



ALGEBRA PROBLEM SOLVING ABILITY BASED ON SOLO TAXONOMY ASSESSED FROM COGNITIVE STYLE

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Abstract

Algebra is a branch of mathematics that uses mathematical statements to describe the relationship between various things. This study aims to describe the algebra problem solving abilities of students in the Linear Program course. There are differences in student problem solving, which are caused by students' cognitive styles. Reflective and impulsive cognitive styles based on the SOLO taxonomy. This research method is descriptive qualitative. The research was conducted at STKIP Kusuma Negara Jakarta. The research subjects consisted of 4 students, 2 students having a reflective cognitive style and 2 students having an impulsive style. Purposive sampling technique was used in taking the subjects. Data collection techniques used cognitive style test questions Matching Familiar Figures Test (MFFT), algebra problem solving test questions and interview guidelines. Data collection techniques used two techniques, namely written tests and interviews. Technical analysis of data by reducing data, presenting data, and drawing conclusions. From the data processing, the results of the research were 2 students whose have flexible cognitive style also have good algebra problem solving abilities and based on SOLO taxonomy reached the Extended abstract level. Meanwhile, students who have an impulsive cognitive style in solving algebra problems based more on the SOLO taxonomy have Multistructural and Unistructural levels. So each cognitive style of students gives the different results in solving problems.

Keywords: *Algebra problem solving, Reflexive and Impulsive, SOLO taxonomy*

INTRODUCTION

Mathematics has an important role in the development of technology

and science, mathematics becomes a tool for application in other disciplines or as a means of logical, analytical,



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systematic and creative thinking. With problem solving activities will familiarize students (Syahlan, 2017). Mathematical science is divided into theorems and definitions required for formal mathematical proof (Simamora, 2020). Algebra is the beginning of a journey that provides skills to solve more complex problems. As said (Windsor, 2010) that algebra is very important because it can expand thinking to solve concrete problems by using abstractions and operations on mathematical entities logically and independently from the real world. In line with this, linear programming is part of algebra which is a material that requires analytical, synthesis and evaluation skills. Linear program is a course material that requires long processing steps and requires analysis. Difficulties in studying mathematics often occur in linear programming material. The level of mastery of material regarding the Linear Program which is still categorized as low, Linear Program material is material in mathematics that requires more learning (Kusuma, 2017).

Compulsory subjects in the higher education level mathematics education program are linear programs, in various fields such as industry, military, economics, social linear programs are widely applied, and their use is most often found in a company. The linear program is a subject that must be taken by students of the Mathematics Education Study Program at STKIP Kusuma Negara Jakarta, the linear program gets a weight of 2 credits and runs in semester 4, for some students, especially at STKIP Kusuma Negara Jakarta, linear program courses are one of the subjects lectures that are considered difficult,

especially when the learning activities are considered less attractive. Another statement states that among the materials that are long and require analysis is a linear program (Ariawan, 2015). Some students experienced errors in translating the intent and purpose of questions or language that could not be understood and errors in the aspects of problem solving and solving strategies (Kholid, 2011). Another opinion also states that mathematical modeling of a real problem is an inherent part of everyday life. Problem solving is the heart of mathematics education, so that every student is required to have problem solving abilities (Barham, 2020). The use of this symbol is often encountered when someone is doing algebra thinking processes in learning mathematics. This statement is in accordance with the definition of algebra thinking as the ability to use one of the representations to solve quantitative situations in a relational way with the use of symbols (Agoestanto et al., 2019). Understanding the basic concepts of algebra is important because it will provide superior initial knowledge when students learn material that involves algebra at a later stage (Wilson & Janes, 2008). Someone who carries out the algebra thinking process in mathematics learning is usually characterized by the use of symbols which are representations to solve quantitative situations relational using symbols (Andriani, 2015).

