ANALYSIS OF CLASS X STUDENTS' REASONING ABILITY IN SOLVING LINEAR EQUATION SYSTEM OF TWO VARIABLES

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Abstract - 'Reasoning ability' is an aspect of knowledge which often is less paid of attention by teachers. It is a necessary skill for students to figure out the subjects or mathematical concepts. Many students, in fact, have an arduous situation when they attempt to comprehend with those kind of mathematical equipments. The impact of it is that the students merely learn mathematics insignificantly or obtain inadequate understanding particularly in solving mathematics problems. Based on the teachers information, one material considered most difficult is 'Linear Equation System of Two Variables'. Numerous students are having a difficulty in creating the systems of linear equations which made up of two or more variables such that all the equations in the system are considered simultaneously. Thus this research was conducted to see how the reasoning abilities of students of grade X in accomplishing the system of linear equations in two variables. This study is descriptive qualitative research in which three participants were taken from students with different level of ability such as high-ability, medium-skill, and low-ability. The reasoning skills wereexplored through descriptive analysis on the test results of students reasoning ability. According to the data analysis, the researchers concluded that the high-ability student can analyze mathematical situations using appropriate patterns, compile valid arguments, draw logical conclusions, and provide the correct reasons. While in contrast, medium and low-ability student cannot propose valid conclusions from the given problem, so the reasoning indicator used in this research is not fulfilled.

Keywords - Reasoning Ability, Linear Equation System of Two Variables.

I. INTRODUCTION

Thinking is an activity to process information cognitively. The most common definition of thinking is the development of ideas and concepts in a cognitive development stage [1]. According Wells, Cognitive development is the construction of thought process, including remembering, reasoning, and problem solving from childhood through adolescence to adulthood [2]. Cognitive development is a series of thought processes consisting of phase remembering, reasoning, and problem solving done from childhood to adulthood.

Mathematics is one field of science that is closely related to the thinking activities [3]. Studying mathematics requires considerable understanding and practice. Many students have difficulty in learning math. As research conducted by Fatimah Ramli[4]that students have difficulty in learning mathematics due to various factors, including: primitive teacher explanation and decreased student persistence. It causes that the students are not optimal in solving math problems.

One way to solve the problem is by knowing how students' reasoning abilities are. Mathematical reasoning is a mathematical skill that is necessary and important for every student. One of the benefits of reasoning in learning mathematics is to help students improve the understanding ability which is very important in mathematics[5]. In the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 53, 2015 on the Students Development Evaluation in Senior High School, stated that mathematics assessment aspects in the report card are grouped into three aspects, namely concept comprehension, reasoning and communication, and problem solving. So we can conclude that one of the goals of learning mathematics is to develop reasoning.
Reasoning becomes important especially in mathematics because mathematics contains an active, dynamic, and generative process done by mathematics users[6]. The National Council of Teachers of Mathematics [7][8] has also declared mathematical reasoning to serve as a learning center for students' mathematics at every level of education. Increased students' math skills at school will be comparable to student learning outcomes [9].

One example of teaching material that uses reasoning is linear equation system of two variables. It requires good understanding and reasoning ability. Student's lack of concept understanding can hinder the learning process. Based on the teacher information of class X in South Sulawesi, there are still many students who have difficulty in understanding linear equation system of two variables. It is seen from the results of student exams where more than 50% of students score below minimum mastery criteria , which is 75.
Therefore, based on the above description, the researcher intends to conduct research related to the analysis of class x students' reasoning ability in solving linear equation system of two variables.

II. RESEARCH METHOD

This research is a qualitative descriptive research that aims to describe the students' reasoning ability of

class X in solving problem of linear equation system of two variables. Subjects in this study are divided into three levels of categories, namely high-ability students (S1), students with moderate (S2) and low-ability students (S3). The spatial capability is based on the student's previous daily test score. Then the learning outcomes of students are categorized qualitatively based on categorization techniques according to methods of grading in Summative Evaluation from Bloom [10].

The instrument used in the study is a description test related to reasoning ability. The problem of reasoning skills is given to students who have studied linear equation system of two variables. The test results are used to determine students' reasoning ability and the assessment sheets are used to obtain data about students' reasoning abilities in solving problems of linear equation system of two variables.

The results of this research were analyzed using indicators of mathematical reasoning ability. Based on the theoretical study that has been done, the researchers formulated four indicators of mathematical reasoning ability, namely: (1) predicting the completion process: students estimate the process of completion of a math problem, (2) using patterns and relationships to analyze the mathematical situation: students use patterns (3) formulating valid arguments using systematic steps: students construct valid arguments using systematic settlement steps, and (4) draw logical conclusions: students draw logical conclusions . In order to avoid misinterpretation, the researchers also conducted interviews with the three subjects of the study. Interviews were conducted to further track students' answers that can not be traced through test results.

