Kreano 13 (2) (2022): 319-327
KREANO
Jurnal Matematika Kreatif-Inovatif
http://journal.unnes.ac.id/nju/index.php/kreano

The Connection between Algebraic Ability and Self-Efficacy in Senior High School Student

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Abstract

Algebra is important to learn as a provision in the face of future life, both at work and as preparation for higher education. However, basically students still have difficulty in solving algebra problems. Therefore, it is necessary to find out the factors that cause students' low algebraic abilities.The purpose of this study is to find the relationship between the algebraic abilities of students at Senior High School with their self-efficacy. The research is qualitative and quantitative. Statistic descriptive is to determine the connection and contribution of two variables, students' self-efficacy, and algebraic abilities. The research subjects taken were 200 students from Bukittinggi (West Sumatra). In this study, there were two instruments used, namely a self-efficacy questionnaire and an algebra test (SPLTV & linear programming). The result shows that (1) In general, students' algebraic abilities are at a medium level with an average of 53.87. (2) Between algebraic abilities and self-efficacy have a very weak or very low correlation, so the correlation is ignored (it is assumed that there is no correlation between students' algebraic skills and self-efficacy) (3) Almost all students have good self-efficacy which is at a very high and quite low level. The finding implies that it is necessary to conduct research on the discovery of other factors that affect students' algebraic abilities.

Abstrak

Aljabar penting dipelajari sebagai bekal dalam menghadapi kehidupan masa depan, baik di tempat kerja maupun sebagai persiapan menuju pendidikan tinggi. Namun, pada dasarnya siswa masih kesulitan dalam menyelesaikan soal aljabar. Oleh karena itu, perlu di cari tahu faktor penyebab kemampuan aljabar siswa yang masih rendah. Tujuan dari penelitian ini adalah untuk mengetahui hubungan antara kemampuan aljabar siswa SMA Negeri Bukittinggi dengan efikasi diri siswa. Penelitian ini merupakan gabungan antara kualitatif dan kuantitatif. Deskriptif statistik untuk mengetahui hubungan dan kontribusi dua variabel yaitu efikasi diri dan kemampuan aljabar siswa. Subjek penelitian yang diambil adalah 200 siswa dari Bukittinggi (Sumatera Barat). Dalam penelitian ini terdapat dua instrumen yang menggunakan angket efikasi diri dan tes aljabar (SPLTV & Program linear). Hasil penelitian menunjukkan bahwa (1) Secara umum kemampuan aljabar siswa berada pada taraf sedang dengan rata-rata 66,125. (2) Antara kemampuan aljabar dan efikasi diri memiliki korelasi yang sangat lemah atau sangat rendah, sehingga korelasi tersebut diabaikan (diasumsikan tidak ada hubungan antara kemampuan aljabar siswa dengan efikasi diri) (3) Hampir semua siswa memiliki efikasi diri yang baik berada pada tingkat yang sangat tinggi dan cukup rendah. Penelitian ini menunjukkan bahwa perlu dilakukan penelitian lebih lanjut tentang faktor lain yang mempengaruhi kemampuan aljabar siswa.

Keywords: Self efficacy; algebra ability; senior high school student

p-ISSN: 2086-2334; e-ISSN: 2442-4218

INTRODUCTION

Students should gain experience that math makes sense every day.(Firmanti, Rahmat, Yuberta, & Fitri, 2020). Meanwhile, many problems in everyday life can be solved using algebra. Algebra is a branch of mathematics that deals with the representation of problems by using symbols and arithmetic operations. This will be used when someone finds and explains structures in the context of solving problems related to numbers or models from various situations (Permatasari & Harta, 2018). Children are introduced to variables and various mathematical symbols that can be used to simplify sentences into mathematical models (Widyawati, Astuti, & Ijudin, 2018).

Algebraic ability is an important component in mastering mathematics because it can explore students' thinking abilities. Students who have high thinking ability have different algebraic abilities from students who have low thinking ability as well as students with medium thinking ability (Ashar, Permadi, & Susanto, 2021). In addition, many problems in everyday life can be solved using algebra. Through Algebra, children are introduced to variables and various mathematical symbols that can be used to simplify sentences into mathematical models (Widyawati et al., 2018).

