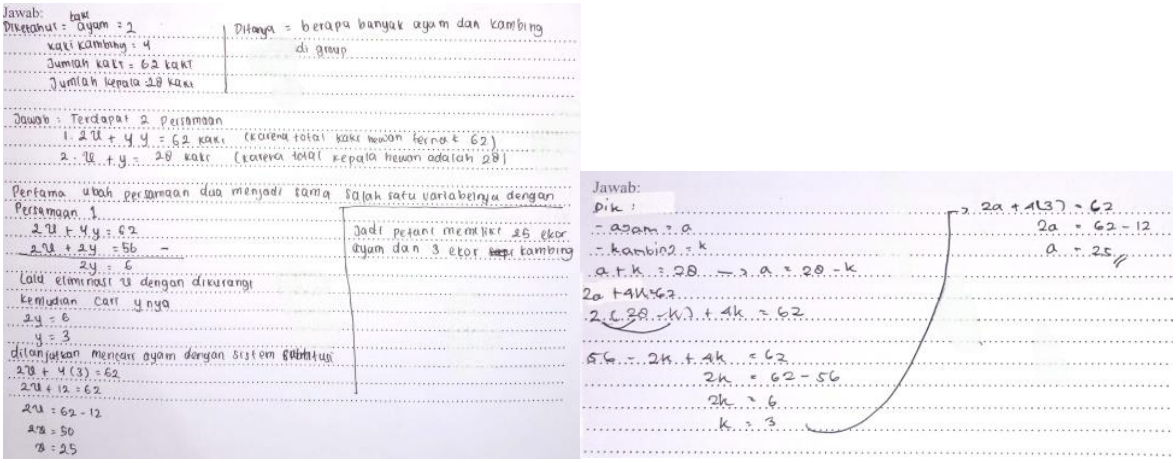
Based on Figure 1, the categories of students' critical thinking skills are grouped based on qualitative scores, which consist of high scores, medium scores, and low scores (Rodiah & Triyana, 2019). The data obtained from Figure 1 are two male students and two female students who occupy the highest category of critical thinking ability, then there are ten male students and fifteen female students who occupy critical thinking ability in the medium category, and there are three male students and two female students occupying critical thinking ability in the low category. The research subjects were then selected based on critical thinking ability as shown in the table.

Table 2. Research Subject

No	Category	Gender	Code
1.	High	Woman	S1
2.		Man	S2
3.	Medium	Woman	S3
4.		Man	S4
5.	Low	Woman	S5
6.		Man	S6

Subjects who have been selected after taking a critical thinking ability test consisting of seven questions will conduct an interview regarding the answers that have been done. The

following are the results of the answers to the mathematics written test, interview results, and research observations.



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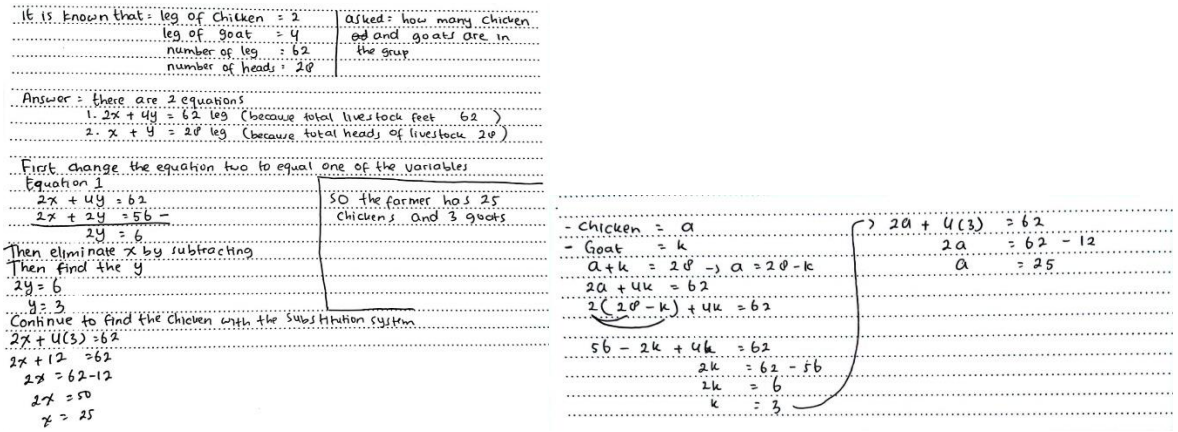
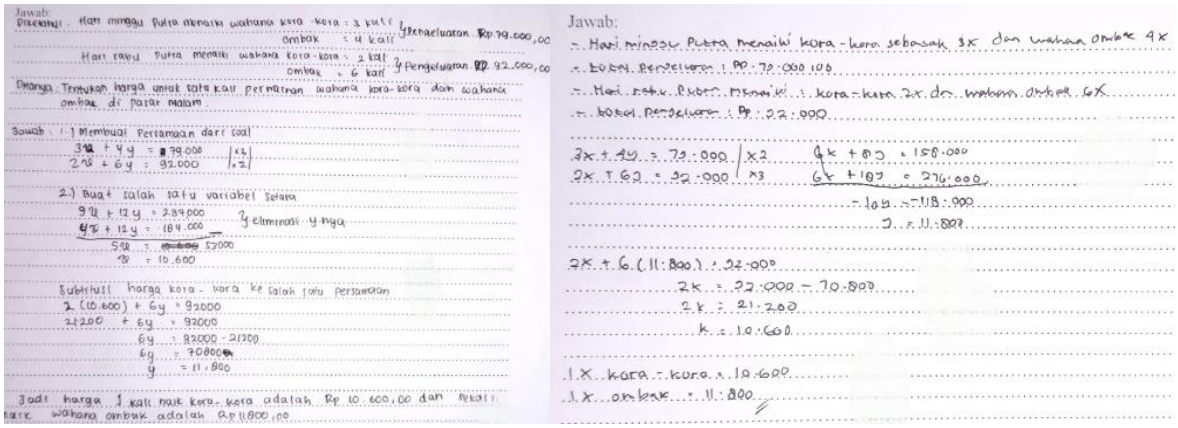


