

IMPROVING STUDENTS' MATHEMATICAL REASONING ABILITY AND SELF-REGULATED LEARNING THROUGH GEOGEBRA-ASSISTED PROBLEM-BASED LEARNING MODEL ON JUNIOR HIGH SCHOOL

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ABSTRACT

Reasoning is a skill that students must possess to improve their ability in solving mathematics problems related to everyday life. Meanwhile, self regulated learning skills is aims to increase their sense of responsibility for their own learning. This research aims to improve both of these abilities through the geogebra assisted the problem-based learning, so the students can be better understand about concepts that taught by the teacher, take responsibility, and build their self regulated learning. The researcher used a quasi-experimental design with a pretest-posttest approach involving both experiment and control groups, that each consisting of 25 student in eighth-grade from SMP EL Fitra Bandung. The first step that reseacher take is given a pretest to both of class, after that continue to give experiment class with geogebra assisted the problem based learning method and control class with a conventional method. The research instruments used were a mathematical reasoning essay test about system linear equation in two variabels (SPLDV) and a self regulated scale. The integration of geogebra software is in line with current technological advancements and make the student more interesting when learning many subject at school specially in mathematic program. The results showed that students who received geogebra assisted problem-based learning method performed better in reasoning ability compared to those who received conventional method. However, there was no significant difference in self regulated learning between the two groups, indicating that both the experimental and control groups experienced an increase in self regulated learning.

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INTRODUCTION

Mathematical reasoning is the foundation for building mathematical knowledge (Faroh & Dewi, 2022). Reasoning is a process of reaching logical conclusions based on facts and relevant

sources, involving transformations presented in a certain sequence to arrive at a logical conclusion (Fauzi, 2016). According to the Cambridge English Dictionary, reasoning is “the process of thinking about something in order to make a decision” 1) Mathematical reasoning has often been connected to mathematical proving and the logical process that comes with it 2) However, other scholars take the concept of reasoning in a broader sense, in which reasoning is not restricted to a logical way of thinking but can be based on what makes sense to the person giving the reasons—logical or not 3) Researchers point out that on a methodological level investigating students’ mathematical reasoning helps both teachers and researchers to understand students’ understanding and learning of mathematics. On the other hand, reasoning is seen as the process of learning itself, where the learner builds on knowledge through reasoning (Hjelte et al., 2020)

Having reasoning ability is very important for the student even a teacher. Reasoning is an essential skill that students must possess, because through reasoning activities, students are able to solve mathematical problems, and for teachers, it serves to evaluate how students think or the flow of their reasoning (Hutauruk, 2018)

Mathematical reasoning is divided into two types: deductive reasoning and inductive reasoning. Inductive reasoning is the process of drawing conclusions based on observed data (Mulyana, 2015). Activities that fall under inductive reasoning include providing explanations to solve problems, giving reasons for the truth of a statement, and making predictions or estimations. On the other hand, deductive reasoning is the process of drawing conclusions that begins with general statements to reach specific, logical, and certain conclusions. Activities categorized as deductive reasoning include performing calculations based on specific rules, constructing proofs, providing justification for the correctness of a solution, and applying logical reasoning to a given problem.

There was a need to focus on the quality of learning imparted to the students. Considering this need, our study focuses on students’ self regulated learning besides reasoning ability. Self-regulated learning is the active process in which students play a major role in mastering their own learning process. Self-regulated learning (SRL) are used to assist students to learn efficiently (Anthonysamy et al., 2020).

Self regulated learning is the attitude or behavior of students who have the characteristics of being able to take the initiative in learning, diagnose their needs in learning, be able to set learning goals, monitor, organize and control the learning process, view difficulties as a challenge, be able to find and utilize relevant learning resources, choose and apply strategies in learning, evaluate the process and results of learning, and be able to self-concept (Ghassani et al., 2023)

Self regulated learning in mathematics is a very important personality that students must possess in order to achieve high learning outcomes. Self regulated learning is necessary in the education system to achieve learning goals that emphasize active student participation in developing their potential (Rahmawati et al., 2023).

