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Fragmentation of Thinking Structure's High School Students to Solve the Problem in System of Linear Equation in Two-Variables

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ABSTRACT
Fragmentation of students' thinking structure is a student's thinking error. In this study, we want to know how students think in solving problems in everyday applications. This study aims to describe the fragmentation of the thinking structure of high school students in solving problems of a two-variable linear equation system. In line with the research objectives, the research uses qualitative discrete research methods. The research subjects were 2 students. Methods of data collection using tests and interviews. The technique of checking the validity of the data uses. Data triangulation and previous researchers references analysis techniques through data reduction steps, data presentation and conclusion drawing. Based on the results of the study, it was found that the subject's errors in solving problems included the construction of the concept of missing information and partial insight. The focus in this study is students who experience concept construction in understanding the concept of a Two-variable Linear Equation System in story questions from the application in everyday life. Most students can only write examples correctly and cannot understand how to formulate story questions into mathematical models, because most of the Two Variable Linear Feeling System questions are directly in the form of mathematical models and only need to look for variables x and y, so students do not understand how to apply the problem story into mathematical model.

Keywords: *Fragmentations, Missing information, Partial insight.*

1. INTRODUCTION

Learning is an active process of students in constructing knowledge, meaning that knowledge will be formed when students carry out the construction process actively. Knowledge in students is not formed by the teacher, but the students themselves are able to form it. The teacher's role is to motivate, facilitate, stimulate and create an environment for students so that students can learn.

Learning is an active process in which students construct knowledge, implying that knowledge is formed when students actively participate in the creation process. Students' knowledge is not formed by the teacher, but rather by the students themselves.

The function of the teacher is to motivate, facilitate, stimulate, and provide a learning environment for students. In the learning process, a person will interact with learning resources and an adaptation process will occur. At the time of adaptation, a person experiences two cognitive processes, namely assimilation and accommodation. Assimilation is the process of integrating the stimulus in the already formed scheme [1]. Meanwhile, accommodation is the integration of a new stimulus through the formation of a new scheme or changing the old scheme to match the received stimulus [1]. [2] revealed that in the assimilation process, the problem structure is in accordance with the thinking structure (scheme) that is owned by a person. So that the stimulus can be interpreted directly by the person. In this case, the stimulus is integrated into the existing scheme. When the problem structure does not match the existing schema, there will be a process of modifying the old schema or forming a new schema so

that the problem structure can be integrated into the schema. In the problem-solving process, both processes, assimilation and accommodation can occur simultaneously.

During the learning process, a person will interact with learning resources, and an adaptation process will take place. A person goes through two cognitive processes during adaptation: assimilation and accommodation. Assimilation is the process of incorporating the stimulus into an already established scheme [1].

Meanwhile, accommodation is the process of integrating a new stimulus into an existing scheme or altering an existing scheme to reflect the received stimulus [1]. According to [2], the problem structure in the assimilation process corresponds to the thinking structure (scheme) that a person owns. So that the stimulus can be directly interpreted by the person. The stimulus is incorporated into the existing scheme in this case. When the problem structure does not match the existing schema, the old schema will be modified or a new schema will be formed so that the problem structure can be integrated into the schema. Both assimilation and accommodation can occur concurrently during the problem-solving process.

The problem in learning mathematics in Indonesia is the low achievement of students. In line with that, Mumun Syaban stated that: “The classic problem in learning Mathematics in Indonesia is the low achievement of students and the lack of motivation of students to learn mathematics. This can be seen from the learning outcomes in junior high and high school which are shown by the results of the National Examination from year to year the results are not yet encouraging when compared to other subjects. The average score obtained by Indonesian students is 411. This score is still far below the international average of 467. In addition, when compared to two neighbouring countries, namely Singapore and Malaysia, the ranking position of our students is far behind. Singapore is in first place and Malaysia is in tenth place”.

[3] argues that in problem solving there are usually five steps taken, namely: (a) Presenting the problem in a clearer form; (b) State the problem in a more operational form; (c) Develop hypotheses and do work to obtain the results, and (d) Re-check the results that have been obtained. In the problem solving process, students must use mathematical knowledge, reasoning and communication skills, as well as a good attitude towards mathematics. This is what can train students to be skilled in solving problems faced in everyday life.

[4] state that thinking is a mental activity carried out by students in solving problems that can be seen in their behavior through the results of task completion. Assessing students' thinking becomes very important, especially for photographing mathematical thinking errors and correcting their mistakes. Portraits of students' thinking can be used as a tool for diagnosing students' difficulties and errors in solving mathematical problems. Furthermore, it can be used to correct errors that occur and be used to find patterns to develop appropriate mathematical reasoning.