Figure 2. S1 & S2 Question 1 Answers

In the aspect of abstraction, S1 is able to list important information contained in the question by stating what is identified and asked clearly and concisely. The information does not repeat as in the question but explains the essence of the problem. Meanwhile, S2 does not list the information identified in the question but only lists the calculation of chickens and goats. In the decomposition aspect, S1 and S2 are able to divide the problem by making mathematical model equations according to what is explained in the problem. In the aspect of algorithmic thinking, S1 and S2 are able to solve problems using methods that are in accordance with the linear equation system method. In the generalization aspect, S1 gets the results from the questions in the question and states the conclusion with the sentence so the farmer has 25 ayan and 3 goats. S2 does not provide a conclusion so that S2 cannot work on the problem with the patterns that have been obtained.



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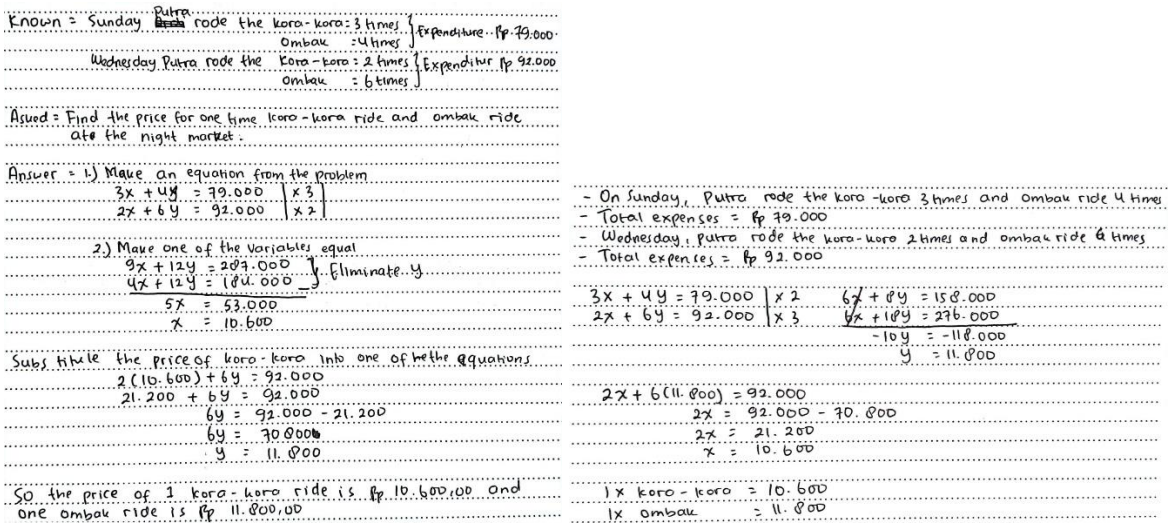
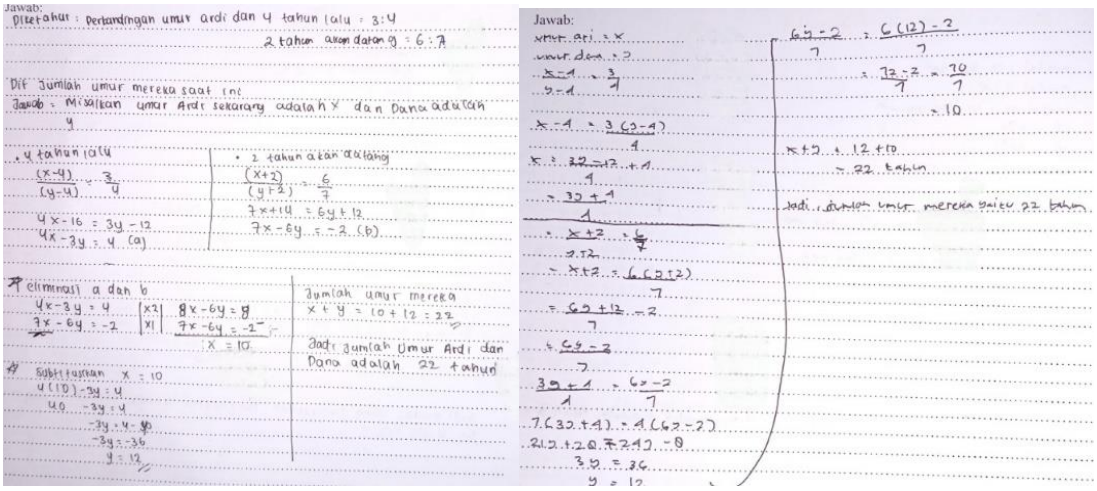