Lew Hee-Chan (2004) explains that algebra is a way of thinking in that the success of thinking in algebra is based on 6 types of mathematical thinking, namely: Generalization, Abstraction, and Analytical thinking. High school students who are already able to think deductively allow to maximally develop their abilities in algebra. In addition, sari et al stated that the components in algebraic thinking process include; generalization (to describe what is known and asked), abstraction (to describe symbols related to concepts and perform arithmetic operations), dynamic thinking (to solve problems with trial and error strategies), analytical thinking (re-checking), organizing (to simplify information), modeling (to explain the situation using pictures/ diagrams). (Sari, Fuad, & Ekawati, 2020)

Understanding the basic concepts of algebra is crucial because it will be the main prerequisite when students learn material that involves algebraic forms in the following stages. For example, when learning functions, line equations, quadratic equations and inequalities, circular equations, trigonometric equations, and other materials that require algebraic operations. (Badawi, Rochmad, & Agoestanto, 2016)

Students have been familiar with algebraic thinking since the seventh grade of junior high school, and students are currently in the formal operational stage of thinking abstractly and logically. However, there is still a need for a process of developing learning and teaching materials to improve algebraic thinking skills at all levels (Riskon, Rochmad, & Nuriana Rachmani Dewi, 2021)

Kieran (1992) states that there are some difficulties for students in solving algebraic function. Some of them are algebraic function focus on the relationship among variables not just calculations. Also, some situations cannot be directly calculated to obtain the answer, but must first be expressed in an algebraic function. In addition, numbers and letters are used together so that numbers can be interpreted as symbols in an algebraic function.

However, the fact is that some research results still have students at the secondary education level who do not master or have difficulty learning to understand algebra (Nurhayati, Herman, & Suhendra, 2017). Students seem to master arithmetic but have difficulty in alge-

braic concepts. Some students show excellent ability in applying the material that has been taught by the teacher in solving problems. However, there are still students who have difficulty solving problems (Afrilia, Sugita, Rochaminah, & Info, 2022).

Students' algebraic thinking must be considered by mathematics teachers both at the elementary and secondary levels for a successful experience of algebra. In other words, efforts to develop students' algebraic thinking skills are very important, to be able to solve various algebraic problems formally or close to everyday life (Setyawati, Nurbaiti, & Ariyanto, 2020). Therefore, it is necessary to find out the factors that affect students' algebraic abilities.

One of the caused factors which are indicated to affect algebraic abilities is self-efficacy. Albert Bandura first introduced the term self-efficacy in 1997 as a result of cognitive processes in the form of decisions, beliefs, or awards about how ready an individual is to estimate his ability to carry out certain tasks or actions needed to achieve the desired results. This is not related to the abilities possessed, but related to the individual's beliefs about what can be done with the abilities that he has, no matter how big (Bandura, Freeman, & Lightsey, 1999). The type of previous studies has shown the effect of self-efficacy in mathematics (Sukma & Priatna, 2021). It can be concluded self-efficacy is the belief that students need to have to succeed in the learning process (Sylvia & Dkk, 2017).

Self-efficacy in mathematics has an impact on learning and performance on several levels: cognitive, motivational, affective, and decision-making. These beliefs determine how well students motivate themselves and persevere in the face of adversity. Students' beliefs in mathematics consist of math self-efficacy (MSE), math self-concept (MSC), math anxiety, and student involvement in mathematics both inside and outside school (Widodo et al: 2018). In addition, Pajares and Miller (1994) mention that mathematics self-efficacy is the most important psychosocial in academic achievement.

Uzuntiryaki (2008) stated that they put forth all the effort and high tenacity to complete the task and strongly believed in the success of the task. In addition, in performance, they tend to have better work results compared to students who have the same ability. Bandura (1977) mentioned that four sources develop personal self-efficacy: performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousal.

Self-efficacy should be understood by students so that they can recognize themselves as human beings with emotional and intellectual abilities, having a sense of empathy and sensitivity to the problems faced both by themselves and by others (Moma: 2014). Students' self-efficacy can be identified through their task orientation, effort and persistence, belief, and performance.

In task orientation, students who have high self-confidence tend to choose and solve challenging questions or assignments (Uzuntiryaki, 2008; Zimmerman, 2000). However, there is no further explanation as to whether it includes algebraic problems.

In accordance with this Imaroh et al stated that one of the causative factors is thought to be due to students' lack of efficacy in their ability to solve problems, but further research is needed to prove it (Imaroh, Umah, & Asriningsih, 2021).