Students will face some problems in the process when they try to solve algebra problems. This is because the basic skills needed have not been mastered by them. Algebra problem solving is part of solving

mathematical problems because algebra is a branch of mathematics. When dealing with math problems, it will be seen how they respond to solving problems. Someone cannot see directly and know the thinking process of students, but can tell by looking at the responses given by students can use the SOLO taxonomy (Structure of Observed Learning Outcomes). SOLO taxonomy can be used because (1) Simulates the stages of competency development in the cognitive realm, (2) Formulates or issues learning outcomes, (3) Determines goals in teaching and learning, (4) Activates achievement of results, and (5) Assesses learning (İlgüy et al., 2014). The SOLO taxonomy was developed for use at all levels of subjects, not only in mathematics but also in other science and computer fields (Widada et al, 2018). The SOLO taxonomy provides a means to make a point quickly and spontaneously from students' conceptual understanding and to be able to see views of progress in learning (Hodges & Harvey, 2003). The following five levels are described in the SOLO taxonomy (Caniglia & Meadows, 2018) (1) Pre-structural: Students have very little information that is not even interconnected, so they do not form a unified concept at all and have no meaning, (2) Uni-structural: Students simply answer the questions given but cannot understand the responses given by students, (3) Multi Structural: Students who have the ability to respond to several problems in separate strategies. There are many relationships they can make, but the relations are not correct, (4) Relational: Students can break a unit into several parts and determine how the parts are connected to several models and can

explain the equations of the model, and (5) Advanced Abstract: Students have mastered the material and understood the questions given well so that students can realize the existing concepts.

Based on the description of the five levels in the SOLO taxonomy, it can be seen that students can find out how the process uses the information obtained in the questions and can then be used to solve mathematical problems (Claudia et al, 2020). The creative thinking process is influenced by many factors, one of which is the cognitive condition of the students. In that case, cognitive style needs to be considered. According to Goldstein, cognitive style is a characteristic of individuals in an effort to organize the environment conceptually (Prasetyowati, 2019). In the learning process, children who have an impulsive cognitive style without thinking deeply about them will make decisions quickly.

Impulsive and reflective cognitive styles Cognitive style is an important variable that influences students' responses in class, the behavior of students. Students with impulsive cognitive styles respond quickly and are brave enough to take risks, while reflective students tend to be slower in responding, slower, and more cautiously (Acharya, 2002). Simult & Schuller stated that cognitive style can be defined as how a person thinks, how they process and remember information or how they use that information in problem solving (Simuth & Schuller, 2014).

METHODS

This type of research used in this research is descriptive qualitative

research. Descriptive qualitative research is a type of research that contains data collected and explained in words. This descriptive study aims to describe the results of students' algebra thinking processes as seen from their reflective and impulsive cognitive styles. Qualitative data is generated through joint decisions (Munawwarah et al., 2020; Tohir et al., 2018; Tohir, 2019). Yin (2017) argues that qualitative research designs are used for in-depth investigations of current situations in real life contexts. In taking the subject using purposive sampling technique. The subjects in this study were 4 students of STKIP Kusuma Negara in the 5th semester of the Academic Year 2020/2021 Mathematics Education study program who had taken linear program courses. The four students were selected based on the reflective cognitive styles of 2 students, namely SA and NA, while the impulsiveness of

the 2 students, namely RN and AR. Data collection techniques used were test (MFFT), algebra problem solving ability test and an interview. The interview form used was semistructured interviews. The data analysis technique was by giving the students the matching familiar figures test (MFFT) questions, then the subjects were selected according to the focus of this study, namely analyzing algebra problem solving abilities based on SOLO taxonomy as seen from the students' cognitive styles. Data analysis with three stages, namely data reduction, data presentation and drawing conclusions.

RESULTS AND DISCUSSION

The results of the data were taken by 2 students each to represent each group using the purposive sampling method.