Figure 3. S1 & S2 Question 2 Answers

In the abstraction aspect, S1 and S2 are able to identify important information contained in the questions. But S2 does not list what is asked in the question. In the decomposition aspect, S1 and S2 are able to understand how to divide problems by making mathematical model equations according to what is explained in the problem. In the aspect of algorithmic thinking, S1 and S2 complete the steps in a structured manner according to the existing method, but S1 provides an explanation for each step. In the generalization aspect, S1 and S2 are able to provide conclusions so that they can find their son's expenses the next day using a identified pattern



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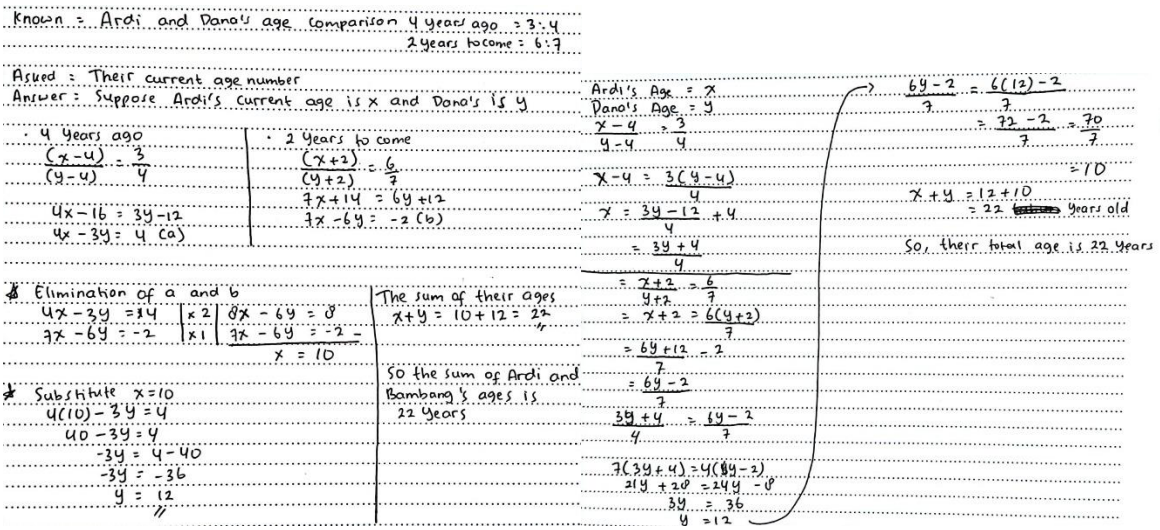
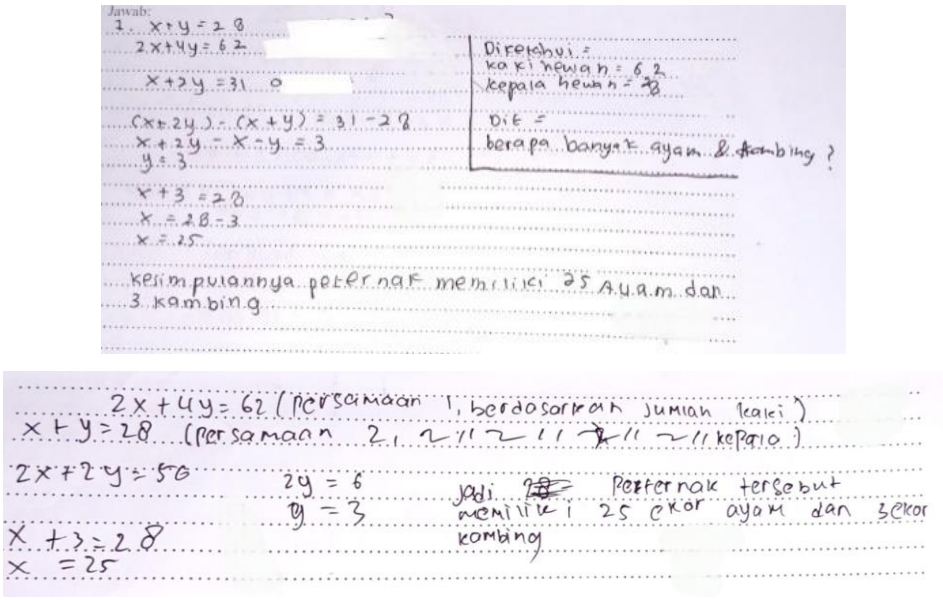


