Algebraic Thought Process in Solving Problems in Linear Program Materials Reviewed from Learning Motivation

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Abstract. The ability to think algebra is the ability to generalize the experience of numbers and calculations, find concepts of patterns and functions, and form ideas using symbols. This study aims to describe how the algebraic thinking process of STKIP Kusuma Negara students in Linear Program material. The subject of research is a semester V student of mathematics education who is studying linear program course Year 2020/2021. The data used in this study are the results of questionnaires, test results, and interviews. Taking the subject using purposive sampling techniques. The main instruments are researchers and auxiliary instruments are written test results and interview results on mathematical problems. Data analysis techniques include: (1) data description of written test results and interview results; (2) analyzed from written tests and interview results; (3) then conclude. The data validity test is done by time triangulation. The results of the study lead to the higher the independence of learning owned by students, the higher the ability to think algebra. Students with high algebraic thinking skills have fulfilled every indicator of algebraic thinking, namely being able to generalize, abstract, model, think dynamically and be able to organize. Students with moderate algebraic thinking ability are only able to win three indicators, namely being able to generalize, abstract, and model. While students with low algebraic thinking ability some can abstract and model.

Key words: algebraic thinking process; problem solving; motivation to learn.

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INTRODUCTION

Mathematics at the higher education level (PT) is very different from mathematics at other levels. According to (Sari, 2017) states, nature develops mastery of good learning concepts, student commitment is needed to give meaning in the process of independent learning, among others by increasing the desire to find conceptual relationships between knowledge possessed and those learned in lectures, and lecturers act as facilitators of the student learning process. Mathematics learning has a goal that supports the improvement of students' ability to develop. Mathematical knowledge can develop only when the child acts on the object. The university level of mathematics usually requires high-level thinking abilities, such as interpretation, synthesis and appraisal skills, not just recollecting factual information or basic usage of different formulas or concepts.One of the areas of mathematics taught at the university level in algebra. According to (Agoestanto 2018) the fundamental principles of algebra are particularly necessary so the students can study the materials of algebra at a later point. Nearly all fields of mathematics requires algebra as a method to solve problems. According to (Usiskin, 2010), algebra is necessary since algebra is fundamentally one of the principles that is used to solve problems. Algebra is the beginning of a path that allows you the opportunity to solve increasingly complicated problems (Gibson, 2014), as mentioned (Windsor, 2010), algebra is very relevant because it will extend reasoning in order to solve specific problems by the rational and autonomous use of abstraction and function of mathematical entities.

In line with this linear program is part of algebra which is a material that requires the ability of analysis, synthesis, and evaluation, a linear program is a material that requires analysis and long workmanship steps. A linear program is one of the compulsory courses in various courses in college because it can formulate the model of a statement into the mathematical model and make the best decision of the formulation of the model. Linear programs are widely applied in various fields such as economy, industry, military, social, and others. Its usefulness is as diverse as the most often faced by companies is to maximize profit and other uses that minimize costs. A linear program is a compulsory course taken by students of the Mathematics Education Study Program at STKIP Kusuma Negara linear program gets a portion of 2 credits in semester 4.

In the course activities of linear courses, there are undeniably still students who have errors in solving linear program problems. In solving linear program problems, for example, students experience errors in language aspects or translate the meaning of problems and errors in aspects of strategy or problem solving (Nur Kholid, 2011). Other research results also stated that students

still have difficulty in understanding and solving problems related to linear programs (Sri Irawati, 2015). Based on the observations in the classroom in working on linear program problems many students experience errors in completion, and the value of learning outcomes is not satisfactory. The research (Dewi T. W., 2015) stated that of the 25 students given the question only 4 students can answer precisely in changing the problem from the problem story to the form of mathematics. The thought process itself can be seen or analyzed when students write down the process of writing tests related to algebraic material. This became one of the great math topics taught in school. The role of algebra in improving algebraic reasoning is underlined by Drijvers, Goddijn, and Kindt (2011). Algebraic reasoning is an ability to concentrate on numbers (Kieran, 2004; Kieran, 2018; Venkat, et al.2018; Widodo, et al.2018).