Table 1. Self-Efficacy Measurement in Solving Algebra Problems

Dimension	Description	Positif Item	Negative Item
Magnitude (levels)	Efficacy in the ability to solve algebra problems with various levels of difficulty	1	2,3
Strength	Efficacy can understand and choose strategies for solving algebraic tasks	4,5,6	7,8,9
	Efficacy in the efforts made in the face of tasks and challenges	10	11
	Efficacy to get good results	12,13	14
Generality	Efficacy in achieving goals in learning mathematics	15,16	17,18
	Efficacy in doing a task that has never been encountered	19	20

Some findings indicate students' difficulties and errors in solving problems with a three-variable system of linear equations. A three-variable system of linear equations is included in the field of algebra in high school which is easily related to the problems of everyday life. Therefore, the research questions that guided the study are as follow: how are students' algebraic abilities and self-efficacy? and is there a relationship between students' algebraic abilities and their self-confidence?

METHOD

The method used in this research is a combination of quantitative and qualitative research. A quantitative approach is used to analyze student algebra test results and self-efficacy questionnaires as well as to determine the level. Qualitative methods were used to explore deeply the test result data and the self-efficacy questionnaire scores obtained.

This study begins with collecting data on the level of self-efficacy through a questionnaire. Which was developed based on the dimensions of self-efficacy, namely level, strength, and generality (Bandura et al., 1999). Giving a questionnaire to all students aims to obtain information related to the level of self-efficacy. The indicators used to develop the questionnaire items can be seen in Table 1.

The magnitude dimension is a person's level of confidence in the actions taken. The second dimension is the strength which refers to the magnitude of a person's stability in the beliefs or expectations he makes. The third aspect is generality related to the scope of the field or behavior. This is related to the experiences that have been obtained by students before. Individuals who have experience completing previous tasks will find it easier to deal with similar or more difficult next tasks (Putri & Fakhruddiana, 2019).

The self-efficacy questionnaire consists of 20 statement items and each with five scales. The highest score that may be obtained by the respondent is 100 and the lowest score is 0. The data obtained from the questionnaire is then analyzed quantitatively to make categories of students based on the level of self-efficacy in Table 2.

Table 2. Criteria for the level of self-efficacy

Interval	Criteria
91-100	Very high
78-90	Tall
65-77	High Enough
52-64	Currently
39-51	Pretty low
26-38	Low
14-25	Very low

Source : (Yoni Sunaryo, 2017)

Table 4. Interpretation of the "r" Product Moment Correlation Index Score

Interval	Criteria
0.00-0.20	There is indeed a correlation Between variable x and variable y, but the correlation is very weak or very low, so the correlation is ignored (it is assumed that there is no correlation between variable X and variable Y)
0.2-0.4	There is a weak or low correlation Between variable x and variable y
0.4-0.7	There is a moderate or sufficient correlation Between the variables x and y
0.7-0.9	There is a strong or high correlation Between variable X and variable Y
0.9-1	There is a very strong or very high correlation Between variable X and variable Y

Source : (Sudijono, 2005)

The next data collection was carried out on 200 students of classes X and XI in Bukittinggi (West Sumatera) from different schools who had been given a self-efficacy questionnaire and then given an algebraic ability test. Algebra test questions are distinguished for each grade level as presented below:

> *"There are three numbers whose average of the three numbers is 16. The second number plus 20 equals the sum of the other numbers. The third number is equal to the sum of the other numbers minus 4. Determine the numbers using the problem-solving steps!" (Class X)*

> *"A baker has 8 kg of flour and 2 kg of sugar. He wants to make two kinds of cakes, namely lupis cake and serabi cake. To make Lupis cake it takes 10 grams of sugar and 20 grams of flour, while to make a pancake it takes 5 grams of sugar and 50 grams of flour. If the lupis cake is sold for Rp. 1500/fruit and the pancake is sold at Rp. 1000/fruit, determine the maximum income that the cake maker can earn. Determine the solution based on the troubleshooting steps!" (Class XI)*

The results obtained after students were given an algebraic ability test were then classified into high, medium, and low algebraic thinking skills according to Azwar according to the Table 3.