Mathematical thinking processes can take the form of reflective thinking studies, algebraic reasoning, thinking transitions, mathematical gestures & thinking, as well as providing scaffolding. Related to the importance of studying mathematical thinking. Assessing students' thinking becomes important, especially while photographing and correcting mathematical thinking errors. Portraits of students' thinking process can be used to identify students' difficulties and errors in solving mathematical problems. It can also be used to correct errors and find patterns in order to develop appropriate mathematical reasoning.

Mathematical thinking processes can include reflective thinking studies, algebraic reasoning, thinking transitions, mathematical gestures and thinking, and scaffolding. This is related to the importance of studying mathematical thinking. What is very interesting in learning is how students construct mathematical concepts and build knowledge through linking one concept to another. The process of building knowledge in the concept of learning mathematics is carried out continuously so that it becomes knowledge for students. The knowledge formed can be used to solve the problems at hand. Therefore, learning mathematics requires initial knowledge as capital to build new concepts. In this case learning must have meaning, which means that in learning mathematics there is always a process of linking new knowledge [1]

The most interesting aspect of learning is how students construct mathematical concepts and build knowledge by connecting one concept to another. The process of building knowledge in the concept of learning mathematics is carried out continuously, so that it becomes knowledge for students. Formalized knowledge can be applied to solve current problems. As a result, learning mathematics necessitates the acquisition of prior knowledge in order to construct new concepts. In this case, learning must have meaning, which means that there is always a process of connecting new knowledge when learning mathematics [1].

One of the fundamental goals in learning mathematics is that students have problem solving abilities [5]. [6] Problem solving is a very important part of the mathematics curriculum because in the learning process it is possible for students to gain experience using the knowledge and skills, they already have to be applied to non-routine problem solving [7] states that the better the problem-solving ability of students, the greater the opportunity to be able to face the challenges of an ever-changing life.

One of the main goals of learning mathematics is to develop students' problem-solving abilities [5]. [6] Problem solving is an essential component of the mathematics curriculum because it allows students to gain experience applying their prior knowledge and skills to non-routine problem solving during the learning process [7] the better a student's problem-solving ability, the better their chances of facing the challenges of an ever-changing life. To find out how the students' thinking structure errors in the Mareti story problem, a system of two-variable linear equations

Brodie (2010) [4] explains that students' mistakes in building mathematical reasoning include: basic error, appropriate error, missing information, partial insight. Errors in the form of basic errors and appropriate errors according to Subanji et al are classified as conceptual errors. Biongbali, et al explored the causes of students' mathematical difficulties based on the teacher's view which included: epistemological causes, psychological causes, pedagogical causes. Students' difficulties in learning mathematics are influenced by the complexity of the material, students' perceptions of mathematics, and the way the teacher teaches. Students' difficulties occur because of difficulties in understanding concepts, difficulties in abstracting concepts, and difficulties in relating mathematics to everyday life. Mathematics is only taught formally and is not associated with everyday life. Therefore, students' perception of mathematics is just a rule that must be met. For students it is important to follow the rules of problem solving to be able to work in mathematics.

To be able to correct errors made by students, knowledge of the source of errors is needed. Some researchers search for the source of the problem by using a cognitive map (cognitive map). [9] based on the results of their study concluded that cognitive maps can describe causal relationships of various phenomena and concepts, and can be modelled. Furthermore, with this model errors made by students can be corrected. [10] revealed that cognitive maps can show the direction of thinking, so that it can be used as a guide for the next step

[11] explored the causes of students' mathematical difficulties based on the teacher's view, which included: Epistemological causes, psychological causes, Pedagogical causes. It was further found that students had difficulty understanding concepts, abstracting concepts, and relating mathematics to everyday life. Meanwhile, when viewed from the level of error, it can be found that the student answered correctly the questions given, but could not give a reason why he answered the question, or vice versa he actually understood what was asked but gave the wrong answer.