At the school where the researcher conducted the research, it was found that students' reasoning abilities and self regulated learning were still low. Researchers knows about that based on interviews and questionnaires and also by looking at the development of students' mathematics scores. To achive that goals, reseachers use geogebra assisted by a problem base learning models.

The models of Problem-Based Learning (PBL) describes a learning environment where problems drive the learning. That is, learning begins with a problem to be solved, and the problem is posed is such a way that students need to gain new knowledge before they can solve

the problem. Rather than seeking a single correct answer, students interpret the problem, gather needed information, identify possible solutions, evaluate options, and present conclusions. (Roh, 2003) The goal of problem-based learning is to enhance students' conceptual comprehension and critical thinking abilities by exposing them to real-world (contextual) situations from the outside world (Asriningtyas et al., (2018); Rerung et al., (2017). The steps in Problem-Based Learning (PBL) namely: a) Orientate student with a contextual problem; b) Organize student for researching by help student to define and to organize learning tasks related to the problem; c) Direct student to solve the problem, by motivating student to find precise information, to carry out experiment, and to seek explanation and solution; d) Improve and present the result of solving problem; e) Analyze and evaluate the process and outcome of problem-solving(Hendriana et al., 2018) When using the problem-based learning model, students are presented with tasks to solve problems in the actual world, either individually or in groups(Ramdhan et al., 2022)

Beside using a good method, we have to combine with technology that could make a student more interesting when they learn of mathematic. One of the technology is using application of geogebra that can represent a mathematical model or represent a linear equation of two variables in graphical. GeoGebra is dynamic geometry software that combines geometry, algebra, and calculus. This software is commonly used as a medium of calculation and visual media to visualize mathematic abstract working objects (Ishartono et al., 2022). According to (Simbolon & Siahaan, 2020) geogebra is mathematical software that is easy to use, in geometry, algebra, and calculus material. This leads to the conclusion that teaching with Geogebra can influence and enhance students' capacity for reasoning ability as well as their motivation in learning. The software of geogebra could be downloaded for free both in PC or using handphone of student.

In the a linear equation of two variables (SPLDV) in graphical topic, students are expected to translate real-life problems into mathematical models. They are not only tasked with constructing these models but also with solving them. To find solutions to the mathematical models in a linear equation of two variables in graphical (SPLDV), students can use methods: the graphical method, the elimination method, the substitution method, and we can use software geogebra to proof the answer and draw the graph. GeoGebra possesses features that effectively support the communication of mathematical concepts, making it a suitable tool for transforming abstract mathematical ideas into more tangible forms. Furthermore, by enabling students to interact with and manipulate mathematical objects, GeoGebra offers opportunities for exploration and discovery, which can enhance their understanding and deepen their knowledge. Geogebra has been proven to be effective in improving students' mathematical problem-solving skills in trigonometry (Farihah et al., 2022).

Based on the explanation above, the researcher found that both reasoning ability and self regulated learning could be increasing with geogebra assisted problem based learning models. It could be make the student more active in learning, besides understanding better about the concept. The student are invited to discover for the concepts by themselves and understanding related the subject by using problem based learning models.

METHOD

The type of reseach is quantitative reseach that focuses on the collection and analysis of numerical data (numbers). The design used is experimental reseach, namely a method that aims to test the influence of an action a particular group or class. The participant are the student in junior high school of El Fitra Bandung. The study involve 50 pupils in eight grade in that school. The reseacher divided them become two grups, experiment class and control class.. Each grup consist of 25 student. The reseacher comparison between both of that class.

The instrumen that researcher used is consisted of test and non test. The test instrument was in the form of 5 descriptive questions that measure the level of student reasoning, while the non-test questions were in the form of a questionnaire on the scale of students' self regulated learning.