Table 3. Criteria for students' algebraic ability

Interval	Criteria
$X > M_i + SD_i$	High
$M_i - SD_i < x \leq M_i + SD_i$	Medium
$x \leq M_i - SD_i$	Low

Source : (Permatasari & Harta, 2018)

After obtaining the students' algebraic ability scores and questionnaire scores, the relationship was searched using the product moment correlation formula. For example, the variable X is the student's algebraic ability score, and Y is the student's questionnaire score, each of which has a scale from 0 to 100.

$$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{N\sum X^2 - (\sum X)^2}\, x \sqrt{N\sum Y^2 - (\sum Y)^2}}$$

Description: $\sum XY$= the number of multiplication values of algebraic abilities and questionnaires; $\sum X$= sum of algebraic ability values; $\sum Y$= the sum of the values of the questionnaire ability; $\sum X^2$= sum of squares of algebraic ability values; $\sum Y^2$= sum of squares of questionnaire score values; N= number of pairs of values.

The score of r obtained is then matched with the table below for interpretation. It can be seen in Table 4.

RESULT AND DICUSSION

The results of the study will be described in the form of a description of students' algebraic abilities, a description of students' self-efficacy and a description of the relationship between the two.

Description of students' algebraic abilities

Before describing algebraic abilities, it is necessary to set a scale for classifying the categories of students' algebraic abilities. Based on Table 3, the following provisions are obtained.

M_i = the ideal mean scores

$M_i = \frac{1}{2}(100 + 0) = 50$

SD_i = standard deviation

$SD_i = \frac{1}{6}(100 - 0) = 16{,}7$

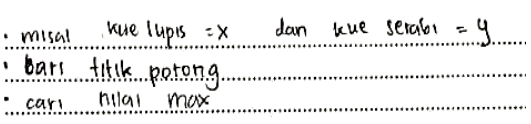
Thus, the criteria for the ability to think algebraically can be seen in Table 5.

Table 5. Criteria for students' algebraic ability based on the problem

Interval of Algebraic abilities	Frequency	Percentage
High	73	36,5 %
Medium	74	37%
Low	53	26,5 %
Average	53.87	

Based on table 5, the average of students' algebraic abilities generally is 53,87. They are dominantly at a medium level based on table 5.

This shows that there are still weaknesses in students' algebraic abilities. Algebraic thinking cannot be separated from students' ability to solve problems. (Sari et al., 2020). The following is an example of student errors in answering algebra questions at the stage of understanding the problem:

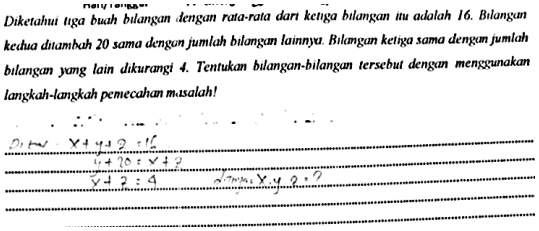


Translation: Suppose that Lupis Cake = x and serabi cake = y. Find the intersection! Find maximum value.

Figure 1. Problem 1

In the Figure 1, students can see a layer cake with an x even though x should be the price of the layer cake and y which is the price of pancakes. This shows that the interpretation of the students' algebraic abilities is still lacking, especially in components of abstract algebra thinking (generalization& abstraction).

This is also in line with other students' answers to different types of questions, as shown in the following figure:


Diketahui tiga buah bilangan dengan rata-rata dari ketiga bilangan itu adalah 16. Bilangan kedua ditambah 20 sama dengan jumlah bilangan lainnya. Bilangan ketiga sama dengan jumlah bilangan yang lain dikurangi 4. Tentukan bilangan-bilangan tersebut dengan menggunakan langkah-langkah pemecahan masalah!

Translation: It is known that there are three numbers with the average of the three numbers being 16. The second number plus 20 equals the sum of the other two numbers. The third number is equal to the sum of the other two numbers minus 4. Determine these numbers through problem solving steps!

Figure 2. Problem 2.

In the Figure 2, students intend to assume the first number with x, the second number with y and the third number with z. However, students are not able to correctly model what is known from the problem into the form of mathematical functions. What is known from the problem is the average of the three numbers, but what the student catches is the sum of the three numbers. It also shows a low generalization ability.

In addition, at the stage of planning problem solving, there are students who leave the answers blank. The students' mistake in using the solving strategy was not mastering the skills in drawing graphs to determine the solution area for linear programming problems. This shows that the component of modelling algebraic thinking is still lacking.

Meanwhile, in determining the strategy for solving the problem of a

three-variable linear equation system, students have difficulty in carrying out the completion steps or procedures. In addition, there are also students who do not understand the concept of elimination and substitution. In general, students do not apply the trial-and-error strategy which is very necessary in answering or rechecking answers. This shows that the components of organizing algebraic thinking and dynamic thinking are still lacking.(Sari et al., 2020)

Description of student self-efficacy level

Based on the algebraic ability test that has been given, the results obtained are described in the Table 6.