2. METHODS

This study uses a qualitative descriptive. This research was conducted in class X Senior High School in the 2020/2021 academic year. The selection of research subjects using random sampling. For the selection of subjects using 2 students. Data collection is done by giving students problems to solve. Data collection in this study was done by written tests and interviews. First step I took was to give questions (tests) related to the material and the questions were applied in everyday life, the next step was the subject was given time to work on the questions, with emphasis on the subject, please do as much as you can, from these answers we can ask " how to do the questions that have been given", then from the subject's answers we can see how the subject's errors are in working on the questions, we can see whether the subject's mistakes were from the beginning on the concept or actually the child already understands the concept but cannot solve the problem or can directly use Research Methodology. The next process, the researcher analyzes the data collected by carrying out the stages of qualitative analysis developed by Creswell [12]. For the written test the researcher uses two story questions or questions in the application of daily life, from these questions the researcher can find out how the structure of students' thinking from the subject's answers. After receiving answers from the subject, the researcher will conduct interviews with the subject using a semi-structured interview method which the researcher himself conducts to each subject. To get valid data, the researcher conducted data validity using the triangulation method. The triangulation method is a data validity technique that utilizes something other than the data for checking purposes or as a comparison against the data [12]. The data collected by the researchers were analyzed using data reduction, data presentation, and drawing

conclusions. Data reduction is selecting, focusing and simplifying the data obtained. Presentation of data is to process information in the form of narration and the results of data reduction and to conclude.

3. RESULT AND DISCUSSION

The fragmentation of the thinking structure of high school students in solving the problem of a two-variable linear equation system is classified into several categories of basic error, appropriate error, missing information, partial insight according to [8], for this study the subject is classified as a concept construction error. The test was conducted to find out the students' thinking errors. However, this research is focused on the misconceptions (concept construction) of students' thinking. Based on the results of the subject's answers and the results of interviews, students' thinking processes are grouped according to [2]. Based on the process carried out when working on the problem, it becomes a concept construction. Next, distinguish the construction of concepts based on the final results of students' answers, namely basic error, appropriate error, missing information, partial insight.

3.1 Construction of the Missing Information Concept

Subjects experienced missing information, but in the process of solving problems students seemed able to solve problems properly and correctly. The subject is actually able to answer correctly and in the process of completion as if he had thought conceptually as shown in Figure 1 below:

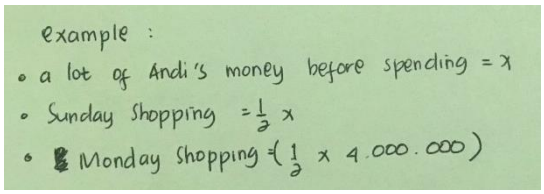

Figure 1 Answers from S1 in question number 1

However, when explaining the steps in solving the problem, there are subject expressions that are not in accordance with the concept. This expression is seen when the subject has translated the problem into a mathematical model. The first expression of the subject is "in writing an example, let's say that Andi has a lot of money before spending = x next for the sentence shopping $week = \frac{1}{2}x$, then, the subject starts to doubt when the word Monday appears, he spends $Rp.4.000.000{,}00$ less of the money he spent on Sunday but the subject could not write the example". After the subject finished answering and expressing the thought process, the researcher tried to clarify the subject's expression by conducting the following interviews:

R	:	*Do you understand the questions we provide?*
S1	:	*yes, I understand,*
R	:	*What is the first step you take when you see the question?*
S1	:	*Read the questions, then write down what you know, then. I will make an example*
R	:	*How do you make an example?*
S1	:	*let Andi's a lot of money before spending = x next* *for the sentence shopping* $week = \frac{1}{2}x$, *then* 4.000.000
R	:	*The next step*
S1	:	*I'm confused by the word pops up on Monday, He spends his money is 4,000.00 less than the money he spends a day. Next week, I will write 1000 for the rest of my shopping*
R	:	*When you meet the sentence on the question what do you understand?*
S1	:	*When met the word less should be reduced, but I don't* *Don't understand where the minus is*

From the results of the interview, it can be seen that the subject only follows the procedures that can be carried out, the subject thinks that the basics are the same, but the subject hesitates with the emergence of the word less than the money he spends. In the process of working for example the first and second steps are correct, but for the next step the subject still does not understand the concept and cannot explain the concept properly. In this case the subject experienced missing information. Conceptually, steps one and two for the work are correct, but the subject is wrong in the example of the third step where the word less than the money he spends appears, which the subject understands when the word less means less but the subject cannot correctly assume.