The test questions discussed in this study are as follows:

"Six years ago, the age of father and mother were same as eleven times of the difference of their ages. Now, father's age is seven-sixth mother's age. Find the age of each person in the 5 years ahead!"!"

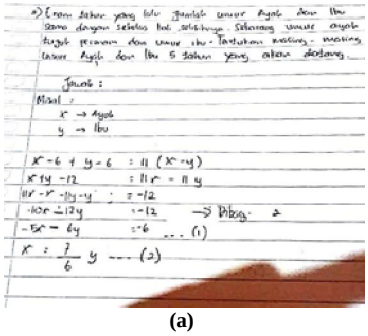
III. RESULTS AND DISCUSSION

3.1.Mathematical Reasoning Test Results

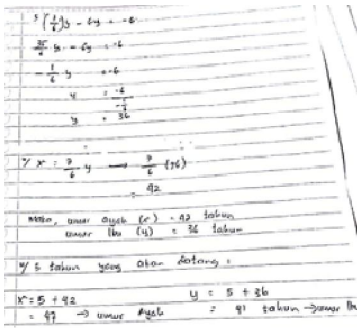
The discussion will be presented the work of the mathematical reasoning ability of high-ability students, moderate, and low in solving the problem of linear equation system of two variables.

3.1.1.The Mathematical Reasoning Ability of Highly Skilled Students (S1)

The following data is result of writing test S1 subject in solving problem of linear equation system of two variables.



(a)



(b)

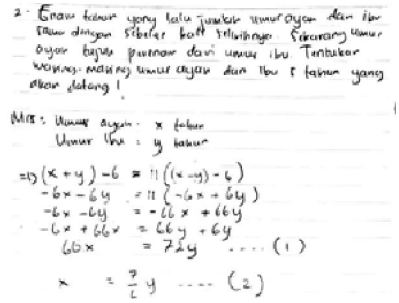
Fig.1. (a & b) written test result of subject S1

Based on written test the results of S1 combined with the results of the interview, obtained the result that S1 understood the problem as a matter of linear equations. It is seen from the pattern of questions marked by the existence of two statements that can be formed into two mathematical equations, where the two statements are interconnected and S1 can use to obtain a valid conclusion. To form a mathematical equation, S1 defines x as the current father's age and y is the current mother's age. It is to facilitate the working of the problem. After that each age of father and mother is reduced by six because the question said "six years ago".

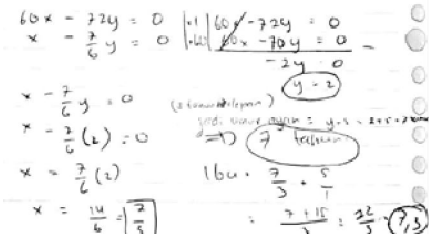
In the question said that the difference between the age of father and mother. It means in the mathematical equation written $x - y$. So the first equation is $(x - 6) + (y - 6) = 11(x - y)$. For the second equation said that now the father's age is seven-sixths of the mother's age. If it is written in a mathematical equation it will be $x = \frac{7}{6}y$. After that, S1 substitutesthe first equation in tothe second equation so that the value of y is obtained, namely 36. After that, the y value is substituted to the first equation to get the x value namely 42. Because of the question ask the age of father and mother about five years ahead, S1 get father's age is 47 years old and mother's age is 41 years old. After obtaining the result, S1 checks again to verify the answer by substituting the x and y values obtained to the first equation, namely $(x - 6) + (y - 6) = 11(x - y)$, so that it is obtained $(42 - 6) + (36 - 6) = 11(42 - 36)$.The equation is true, then the x and y values are definitely true. It makes S1 very confident with the answer. Data related to the way S1 examined the answers obtained from the interview so that the

process is not written on the student answer results. From the results it can be said that S1 has compiled valid arguments along with the use of systematic settlement steps so can provide the correct answer of the given problem and conclude the valid answer.

3.1.2. Mathematical Reasoning Ability of Medium Skilled Students (S2)



(a)



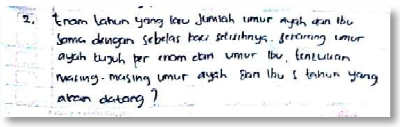
(b)

Fig.2. (a & b) written test result of subject S2

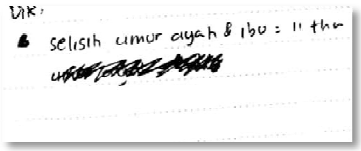
Based onwritten test results of S2 combined with the interview results, obtained that to solve the problem first, S2 created a mathematical model , namely x for father's age and y for mother's age. According to S2, the use of variables x and y is to facilitate the work of the question, as well as the difference between the father's age and the mother's age. However, S2 said that she was unsure of the answer because S2 hardly ever did such a thing. However, S2 still tried to solve the problem.