Figure 4. Answer to S1 and S2 Question 3

In the aspect of abstraction, S1 lists important information contained in the question by stating what is identified and asked clearly and intimately. The information does not repeat as in the question but explains the essence of the problem. S2 does not list the information identified in the question and only writes down information about the ages of Ardi and Dana. In the decomposition aspect, S1 divides the problem by calculating the last four years and the next two years and including an explanation. Meanwhile, S2 divides the problem into four years ago and two years in the future but is not given an explanation. In the aspect of algorithmic thinking, S1 and S2 are able to complete steps in a structured manner using cross multiplication and then using the linear equation system method. In the generalization aspect, S1 and S2 give the right conclusions.



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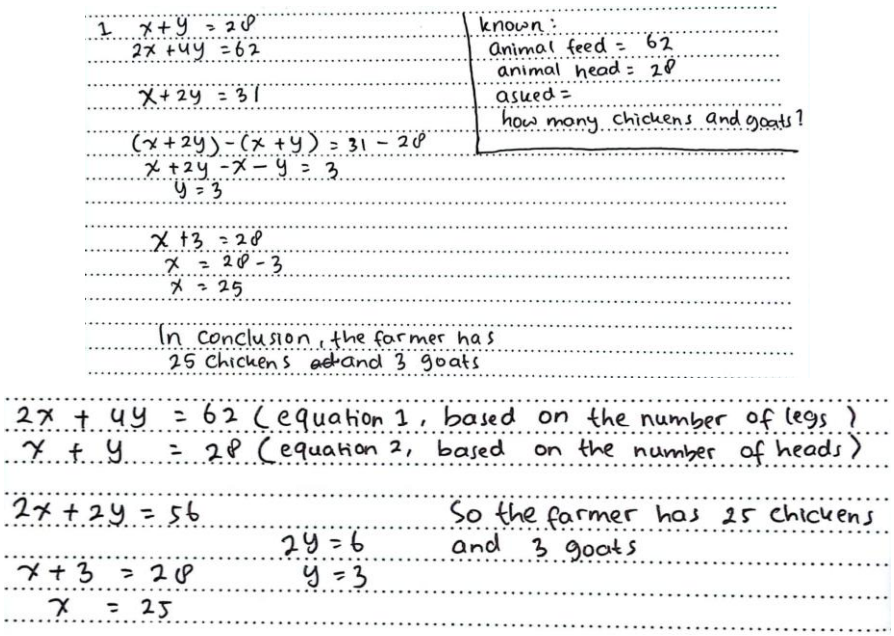
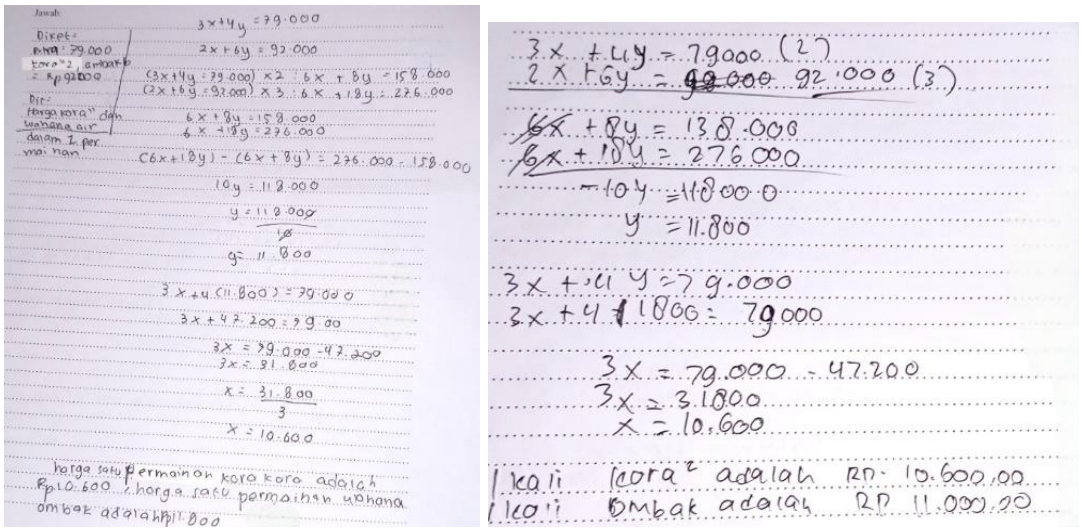


Figure 5. Answer to S3 and S4 Question 1

In the aspect of abstraction, S3 provides information in the problem such as the number of animal legs which is 62 and the number of animal heads which is 28. And S3 also lists what is asked in the question. S4 does not provide information in the question and does not provide information that will be asked in the question. In the decomposition aspect, S3 and S4 divide the problem into two equations. In the aspect of algorithmic thinking, S3 solves problems without using the identified linear equation system method. S4 gives a direct answer to get the value y is unidentified from where the value comes from and then

substitutes to equation one. In the generalization aspect, S3 and S4 gave the conclusion that farmers have 25 chickens and 3 goats.