The first step taken by the researcher was to create a grid of mathematical reasoning indicator questions in the form of 5 descriptive questions on the material on two-variable linear equation systems in essay question using indicators that had been adjusted to align with mathematical reasoning ability. That question given even to experiment and control class in pretest. The pretest was used to determine students' initial abilities before applying different treatments to the experimental and control classes. After that, the experiment class given a geogebra assisted problem based learning models in learning a system linear equation of two variables. In the other hand, the control class given by conventional models. After 8 times, Using the same measuring tools, both classes were assessed at the end of the teaching and learning process using posttest.

Meanwhile, the posttest was administered after the experimental class received instruction through geogebra assisted the problem-based learning model, while the control class received conventional instruction. The same test was given to both the experimental and control groups. The posttest is approach allowed for the identification of differences in students' mathematical reasoning abilities when using geogebra assisted problem based learning models with the class that without geogebra. The test results from both the experimental and control classes were used to obtain final quantitative data, which were analyzed to verify the research hypothesis. The guidelines for this study were developed based on indicators of students' mathematical reasoning abilities.

RESULTS AND DISCUSSION

Results

The reseacher have teach all the pupils both experiment class an control class. the reseacher give pretest and continue with give treatment to experiment class and at the end of learning, reseacher give posttest to both of classes.

Table 1. Pretest, Posttest and N-Gain Data on Students' Mathematical Reasoning Ability

Test	Experiment Class					Contol Class				
	N	Max	Min	Average	SMI	N	Max	Min	Average	SMI
Pretest	25	80	28	52,7	100	25	70	28	44,6	100
Posttest	25	98	70	84	100	25	88	54	74,3	100
N-Gain	25	0,9	0,56	0,68	100	25	0,66	0,34	0,53	100

Table 1 shows the results of the pretest, posttest, and N Gain of students' mathematical reasoning ability. Based on these data, the average value of the experimental class pretest score for mathematical reasoning ability is 52.7 while the control class is 44.6. This shows a difference between them is of 8.1. It's means that in the beginning of class, the experiment is higher than control class even still small so it could be said there isn't any different between both of them.

The reseacher continue to give posttest after give a treatment to experiment class. The result show from the table 4 is the experiment class get maximum value is 98 and control class get

88, even the minimum value of experiment class is 70 and control class 54. The difference between them is quite signifikan.

Analysis of Mathematical Reasoning Ability Pretest and Posttest

The reseacher give have teach all the pupils both experiment class an control class. In he fist step, the reseacher give pretest to determine ability of the experimental class before being given treatment and the control class without treatment.

Table 2. Normality test of mathematical reasoning ability for pretest

Tests of Normality							
		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
kelas	Statistic	df	Sig.	Statistic	df	Sig.	
nilai	1	.122	25	.200 [*]	.939	25	.138
	2	.119	25	.200 [*]	.957	25	.357

*. This is a lower bound of the true significance.
 a. Lilliefors Significance Correction

Based on Table 2, the results of the normality test for pretest, it can be seen that the Shapiro Wilk output value obtained a significance value of 0.138 for the experimental class and a significance value of 0.357 for the control class. Because the significance value of both classes is greater than 0.05, it can be concluded that both classes are normally distributed. Because of the data is normally distributed, so reseacher contine to homogenitas test. The homogeneity test is conducted to determine whether the two variances are homogeneous or not.

Table 3. Normality test of mathematical reasoning ability for posttest

Tests of Normality							
		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
kelas	Statistic	df	Sig.	Statistic	df	Sig.	
nilai	eksperimen	.097	25	.200 [*]	.966	25	.553
	kontrol	.230	25	.001	.896	25	.015

*. This is a lower bound of the true significance.
 a. Lilliefors Significance Correction

Based on Figure 2 above, it can be seen that the significance value of the experimental class is 0.553 while the significance value of the control class is 0.001. Based on the results of the normality test, it was found that the significance value of the experimental class is greater than 0.05 (normally distributed) while for the control class < 0.05 (not normally distributed) seen from Shapiro Wilk significance value for control class is 0,15. Because the two data are not the same, one of the classes is not normally distributed, the next test is Monte Carlo test.