3.2 Construction of the Concept Partial Insight

Subjects experienced partial insight, but in the process of solving problems students seemed able to solve problems properly and correctly. The subject is actually able to answer correctly and in the process of completion as if he had thought conceptually as shown in Figure 2 below:

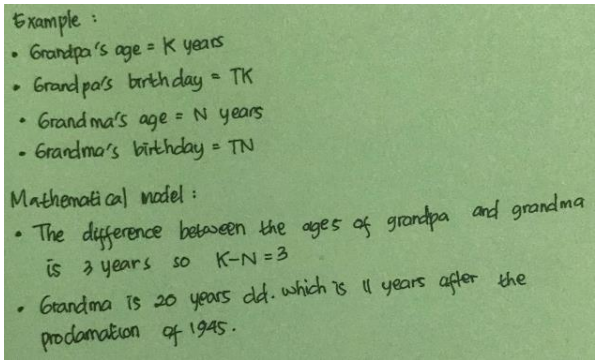

Figure 2 Answers from S2 in question number 2

However, when explaining the steps in solving the problem, such as the 2nd subject, he can write the correct example, such as Grandpa's age = K, Grandpa's year of birth = Kindergarten, Grandmother's Age = N, and Grandmother's Year of Birth = TN and so on, the 2nd subject starts write the first mathematical model correctly, the age difference between Grandpa and Grandmother is 3 years, so KN=3 then there are subject expressions that do not match the concept when writing the second mathematical model. This expression is seen when the subject translates into a second mathematical model. The second subject was confused when the sentence 11 years after the proclamation of 1945 appeared. After the subject finished answering and expressing the thought process, the researcher tried to clarify the subject's expression by conducting the following interview:

R : *Do you understand the question I gave?*
S2 : *yes, I understand,*
R : *How to do it?*
S2 : *I read the question, then I read the command,*
R : *Next,*
S2 : *I assume grandfather's age = K, Grandpa's year of birth = Kindergarten, Grandmother's age=N, Grandmother's year of birth=TN*
R : *Next step?*
S2 : *write mathematical models such as on the answer sheet, age difference Grandpa and Grandmother are 3 years old so K-N=3, Grandma is 20. That is 11 years, so 11 years after the proclamation of 1945*
R : *what about the second mathematical model?*
S2 : *I am confused by the emergence of the word 11 years after the proclamation of 1945*

From the results of the interview, it can be seen that the subject only follows the procedures that can be carried out, the subject thinks if the basics are the same, but the subject is doubtful about the emergence of the word population census in early 2013. does not understand the concept and cannot explain the concept properly. In this case the subject experienced partial insight. Conceptually, steps one and two for the work are correct, but the subject is wrong in the example of the third step where the word population census in early 2013 appears, which the subject understands that there is only the age of grandparents who are 3 years apart. Based on the results and interview data, the subject experienced a concept construction error. Logical thinking errors occur because the subject experiences logical errors in constructing problem solving. In accordance [13], the subject experienced logical thinking errors due to an error in the logic of a problem. This is as expressed [14] which states that misconceptions are inaccurate assumptions caused by wrong thinking or understanding. This statement is also supported by [15] which state that misconceptions can cause students' errors in solving problems. Construction holes occur because there are schemes that do not yet exist in the construction of problem solving carried out by the subject. Construction holes occur because of the impact of logical thinking errors that occur on the subject. With these logical thinking errors, there are schemes in the construction of incomplete problem solving. This is in accordance with Subanji's statement [13] that construction holes occur because there are schemes in constructing incomplete problem solving.

4. CONCLUSION

From the results of the study, it was concluded that: 1. the subject experienced the construction of the concept of missing information. 2. Subjects who

experienced partial insight concept construction The thinking process of concept construction in solving the Two Variable Linear Equation problem applied to story problems can be seen from the results of this study, most students can only write examples correctly and have not been able to understand how to translate story questions into mathematical models, because most of the questions in the Two-variable Linear Equation System are directly in the form of mathematical models and only need to look for variables and Tracing concept construction while working, the teacher may be able to ask students to make a concept map first and then work on it. So that the teacher can see how the structure of students' thinking in working on the problem. Teachers may also be able to find the construction of concepts when they have corrected students' answers. 2. Subjects who experienced partial insight concept construction The thinking process of concept construction in solving the Two Variable Linear Equation problem applied to story problems can be seen from the results of this study, most students can only write examples correctly and have not been able to understand how to translate story questions into mathematical models, because most of the questions in the Two-variable Linear Equation System are directly in the form of mathematical models and only need to look for variables and Tracing the construction of concepts while working, the teacher may be able to ask students to make a concept map first and then work on it. So that the teacher can see how the structure of students' thinking in working on the problem. Teachers may also be able to find concept construction when they have corrected students' answers.

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