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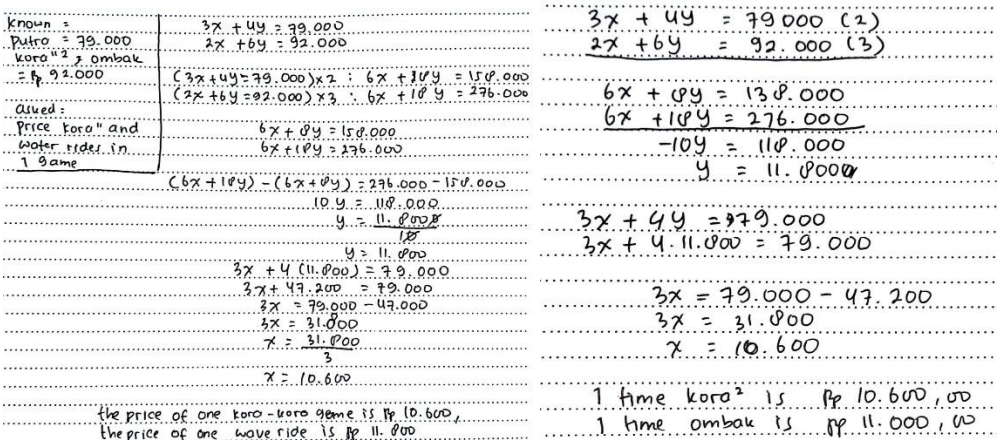
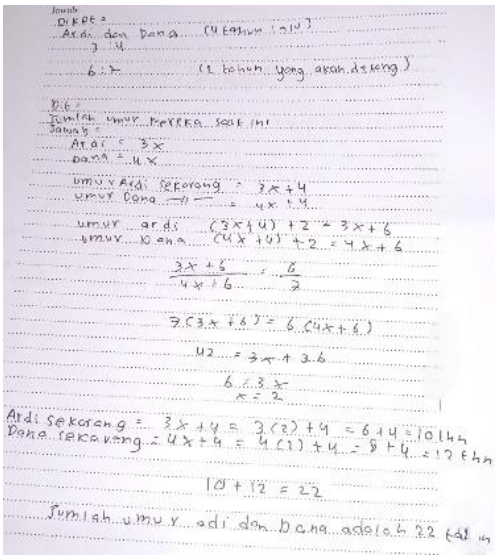
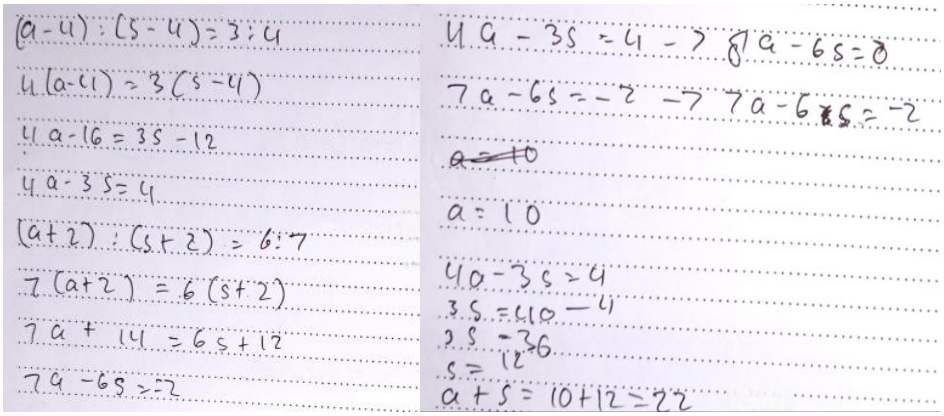


Figure 6. Answer to S3 and S4 Question 2

In the abstraction aspect, S3 provides information listed in the question but is incomplete and also provides information on what is asked in the question. S4 does not provide the information listed in the questions and directly solves the problems into the aspect of decomposition thinking. In the decomposition aspect, S3 and S4 are able to make two problems according to the problem into an equation. In the aspect of algorithmic thinking, S3 and S4 are able to solve problems using appropriate methods and get appropriate results. In the generalization aspect, S3 can provide conclusions. While S4 also made a conclusion but there was a mistake in writing the final result.