1. Students with a reflective cognitive style (SA).

(3)
$$\begin{array}{r} 2x + y = 170.000 \quad \times 1 \\ x + 3y = 185.000 \quad \times 2 \\ \hline 2x + y = 170.000 \\ 2x + 6y = 370.000 \quad - \\ \hline y - 5y = -200.000 \\ -5y = -200.000 \\ y = \frac{-200.000}{-5} \\ y = 40.000 \end{array}$$

$$\begin{array}{r} 2x + 40.000 = 170.000 \\ 2x = 170.000 - 40.000 \\ 2x = 130.000 \\ x = \frac{130.000}{2} \\ x = 65.000 \end{array}$$

$x = \text{basket} = 65.000$
 $y = \text{bola sepak} = 90.000$

Jadi: 1 bola basket = Rp. 65.000
 1 bola sepak = Rp. 90.000

Figure 1. SA's answer

Based on the results of solving the algebra problem, SA is able to

abstract by written basketball with x and footballs with y , modeling by

thinking, namely generalizing, abstracting, modeling, dynamic thinking and organizing (this is because NA already understands the concept of linear equations).

The problem-solving process carried out by NA shows that NA applies the information provided to the existing problem, then NA on the given problem connects all the information. NA links the concept / process so that all information becomes relevant so that the final result is the right one. So based on the SOLO SA taxonomic level indicator in solving algebra problems it reaches the extended abstract level. Based on this, it can be obtained that the results of students who have a flexible cognitive style have better results in solving algebra problem solving, this is supported by other research which states. The results of problem solving and the explanation above, it is seen that reflective students write down in detail and solve it at each problem-solving step. In accordance with the time needed, reflective students seem to take longer to solve the problem. In addition, during the interview, students answered questions clearly and carefully (Satriawan et al., 2018). This is also supported by other research which states that reflective students can also make equations in mathematical symbols and solve problems using correct mathematical expressions (Septiani, 2020). Reflective cognitive abilities are consistently able to answer all existing problems given the correct outcome even for a long time (Utami & Indriana, 2018). Students with a reflective cognitive style tend to spend more time examining problems, considering problem-solving alternatives, and checking the accuracy

and adequacy of hypotheses so that answers / solutions tend to be correct (Margunayasa et al, 2019). students are able to make geometric drawings well and translate images to clarify problems well, can make mathematical models well and solve them by involving mathematical expressions well, and are able to write concise and clear closing steps and answer questions in words with right (Khairunnisa, 2020).

3. Students with impulsive cognitive style (RN)

Based on the results of the test, RN has not been able to generalize because in the answer RN has not made an example. RN is able to abstract by written basketball with x and football with y . RN is able to model, in this case RN is able to make equations from the presented statements, which is the x coefficient in the second equation should be 1, but RN writes 3, able to think dynamically, in this case RN substitutes the y value in the first equation so that the variable value x is obtained, although the value is also not correct, then the solution of the two equations is obtained and organizes that is, RN is able to answer the question in the question even though the answer is not correct, because the equation written at the beginning is not correct. Then RN was interviewed regarding her answer and said that she was not careful in reading the questions because she was in a hurry so that RN wrote the wrong equation, but when she was interviewed RN was able to answer the equation that should be. Based on the results of tests and interviews, it can be said that the new RN is able to meet the four indicators of algebra thinking, namely

abstracting, modeling, dynamic thinking and organizing (this is

because RN already understands the concept of linear equations).

$$\begin{cases} 2x + 3y = 170.000 \\ 3x + 4y = 185.000 \end{cases}$$

$$\begin{cases} 2x + 3y = 170.000 \\ 6x + 8y = 570.000 \\ 6x + 8y = 370.000 \end{cases}$$

$$y = 140.000$$

$$2x + 3(140.000) = 170.000$$

$$2x = 170.000 - 420.000$$

$$2x = -250.000$$

$$x = 125.000$$
 bola basket

Figure 3. RN's answer

RN uses the information from the questions given, RN can make equations from the statements in the problem, but the equation is not yet correct. From some information / data, RN made several relationships, but the relationship was not right so that the conclusions obtained were irrelevant. Based on this, the indicators for each SOLO SA taxonomic level in solving algebra problems reach a multistructural level.