Lack of algebra can cause difficulties in further studies such as calculus (Müller, Cury, & de Lima, 2014) and other math skills such as mathematical proofing (Güler, 2016) and problem-solving (Ferryansyah, Widyawati, & Rahayu, 2018). It can also be an obstacle for students who are studying higher education and careers that use mathematics, but not mathematics majors; engineering (Sazhin, 1998). The algebraic thought process of students expressed through writing in the process of working on the written test can also be seen in the students' mathematical communication in writing. The most common problems are how to grow students' movements from seeing patterns as their units to generalizations (Lannin, 2005), (Kenedi, et al., 2019) and how students connect ideas in mathematics Papadopoulos, I ., & Patsiala, N. (2019). The relevant research literature provides evidence that elementary school students can describe algebraic relationships in words and symbols and use symbolic language to model and solve equations (Hunter, et al., 2018). Teachers need to be aware of the spontaneous opportunities that arise in the classroom to encourage learners to think algebraically and use them to develop different ways of thinking about numbers and relationships (Kieran, 2004).

Thinking ability to identify and construct mathematical formulas is needed to foster students' understanding of the material and produce meaningful learning processes (Reyes-Cedeno et al., 2019). Problem-solving is at the heart of math education, so every student is required to have problem-solving skills (Barham, 2020). The use of this symbol is often encountered when a person performs algebraic thought processes in learning mathematics. The statement is following the definition of algebraic thinking as the ability to use one of the representations to solve quantitative situations in a relational way with the use of the symbol Agoestanto, et al (2019). Understanding the basic concepts of algebra is very important because it will be a superior initial knowledge when students study materials involving algebra in the later stages of Wilson, S., & Janes, D. P. (2008). Agoestanto, et al (2019) defines several algebraic components as follows: a) the development of mathematical thinking devices divided into three topics, namely: problem-solving skills, representation skills, and quantitative reasoning skills; b) Fundamental algebraic ideas, divided into three subjects, namely: algebra as general arithmetic, algebra as a language, and algebra as a tool for mathematical and modeling functions. Furthermore, it describes the rules of the given examples or problems represented in different ways. Students' difficulty in working on linear program problems can also be considered from their confidence level in working on the problem. A person who performs algebraic thought processes in mathematics learning is usually characterized by the use of symbols that are a representation to solve quantitative situations relationally using symbols (Andriani, 2015).

One way to improve students' algebraic thinking ability is to have a good motivation in learning in them, with the motivation of a student consciously and intention to be moved or encouraged to do learning activities by directing all the resources and efforts to achieve the goals he wants, in this case, the results of students can think critically. In line with what was revealed by Mc. Donald (in Sardiman, 2007) that motivation is a change of energy in a person that is characterized by the appearance of feeling and preceded by a response to the existence of a goal. Everyone's learning motivation is different, different backgrounds of majors in school (science, social sciences, language, and vocational) can lead to differences in students' perceptions in absorbing courses. Differences in perception about this course will certainly lead to different learning motivation and critical thinking ability in each student (Zanthy, 2016). According to (Taskesen, 2019) accomplishment incentive is to motivate individuals to respond to best outcomes and outcomes focused on success expectations and to be able to awaken, control and

sustain our behavior and regulate our conduct to start a task and hold it periodically. Zhou and Wang (2019) found a positive correlation between academic achievement, self-regulation, and learning motivation. Mathematical motivation: this refers to the tendency of learners to engage in math learning because of the inherent interest and pleasure that comes from working on math problems (Garcıá, Rodrı use, Taruhan, Areces, & González-Castro, 2016). High motivation in learning outcomes from high cognitive assessment and emotion-pleasing achievement (Pekrun, 2006). highly skilled students demonstrate high self-motivation and efficacy in math and science (Andersen & Cross, 2014). Based on some of these quotes, it is theoretically that motivation affects mathematical performance in the context of solving problems. Based on this background, the research problem focused on analyzing algebraic thought processes in problem-solving is reviewed from motivation with linear program materials in students of STKIP Kusuma Negara. The aim is to analyze the algebraic thought process reviewed from the motivation of students of STKIP Kusuma Negara on linear program materials. lectorum.