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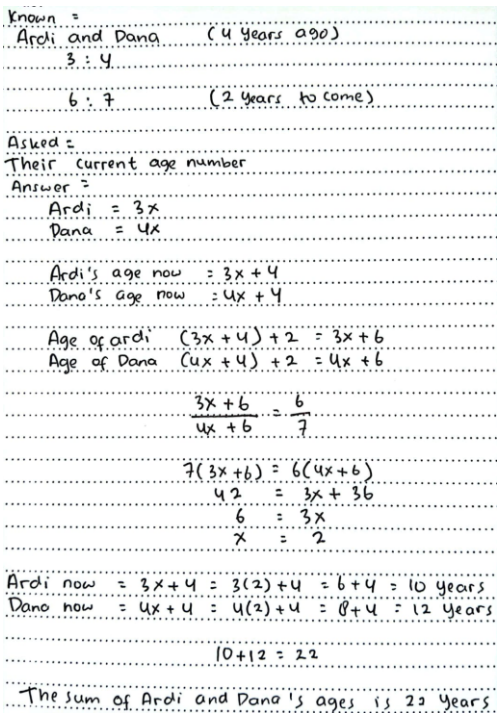
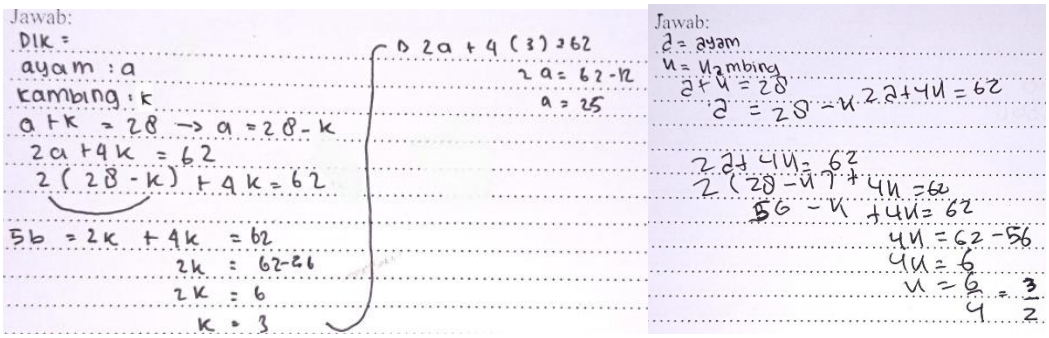


Figure 7. Answer to S3 and S4 Question 3

In the aspect of abstraction, S3 is able to provide information contained in the questions and is given a description of each information obtained briefly. And also S3 provides information about what is asked in the question. In the decomposition aspect, S3 divides into two parts, namely the age of the ardi is 3x and the age of the funds is 4x. Furthermore, S3 makes an equation, namely the age of the current ardi = 3x + 4 and the age of the current funds = 4x + 4. S4 makes two problems, namely the first problem is (a – 4) : (s – 4) = 3 : 4. There is a second problem, namely (a + 2) : (s + 2) = 6 : 7. At this stage S4 does not provide information on what a and s are. In the aspect of algorithmic thinking, S3 solves problems without using the four linear equation methods. S4 uses cross-multiplication calculation and then uses elimination. In the generalization aspect, S3 can provide conclusions while S4 does not provide conclusions.



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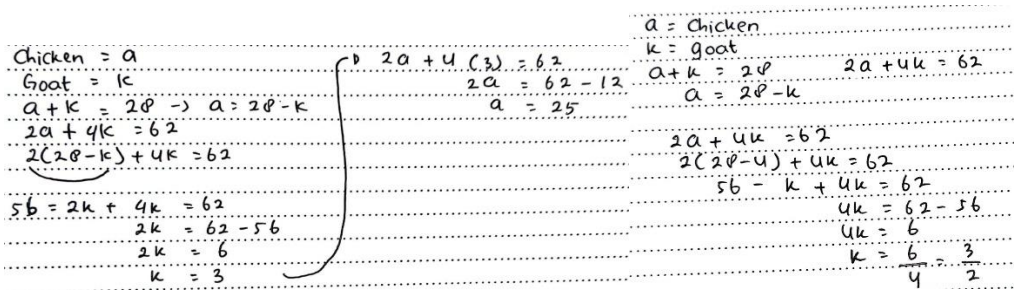
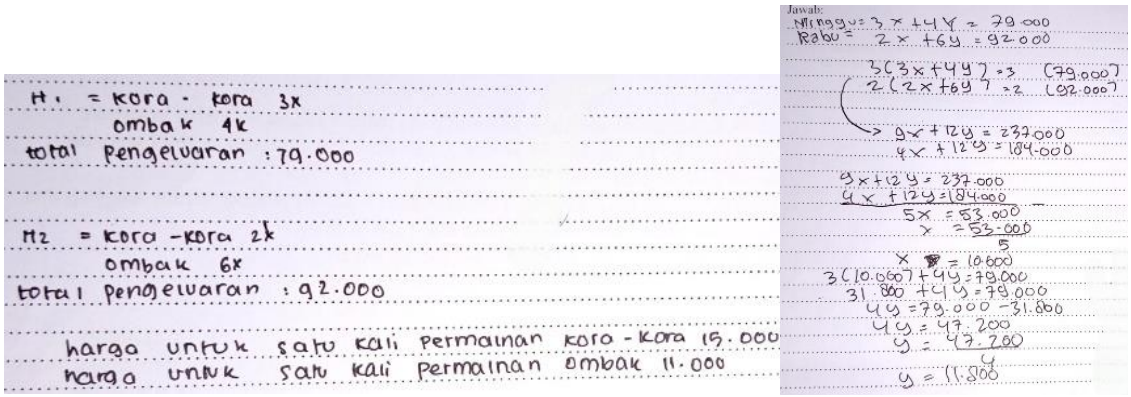