In the question said that six years ago, the age of father and mother were same as eleven times of the difference of their ages. According to S2, the mathematical model of the statement is$(x + y) - 6 = ((x - y) - 6)$.The equation clearly mistakes so it can be concluded that the final result obtained S2 is not appropriate. In this case S2 is not able to use existing patterns and relationships to analyze the problems given. S2 also can not construct arguments validly. In addition, in the process of obtaining the final answer, there are some mistakes that S2 does. From the results of the interview, S2 also realized that the answer obtained that y (age of mother) is 2 years is logically unreasonable because if the current age of mother is 2 years, then the mother is not born six years ago. It reinforces S2 inability to understand the problem which leads to illogical conclusions.

3.1.3. Mathematical Reasoning Ability ofLow Skilled Students (S3)



(a)



(b)

Fig.3. (a & b) written test result of subject S3

Based on written test result of S3 combined with theinterview results, obtained that S3 did not understand the problem. S3 does not give an answer in the given question sheet so nothing can be described. Based on interview results conducted, S3 can not solve the given problem, so S3 emptied answer and prefered to collect it.

3.2.Mathematical Reasoning Test Discussion

The discussion will be presentedanalysis of students' reasoning ability in solving linear equation system of two variables.

3.2.1. The Mathematical Reasoning Ability Discussion of Highly Skilled Students (S1)

On the test sheet shows that S1 does not write down the approximate settlement process in identifying the problem of linear equations of two variables. However, from the overall answer given, S1 able to solve the problem properly. Here is an analysis of the situation given by S1

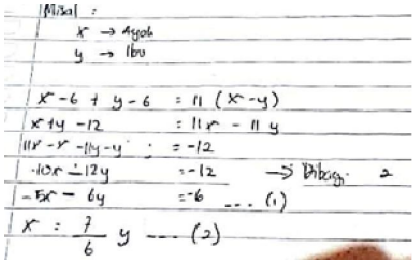


Fig.4. S1's answer in mathematical situation analysis step

Fig.4 shows that S1 understands if problem given is linear equation of two variables.It is seen from the existence of two statements that can be formed into two mathematical equations, where they are interconnected and can be used to obtain a valid conclusion later. To form a mathematical equation, S1 defines x and y based on question instruction. As a result, S1 compiles valid arguments in the form of two mathematical equations. Then both equations are completed by using a systematic step, namely substitution process. The following S1's answer related substitution process.

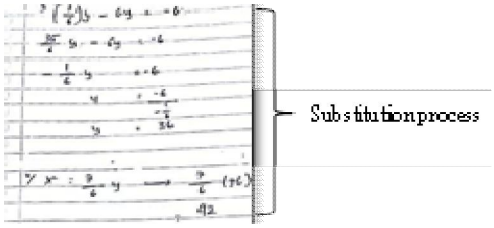


Fig.5. S1's answer in the step of constructing a valid argument using systematic steps

Based on fig.5, it can be concluded that S1 analyzes mathematical situations using patterns and relationships appropriately, S1 can construct arguments from patterns obtained andtake a systematic step(substitution process) to determine the values of x and y. The withdrawal of conclusions made S1 is as follows:

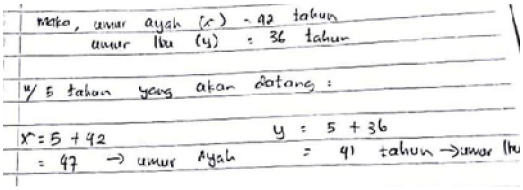


Fig. 6. S1's answer in conclusion step

Based on fig. 6, S1 concludes that father's age now is 42 years old and mother's age is currently 36 years old. So the age of Father and Mother five years aheadare 47 and 41 years respectively. It means that S1 draws a conclusion logically and can give the right reasons in the settlement step.

3.2.2. The Mathematical Reasoning Ability Discussion of Medium Skilled Students (S2)

On the test sheet shows that S2 did not write down the approximate settlement process in identifying the problem of linear equations of two variables.Here is a situation analysis given by S2.