METHOD

This research uses a descriptive qualitative research method. Qualitative research follows a natural background in which a study takes place (he looks at the overall context) (Tohir, et al. 2020). Descriptive research contains data collected and described in the form of words. This descriptive research aims to describe the results of a student's algebraic thought process reviewed by motivation. Data qualitative is produced through a joint decision (Munawwarah et al., 2020; Tohir et al., 2018; Tohir, 2019). Yin (2017) argues that qualitative research design is used for an in-depth investigation of the current situation in a real-life context. The subject of this study was the purposive sampling technique. The subject of this research is students of Mathematics Education STKIP Kusuma Negara semester 5 Academic Year 2020/2021 as many as 6 people who have taken linear program courses. The six students were selected based on low, medium, and high student motivation levels. The data collection techniques used in this study are questionnaires, tests, and interviews. The interview form used is a semi-structured interview. Instruments in this research there are two kinds, namely the main instruments and auxiliary instruments. The main instruments are the researchers themselves and the auxiliary instrument consists of two instruments, namely the motivation level determining instrument and the algebraic thinking test instrument in the form of an essay to look at the student's algebraic thought process. Data analysis techniques in this study are by providing motivation questionnaires to students and then selected the subject according to the focus of this research is analyzing the algebraic thought process seen from the level of student motivation. Data analysis of this research through three stages per Miles and Huberman namely data reduction, data presentation, and conclusion drawing.

Table 1. Algebraic thinking indicators

Thought Process	Types of Algebraic thinking	Indicator
Information discovery	Generalization (generalization)	Students can find a pattern or shape, beginning with a pattern identified from the given object.
Information processing	Abstraction	Students may extract mathematical objects and relationships dependent on generalization; abstract symbols are used.
	Modeling	In order to investigate models and explain the relationship of operation, students should address dynamic scenarios with mathematical expressions. This show will use an equation to solve the equation.
Information storage	Analytical Thinking (think analytics)	Students can apply inverse operations used in problem conditions to find the necessary conditions for resolution.
	Dynamic Thinking	Students can involve variables as a changeable object.
Information call	Organization	Students can find all the independent variables, which are important in a variety of problem-solving activities.

RESULTS AND DISCUSSION

In this section, the results of the research were described at STKIP Kusuma Negara Jakarta. Data obtained in this study in the form of market, written tests, and interviews. The questionnaire was given to 21 students to know the category of motivation level of students. This categorization uses the norms of ideal Mean categorical and ideal DS (Ngalim Purwanto, 2010) and obtained results that students tend to have motivation in the moderate category of 6 students, 13 percent others fall into the category of high motivation and 2 students with low motivation.

ere are the results of students' work on questions number 1 and number 3 with high motivation, having high algebraic thinking skills presented in Figure 1.

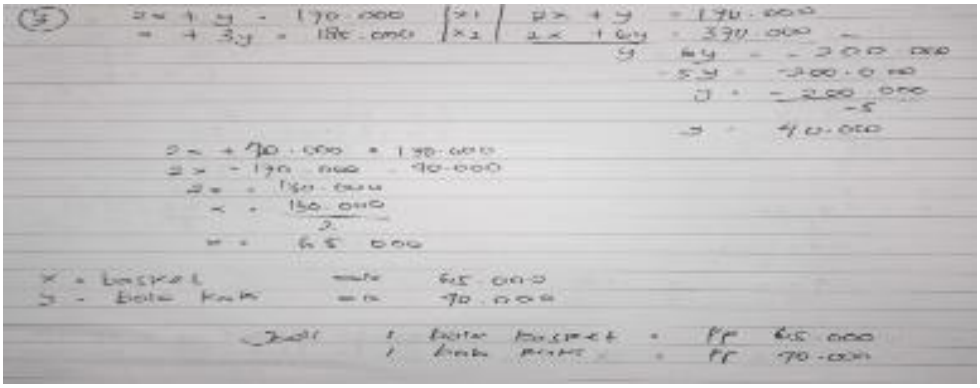

Figure 1. SA Subject Answers

Based on the test results in Figure 1 SA was able to abstract (able to extract mathematical objects and relationships based on generalizations) i.e. SA wrote basketball with x and football with y, modeling (able to present complex situations using mathematical expressions, to investigate situations with models, and to describe the relationship of an activity) i.e. SA can create equations from statements in the question i.e. 2x + y = 170.000 and x + 3y = 185.000, able to think dynamically because the SA answers provide logical statements that lead to answers to questions that are in question and able to organize the correct answers. Sa was then interviewed about his answer and said he could work on the issue because he could identify what was known and what was being asked in the question, and SA could plan and resolve the issue in question. Based on the test results and interviews, it can be determined that SA already meets five indicators of algebraic thinking and it is true that the motivation is high judging by the SA interview answers.