Figure 8. Answer to S5 and S6 Question 1

In the aspect of abstraction, S5 and S6 do not list the information identified in the problem but only list the reasoning for chicken = a and goat = k. And do not list what is in question in the problem. In the aspect of decomposition, S5 and S6 are able to divide the problem into two equations. In the aspect of algorithmic thinking, S5 and S6 are able to solve problems with steps according to the linear equation system method. But S6 made a mistake in calculating the results of the k. In the generalization aspect, S5 does not provide a conclusion so that S5 cannot work on the problem with the patterns that have been obtained.

S6 cannot work on the problem with the pattern that has been obtained because it does not complete the calculation.



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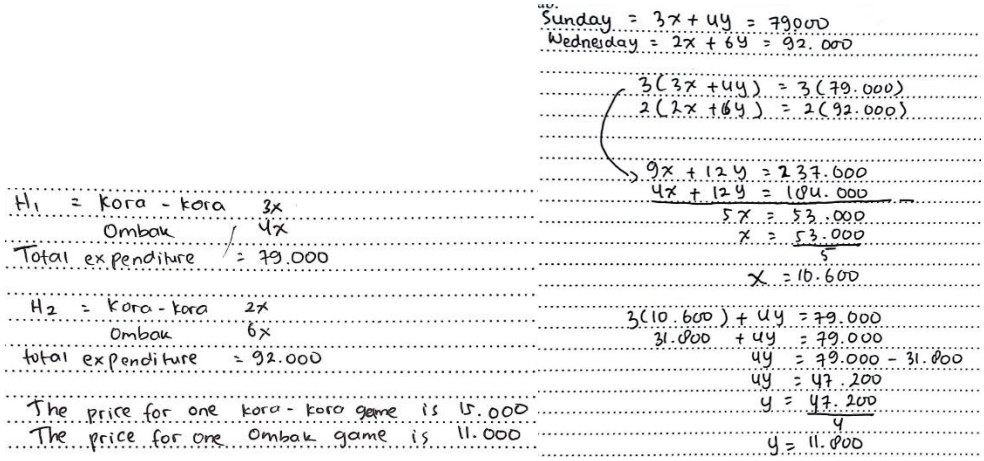

Figure 9. Answer to S5 and S6 Question 2

In the abstraction aspect, S5 only provides the information listed in the question, namely for the abstraction aspect by providing information such as H1 = 3x kora-kora and 4x waves with a total expenditure of 79,000 and H2 namely 2x kora-kora and 6x waves with a total expenditure of 92,000. S6 does not provide the information listed in the problem and immediately solves it into the decomposition thinking aspect. In the decomposition aspect, S5 does not give what problems are contained in the problem and does not provide steps for working on the problem so that it can be interpreted that S5 does not make work to solve the problem and immediately get the result and give a conclusion. While S6 divides the problem into two equations: equation one is 3x + 4y = 79,000 and equation two is 2x + 3y = 92,000. However, S6 does not know where the two equations come from and does not provide an explanation of the two equations. In the aspect of algorithmic thinking, S5 does not solve and S6 first solves the two equations with the elimination method, namely in equation one multiplied by three and equation two, which is multiplied by two so that the value of x is

obtained, which is 10,600. The next step for S6 is to use the substitution method, namely in equation one, substitute the value of x that has been obtained and get the result, namely the value of y is equal to 11,800. In the generalization aspect, S5 is able to make conclusions while S6 does not give conclusions.

Table 3. Differences in Mathematical Computational Thinking Ability of High, Medium, and Low Ranking Students

Indicators	High		Medium		Low	
	Woman	Man	Woman	Man	Woman	Man
Abstraction	Identify information by making reasoning to make it easier to work on the problem and provide information related to what is identified and asked about the question.	Identify information by making reasoning to make it easier to do the problem and in the second question provide information related to what is identified and question.	Identify information by making reasoning to make it easier to work on the problem and also provide information related to what is identified and asked in the question.	Identify information by making reasoning to make it easier to work and not give a statement about what is identified and asked about the question.	Identify information by making reasoning to make it easier to do the question, but in the first question do not list what is identified and asked in the question.	Identify information by making reasoning to make it easier to work on the question but not list what is identified and asked about the question.
Decomposition	Solve problems into pieces appropriately.	Solve problems into pieces appropriately.	Solve problems into pieces appropriately.	Solve problems into pieces appropriately.	For the first problem, solve the problem into several parts correctly, but in the second problem, it does not solve the problem into	Solve problems into the right parts