4. Students with *cognitif Impulsif style* (AR)

Based on the ability to solve algebra problems from the test results AR has not been able to abstract because AR has not written an example for each number, has not been able to abstract the information. AR writes

basketball and footballs not with symbols, has not been able to model, does not make equations from statements in questions, have not been able to think dynamically because in the answer AR has not provided a logical statement that leads to the answer to the question in the question and has not been able to organize the correct answer. Furthermore, AR was interviewed regarding the answer and said that AR had not been able to apply the mathematical modeling concept of a story problem. Based on the results of tests and interviews, it can be said that AR has not met the indicators of algebra thinking (this is because AR has not been able to extract information in questions, and has not understood the concept of linear equations).

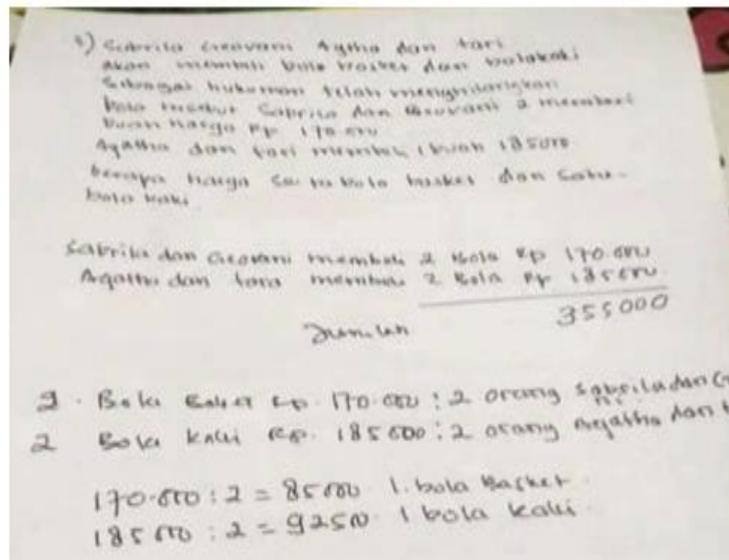


Figure 4. AR's answer

AR only uses one piece of information and only uses one concept in the solving process. In the process of solving problems, AR is only based on the data he chooses, so the conclusions obtained are irrelevant. Based on this, the SOLO AR taxonomic level indicator in solving algebra problems reaches the Unistructual level. Based on these results, it can be explained that students who have a cognitive style are unable to solve algebra problem solving well, this is supported by the results of other studies which state that the results of problem solving show that students have an impulsive cognitive style who do not write down in detail every step in solving problems (Satriawan). et al., 2018). Another statement also states that students with impulsive cognitive style abilities are consistent with a short time but are unable to answer all the questions given (Utami & Indriana, 2018). students with impulsive cognitive styles who tend to respond quickly without checking their accuracy so that the solutions given have a low level of

accuracy (Margunayasa et al. 2019). First, students in the impulsive group have characteristics: reflective thinking with understanding and reflection, using inefficient strategies, not completing answers, and easily giving up in facing difficult tasks (Salido et al. 2020).

CONCLUSION

Students who have a reflective cognitive style level, in answering algebra problem solving questions based on SOLO taxonomy reach the Extended abstract level, students are able to abstract, write, translate questions into symbolic form, model, and are able to draw relevant conclusions.

Students who have an impulsive style from the results of the SOLO taxonomy level reach the multistructual level. Students can collect some information then answer the questions. Furthermore, according to the pattern formed and found from connecting and linking subjects using arithmetic operations, the student has

not been able to generalize information.

Students who have an impulsive style based on the SOLO taxonomy reach the unistructual level of students. In answering questions, students have a mindset that focuses on one solution and one aspect. The algebraic problem solving ability of the student test results has not been able to abstract, has not been able to model, and to describe the relationship of an activity. Students do not make equations from statements in questions, have not been able to think dynamically and have not been able to organize correct answers or draw relevant conclusions.

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