Table 6. Frequency distribution of students' self-efficacy scores

Interval	Criteria	Frequency	Percentage
91-100	Very high	2	1
78-90	High	21	10.5
65-77	High Enough	87	43.5
52-64	Currently	80	40
39-51	Pretty low	10	5
26-38	Low	0	0
14-25	Very low	0	0
Amount		200	100

A student's self-efficacy is influenced by various factors including his personal experience, gender, learning gained from others, positive or negative feedback the students received and etc.. (Hanifah, Waluya, Isnarto, Asikin, & Rochmad, 2020). Based on Table 6, students' self-efficacy, in general, is quite high is 43.5%. Moreover, there are no students who are at the low and very low stages. This shows that students already have good confidence in their algebraic abilities.

Dimensions in self-efficacy can be divided into three.(Firmanti, Putra, & Padang, 2021) Usually the dimensions are interrelated with one another. The results of the self-efficacy questionnaire based on dimensions can be seen in the Table 7.

Table 7. Students' self-efficacy scores based on the dimension

Dimension	Count Average
Magnitude	3,18
Generality	3,6
Strength	3,2
Overall average	3,35

Based on table 7, the highest average score of student self-efficacy is in the generality dimension. The aspect is efficacy in achieving goals in learning mathematics and efficacy in doing a task that has never been encountered. In other words, students, in general, can assess themselves as having self-efficacy and apply it to various activities.

The questions given are questions that have been done by students. This causes self-efficacy to be higher. This is in accordance with the opinion of Jameson and Fusco: 2014 in (marasabesy: 2020) which states that lower self-efficacy for "academic" math tasks is assumed to come from a lack of experience with the tasks given. In other words, low self-efficacy is in their ability to complete "academic" math tasks, but not in their ability to complete more routine math tasks (Marasabessy, 2020).

Description of the analysis of the relationship between algebraic ability and student self-efficacy

Based on the description above, the students' algebraic ability scores and self-efficacy questionnaire scores were obtained. The data is processed and based on the calculations obtained a score of $r = 0{,}105$. It means that between students' algebraic abilities and students' self-efficacy there is indeed a correlation, but the correlation is very weak or very low, so the correlation is ignored (it is as-

sumed that there is no relationship between algebraic ability and student self-efficacy).

By this, researchers found that the relationship between students' mathematical problem-solving abilities and self-efficacy is in the very low category because the r value is less than 0.104 (Utami & Wutsqa, 2017)(Firmanti et al., 2021).

According to Warner & French (in Gita, 2020) self-efficacy does not reflect the skills possessed by individuals, but beliefs related to their abilities in various situations (Kencanawaty, Febriyanti, & Irawan, 2020). It is this belief that will affect students whether they have a contribution to their mathematical abilities, especially algebraic ability.

Students with low thinking ability can understand the problem contents, and can write and elaborate the mathematical models, but are unable to develop a mathematical model that has been made correctly, wrong in executing the numbers in absolute sign, and wrong in making different representations (Ashar et al., 2021). In other words, self-efficacy is not enough to be able in mastering algebra skills, but it takes a good understanding of concepts and sufficient practice on this material.

Limitation

Based on the above description, a math teacher should be able to see that a student's self-efficacy of mathematics is important. But there is another factor which affects the student's algebraic ability such as the way of teaching and teacher competence in delivering material and abstract concept. Thus, it needs the follow up research related to this case. Moreover, in this article the statistic uses r product moment only to find the relationship between student's self-efficacy and algebraic ability. Therefore, for next research, we can use inferential statistics.

CONCLUSION

Based on the research that has been done, it can be said that students' self-efficacy is not one of the inhibiting factors in students' algebraic abilities for senior high school students in Bukittinggi. Student's difficulties in working on the questions may be influenced by other factors such as not understanding the prerequisite concepts or others. However, this requires further research.

Further studies are needed to determine what factors affect a student's algebraic abilities such as the teacher's ability to explain the material or the learning strategies used. This is supported by a study conducted by Kusumaningsih, et al (2018) which showed an increase in algebraic abilities by using the Multiple Representation Strategy on Realistic Mathematics Education (Kusumaningsih, Darhim, Herman, & Turmudi, 2018). Moreover, the Creative Problem Solving integrated 4C as a learning model was effective in students' algebraic thinking skills.(Riskon et al., 2021).

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