Indicators	High		Medium		Low	
	Woman	**Man**	**Woman**	**Man**	**Woman**	**Man**
					several parts.	
Allogoristic Thinking	Solve and explain each step and find a solution to each problem.	Solve each step and find a solution to every problem.	Solve each step and find a solution to every problem.	Complete each step and find a solution to the problem.	In the first question, complete the steps and find a solution to each problem, while the second question does not provide work on the problem.	In question number one, it does not complete the calculation but in number two, it can complete the calculation
Generalization	Find patterns in every problem.	Find patterns in every problem.	Finding patterns in every problem	Finding patterns in problems but not with the third problem	Didn't find a pattern on the issue	Didn't find a pattern on the issue

Based on table 3, the computational thinking ability of students with female gender in the abstract aspect of students with high and medium ratings is the same, namely Identify information by making reasoning to make it easier to work on the problem and provide information related to what is identified and asked about the question. Both students identify the existing information and list the relevant information that is identified and asked. In male students with high ranks, in the first and third questions identified information by reasoning but did not include information related to what was identified and asked, while in the second question he identified information by reasoning and gave what was identified in the question but did not list what was asked in the question. In female students from low ranks, they identified information with reasoning, but in the second question, they listed what was identified but did not list what was asked in the question. As for male students with medium ratings and male students with low ratings, they have something in common, namely identifying information by doing equations but not including information as identified and

asked about the question. In line with (Kaliky & Juhaevah, 2018) stated that female students are more thorough and able to reveal the information needed to solve problems.

The computational thinking skills of students in the aspect of decomposition with high and medium ratings and male students with low ratings are the same, namely solving problems into several parts and making mathematical models appropriately. But in the female students with low ratings in the first problem they shared the problem and made a mathematical model correctly, but in the second problem she did not divide the problem into parts because she did not complete her work. In line with research from (Danindra & Masriyah, 2020) stated that both female and male students have the same skills in terms of decomposition, namely the ability to recognize and create patterns in their own way.

Computational thinking skills in the aspect of algorithmic thinking, students with high and medium ratings are the same Solve each step and find a solution to every problem, but for female students with high ratings she also provides an explanation of each step. In female students with low ratings, in the first question she completes the steps and finds a solution to each problem, but for the second question she does not make the work steps and immediately gives the final result. As for male students with low ratings in the first question did not complete the steps and did not continue the work and there was a mistake in the results of the first work, while for the second question he completed the steps and found a solution to each problem. The results of this study are in line with the results of the research (Davita & Pujiastuti, 2020) that there was no significant difference in problem-solving skills between female and male students. However, female students provide added value because they provide explanations at each step of solving problems.

Computational thinking skills on the generalization aspect for female students, high alert on all problems, she lists the conclusions of the results of the work she has made, so that she finds patterns in each problem. For the male student with the highest ranking in the first question he did not make a conclusion so that he could not find a pattern in each problem but in the second and third questions he gave a conclusion so that he could find a pattern in each problem. In female students with medium ranks, she is the same as female students with high ranks, that is, in all questions, she makes conclusions from the results of the work that has been made so that she finds patterns in each problem. For male students with a moderate rating in the first question so that they can find patterns in each problem while the second question also gives a conclusion but there is a mistake in the writing. This is proven in research (Aminah & Kurniawati, 2018) stated that male students have difficulty in determining the final result and are less thorough in writing. In the third problem because he

did not finish the final part, namely at the conclusion so that he could not find a pattern in each problem. For female students with low ratings in the first question she did not find a pattern for each problem while for the second question she gave a conclusion but no doubt because she did not make the steps to work so from what was identified in the question immediately got the final result but the final result was not in accordance with the answer that should be, while for the third question she did not find a pattern because she did not do the problem. For male students with low grades in the first problem he did not find a pattern because he did not complete the results of his work and only did half of it, while for the second problem he worked on each step but did not give the last thing, namely the conclusion that he could not find a pattern for each problem, then for the third problem he could not find a pattern because he did not teach the problem. Based on the results of the research on the generalization aspect in accordance with the research (Salmina & Nisa, 2018) stated that the ability of female students is better than male students due to the lack of precision in solving problems thoroughly so that the results obtained by male students are less than optimal.

CONCLUSION

Based on the results of the researcher's findings, it can be concluded that the computational thinking ability of students with the highest and medium ratings is almost the same, only distinguishing the accuracy and clarity in their work. Meanwhile, students with low ratings are still lacking in understanding the concept of mathematical completion. All students identify important information by reasoning, divide the problem into several problems, complete each step of the work. But for female students with high and medium ratings to list what is identified and asked on all questions and female students with low ratings only list in the second question and only share the problem into several parts only in the first question. Male students with low ratings for the first question did not complete the results. As for the third question, female and male students with low ratings did not do the question.

The results of the study show that the abilities of each student are different. For female students in high and medium ranks, they are superior because they pay more attention to the abstraction part. Teachers must understand each student's different abilities in capturing learning material. In addition, teachers must also often provide questions to train students' abilities so that all students can do it better and be balanced for each student's ability. So it is hoped that students will get used to thinking in a step-by-step, systematic and logical manner.

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