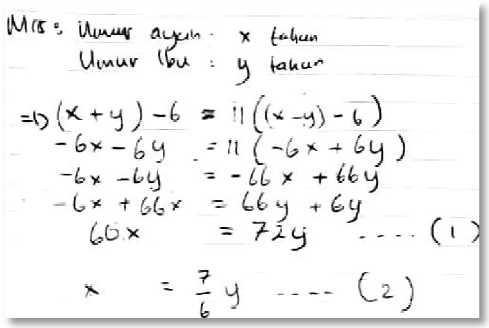


Fig. 7. S2's answer in mathematical situation analysis step

From the fig.7, S2 understood that the problem was a linear equation of two variables. To form a mathematical equation, S2 defined x and y. The definition of x and y is adjusted to the question instruction, but S2 did misconception and mistake in formulating mathematical equation model. See the following picture:

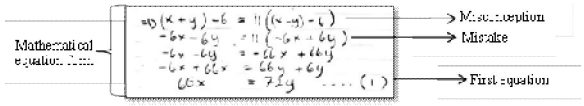


Fig.8 misconception and mistake done by S2

Based fig.8, it was found that S2 did misconception in construct mathematical modeling. Based on interview results that have been done, S2 added father's age and mother's age then reduced by six because the term in the question is "six years ago". S2 did not understand if it means that the father's age and mother's age should be reduced by six each. S2 considers that $x + y - 6 = 11(x - y)$ represents the statement "six years ago, the age of father and mother were same as eleven times of the difference of their ages.

Besides, S2 did mistake when constructed the first equation. S2 should do the reduction process, not multiplication distribution process.This error will obviously affect the final conclusion. However, S2 still continue to solve the problem using elimination and substitution process. Here is an excerpt of S2's answer:

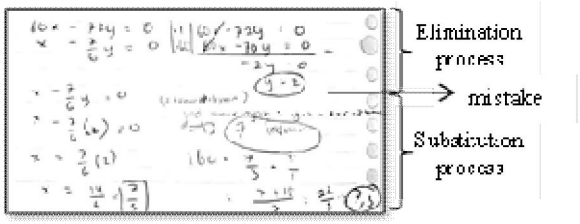


Fig.9 S2's answer in the step of constructing a valid argument using systematic steps

Based on fig.9, S2 did mistake again. S2 wrote $-2y = 0$ and got $y = 2$. It should be $y = 0$.

The drawing conclusions made by S2 are as follows:

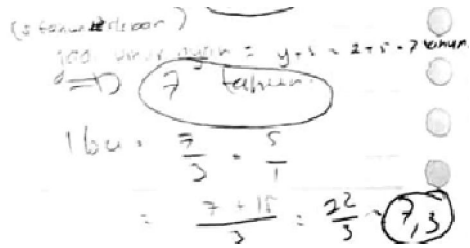


Fig.10. S2's answer in conclusion step

Based on fig.10, got father's age is currently $\frac{7}{3}$ years and mother's the age is currently 2 years. So the age of father and mother five years ahead each are $\frac{22}{3}$ years and 7 years. Based on this situation, it can be concluded that S2 can not draw conclusions precisely. From the interview results, S2 states that the answer obtained namely age of mother (y) 2 years is logically unreasonable. Mother is not born six years ago if the mother's age is currently 2 years. This reinforces the inability of S2 to understand the problem which leads to illogical conclusions.

3.2.3. The Mathematical Reasoning Ability Discussion of Low Skilled Students (S3)

On the test sheet shows that S3 does not write approximate of the settlement process in identifying the problem of linear equations of two variables. The following situation analysis given S3:

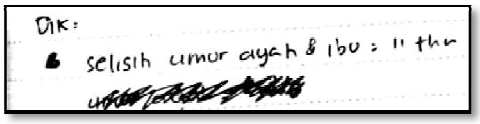


Fig. 11. S3's answer in mathematical situation analysis step

Based on fig.11, there is nothing that can be described. S3 does not give an answer in the given questionnaire. Therefore it can be concluded that S3 has not understood deeply about the concept of linear equations of two variables. Based on interview results conducted, it can be said that S3 does not understand the given question about, so S3 is emptying the answer sheet and prefer to collect it. In addition, the reasoning indicators used in this article which includes estimating the completion process, uses patterns and relationships to analyze mathematical situations, constructs valid arguments using systematic steps, and draws logical conclusions are not fulfilled. So it is necessary the direct action from teacher about this problem. S3 needs to be given basic concepts especially about linear equation system of two variablesso this incident will not happen again in the future.

CONCLUSIONS

Based on the results of test analysis and interviews on the subject to determine the students' mathematical reasoning ability in solving the problem of linear equations of two variables, it can be concluded thatthe high-ability student does not write approximate settlement process in identifying the problems oflinear equations of two variables. However,the high-ability student can analyze mathematical situations using appropriate patterns, compile valid arguments, draw logical conclusions, and provide the correct reasons. While in contrast, medium and low-ability students cannot propose valid conclusions from the given problem, so the reasoning indicator used in this research is not fulfilled.In this case, it can be said that they are not able to answer the question.

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