Homogeneity Test for Experiment Class and Control Class

The homogeneity test is carried out to determine whether the two variances are homogeneous or not.

Table 4. Homogeneity test of the pretest of mathematical reasoning ability

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
nilai	Based on Mean	3.238	1	48	.078
	Based on Median	2.983	1	48	.091
	Based on Median and with adjusted df	2.983	1	47.666	.091
	Based on trimmed mean	3.295	1	48	.076

Based on Table 4, the results of the homogeneity test have a significance value of 0.078 was obtained. This value is greater than 0.05. So it can be concluded that both variances are homogeneous. The next test is the T Test.

Hypotetical Test for Mathematical Reasoning Ability using T-Test

The T test was conducted to determine the differences between the experimental class and the control class.

Table 4. T-test of the pre-test of mathematical reasoning ability

		Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
nilai		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
	Equal variances assumed	3.238	.078	1.523	48	.134	5.880	3.861	-1.883	13.643
	Equal variances not assumed			1.523	45.160	.135	5.880	3.861	-1.896	13.656

It can be seen from the results of the independent T test above (Table 4), that the sig (2-tailed) value is 0.134. Because the sig (2-tailed) value is greater than 0.05, it can be concluded that there is no significant difference between the experiment class and the control class. That is meaning the initial abilities of the experimental class and the control class are the same or there is no difference in initial abilities between the experimental class and the control class.

After the reseacher give pretest, the reseacher give treatment to experiment class with problem based learning assisted geogebra, and control class without geogebra or using learning with ordinary method.

The next test is the Monte Carlo test, to determine whether there is a difference between the experimental class that uses learning with the problem based learning method assisted by Geogebra and the control class that uses regular learning.

Table 5. Mann Whitney PostTest of Mathematical Reasoning Ability

Test Statistics ^a				nilai
Mann-Whitney U				145.500
Wilcoxon W				470.500
Z				-3.246
Asymp. Sig. (2-tailed)				.001
Monte Carlo Sig. (2-tailed)	Sig.			.001 ^b
		99% Confidence Interval	Lower Bound	.000
			Upper Bound	.002
Monte Carlo Sig. (1-tailed)	Sig.			.001 ^b
		99% Confidence Interval	Lower Bound	.000
			Upper Bound	.001

a. Grouping Variable: kelas
b. Based on 10000 sampled tables with starting seed 2000000.

Based on Table 5, p-value (1-tailed) = 0.001, This is less than the conventional alpha level of 0.05. It can be concluded that there is a significant difference between the experimental class that received problem-based learning method assisted geogebra and the control class that received regular learning.

When the reseacher give a linier two-variable linear equation systems, all of the sudent could be get value more than 75. If they get less than that, so the sudent will get remedial program. Based on data from pretest that have been compare with post test, there are many student that

get better mark or value after reseacher teach them with problem based learning method and assisted geogbra.

Discussions

The geogebra assisted problem based learning (PBL) model has a stronger impact on students' mathematical reasoning abilities than the traditional model (Rohmatulloh et al., 2022). Students getting treatment with inductive-deductive approach achieved Mathematic reasoning ability at good grade level, while the second group of students attained at moderate grade level (Maesaroh et al., 2020). Learning using the Problem Based Learning Model can improve the character of students' curiosity (Wijayama, 2020). Problem Based Learning (PBL) models could be increase ability and skilss of students to solve the problem that has given by teacher (Jayadiningrat & Ati, 2018). Student learning outcomes on the Pythagorean theorem material increased after taking action using the GeoGebra application (Pauweni et al., 2022).

Based on the reseach above it could be conclude that geogebra assisted probem based learning could be increase the abiiilty student even reasoning abity and self regulated learning or another skills.

CONCLUSION

In general, learning trough geogebra assisted the problem based learning models on the linier two variable linear equation systems went well, although there were some notes when the learning was carried out. Students gain skills to improve their reasoning and learning independence. This has an impact on increasing the grades students get because students become more understanding of learning concepts.

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