Here are the results of students' work on questions number 1 and number 3 with moderate motivation, having high algebraic thinking skills presented in Figure 2.

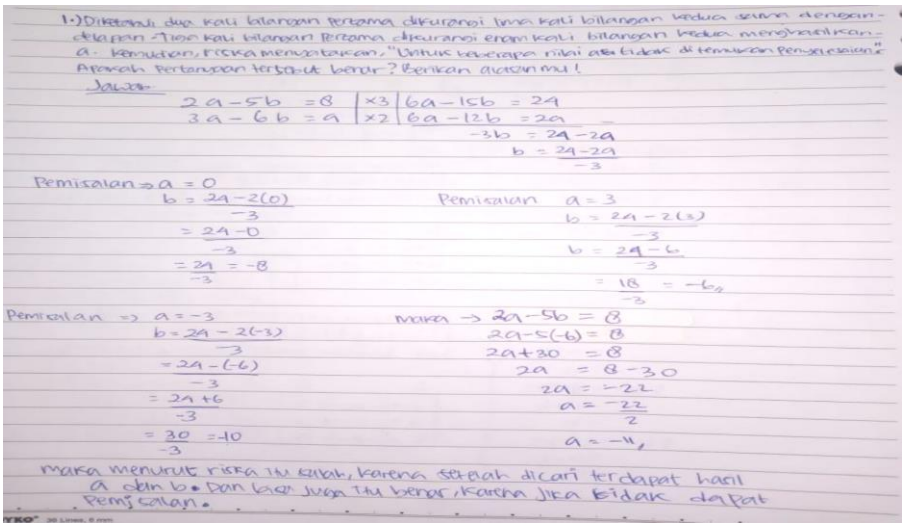

Figure 2. Pa Subject Answers

Based on the test results in Figure 2 PA has not been able to generalize (find patterns or shapes, beginning with the pattern identified from the given question) because in the answer PA has not made the calculation, able to abstract (able to extract mathematical objects and relationships based on a generalization) PA writes the first number with a and the second number with b, able to model (able to present complex situations using mathematical expressions, to investigate the situation with the model, and to describe the relationship of activity) in this case the PA can make similarities from the statements in the question, able to think dynamically in this case pa can give the reason that if the value of a replaced with a certain value, then obtained the solution of both equations and organize the PA can answer questions in the question with the reason. Pa was then interviewed about the answer and said that he was confident in his answer even though he did not know if it was true or not. Based on the results of tests and interviews, it can be said that the new PA can meet four indicators of algebraic thinking namely abstracting, modeling, dynamic thinking, and organizing (this is because pa already understands the concept of linear equations) and it is true that motivation is included being seen from the answers of pa interviews.

Here are the results of students' work on questions number 1 and number 3 with moderate motivation, having low algebraic thinking skills presented in Figure 3.

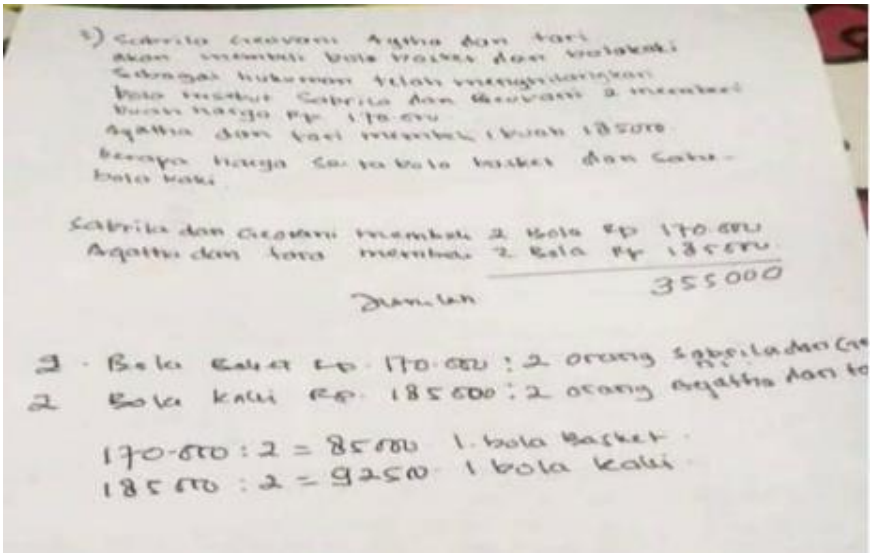

Figure 3. Subject AR

Based on the test results in Figure 3 AR has not been able to abstract (able to extract mathematical objects and relationships based on generalizations) because AR has not written a message for each number, has not been able to abstract i.e. AR writes basketballs and footballs not with symbols, has not been able to model (able to present complex situations using mathematical expressions, to investigate situations with models, and to describe the relationship of an activity) i.e. AR does not make similarities from statements in the question, has 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 that is in the question and has not been able to organize the correct answer. Furthermore, AR was interviewed regarding the answer and said that AR has not been able to apply the concept of mathematical modeling of a story problem. Based on the test results and interviews, it can be said that AR has not met algebraic thinking indicators (this is because AR has not been able to extract information in the problem, and does not yet understand the concept of linear equations) and it is true that the motivation includes low judging by the answers to ar interviews.

In general, highly motivated students have good algebraic thinking ability, and in the work of students who have high algebra, skills tend to be better at doing problems. With the increasing algebraic thinking ability of students, students' learning achievements also increased (Widodo, Prahmana, & Purnami, 2018; Permatasari & Harta, 2018; Kurniati, et al. 2015; Fatah, et al. 2016; Widyatiningtyas, et al.2015). Subjects that have low-achieving motivation also have different algebraic thought processes (Hadi, W., & Faradillah, A. 2019). Some factors that affect student algebra thinking. (Kusumaningsih, et al.

2018) stated that Learning with multiple representation strategies with realistic approaches affects students' algebraic thinking abilities. subjects with high mathematical abilities can solve problems that require algebraic thinking. This is in line with the research results of Saputro & Mampouw (2018) subjects whose algebra skills are good subjects that have the high mathematical ability as well. Students' algebraic thinking skills can make it easier for students to solve open-ended problems. This is in line with the results of Lingga & Sari's research (2013) which explained that algebraic mastery of thinking is one of the factors supporting students' problem-solving ability in mathematics. Faranita (2018) also mentioned that algebraic thinking appears in a person when finding patterns in the context of problem-solving. Silma (2018) said that algebraic thinking ability is required for students in understanding new concepts and then solving math problems.

The results of this study are expected to provide new information about the algebraic thinking process of students towards solving math problems, for students with high algebraic ability can be used as an example so that it can be used as a guideline for lecturers /teachers of mathematics in learning in the classroom. Recommendations for lecturers, prospective teachers, teachers, and researchers, or other disciplines are expected to conduct further research on the results of this study because it still needs to be tried in experimental research. This research also needs to be tested in the forum of subject teachers, especially training to know the algebraic thinking process of students, It is intended so that the algebraic thought process expected by prospective teachers or teachers can be trained and developed continuously. Theoretically, these findings could serve as guidelines and guidelines for evaluating the process of mathematical interaction of students in solving mathematical problems. Besides, educators or researchers must be able to provide the motivation that can support prospective teachers or improve the algebraic thinking skills of students or prospective teachers. Then teachers can develop if the learning process in the classroom also supports the improvement of algebraic thinking ability of students, prospective teachers, researchers, etc. For further research, researchers recommend focusing on practicing students' mathematical communication in writing. This is because in the algebraic thought process mentioned by Driscoll, et al. (2003) there is a mathematical communication process of students related to the use of mathematical symbols, mathematical representations in the form of mathematical models, images, graphs, and others.

CONCLUSION

Based on the results of data analysis, interviews, and discussions in general it can be concluded that the algebraic thinking process of students reviewed from motivation is the higher the motivation of students, the higher the ability to think algebra. Students with high algebraic thinking skills have fulfilled every indicator of algebraic thinking, namely being able to generalize, abstract, model, think dynamically and be able to organize. Students with moderate algebraic thinking ability are only able to win four indicators, namely being able to abstract, model dynamic thinking, and organize answers. Meanwhile, students with low algebraic thinking ability can abstract and model.

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