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Problem-Based Learning Model with Geogebra Support on Students' Ability to Solve Mathematical Problems

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Abstract

The objectives of this study are to: (1) Describe the mathematical problem-solving skills of SMK Negeri 2 Kendari grade X students who are taught using the Problem Based Learning learning model with assistance from Geogebra; and (2) ascertain the impact of the Problem Based Learning learning model with assistance from Geogebra on the mathematical problem-solving skills of SMK Negeri 2 Kendari grade X students. The participants in this study were all SMK Negeri 2 Kendari grade X students enrolled in the 2022–2023 academic year. The experimental class in this study was the X TMA class, and the control class was the X TM B class. The findings demonstrated that: (1) the experimental class students' mathematical problem-solving ability, taught using the Geogebra-assisted Problem Based Learning learning model, are in the following categories: excellent, comprising up to 8 students with a percentage of 29.6%; good, comprising up to 9 students with a percentage of 33.3%; sufficient, comprising 6 students with a percentage of 22.2%; poor, comprising up to 3 students with a percentage of 11.1%; and very poor, comprising 1 student with a percentage of 3.7%. The analysis's findings lead to the conclusion that, when it comes to the two-variable linear inequality system, the experimental class's descriptive mathematical problem-solving ability, which was taught using the Problem Based Learning learning model in conjunction with Geogebra, outperformed that of the control class, which was taught using the Problem Based Learning learning model alone. (2) The value of t_{hitung} = 2.591 was acquired from the hypothesis testing findings. It is evident that when tcount is high, H0 is disproved. In summary, students taught using the Geogebra-assisted Problem Based Learning learning model had an average greater level of mathematical problem solving skill than students taught using the Problem Based Learning learning model..

Keywords: geogebra; problem based learning; students' mathematical problem solving ability.

INTRODUCTION

The capacity to solve problems is a crucial component of the mathematics curriculum because, during the process of learning and completing the assignments, students may obtain experience applying the knowledge and abilities they already possess to solve everyday problems. Students' ability to comprehend a problem and select an appropriate solution technique is known as problem solving. Solving mathematical puzzles is one of the mathematical skills that students need to possess. Problem solving skills are one of the mathematical learning objectives that students must meet, as stated in the Minister of National Education's Regulation No. 22 of 2006 (Utami & Wutsqa, 2017).

As for alternative viewpoints, according to (Pandin, Misu, & Maryanti, 2015), there are a number of reasons why problem solving abilities are necessary, including enabling students to think mathematically and construct concepts fluently as well as ensuring that they have a solid grasp of the issue. Furthermore, issue solving ability is defined by (Gunantara et al., 2014) as the capacity or ability of pupils to solve problems and use those solutions in daily life. According to (Monica et al., 2019), mathematical problem solving skills encompass the

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following: comprehending problems, creating mathematical models, solving models, and interpreting the results. (Sumartini, 2016) define problem-solving skill as an attempt to find a solution in order to accomplish a goal that is not immediately apparent.

Learning models ought to be applicable and aid in the accomplishment of learning goals. Teaching is done to enable students to think critically and to provide them with opportunities to practice what they have learned in a variety of activities. Using the Problem Based Learning model is one of the learning strategies that can help students become more adept at solving math problems. The problem-based learning model is an instructional strategy that gives students tasks to solve problems in the real world either alone or in groups. The foundation of the problem-based learning approach is the idea that solving problems can serve as a springboard for learning new information. It is anticipated that learning problems will motivate students to comprehend the material more thoroughly. A real problem structure related to the mathematical concepts to be taught is the starting point for the Problem Based Learning learning model. Teachers are not only to provide information to their students; they also need to inspire and guide their participation throughout the entire learning process.

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 (Anugraheni, 2018; Rerung et al., 2017). When using the problem-based learning model, students are presented with tasks to solve problems in the actual world, either individually or in groups (Putri et al., 2018; Cheriani, et al., 2015). The direct learning approach is a Conventional Learning model presently used at SMK Negeri 2 Kendari. But because this learning approach is less effective, students' ability to solve mathematical problems during the learning process is not maximized, and they also don't grasp the concept of the content they are studying.

Pupils' inability to fully utilize their mathematical problem-solving abilities during the learning process results in their lack of comprehension of the concept of the content being studied.. Teachers still teach in the old way, where teachers deliver material using the lecture method, then students record the material and do routine problems. The habit of students working on routine problems makes students unable to solve a problem when given non-routine problems. They are not used to solving a problem freely and finding solutions in their own way. If the problem is different they start to get confused because they don't understand the steps in solving a problem. As a result, student involvement in the learning process is not maximized and causes a lack of student mathematical problem solving.

The learning process carried out by the teacher so far has not made many variations in learning and has not focused on understanding the mathematical concepts possessed by students. For students who have a high level of intelligence, the attitude and actions and teaching methods of the teacher are not a problem. On the other hand, low IQ pupils will find learning mathematics to be unpleasant, which will hinder their comprehension of mathematical ideas. As an early phase in the learning process, the Problem Based Learning model's learning principle is to offer challenges. These problems are ones that are common in daily life since they will have a greater impact on enhancing learning outcomes (Amir, 2010).

This problem-based learning model gives students autonomy to explore the material and their abilities based on the problems given at the beginning. Some students in their efforts to understand the material have the potential to have difficulty understanding and imagining the content of the material. This will hinder the learning process because if the student takes a long time to understand the material then the learning process up to problem solving will also take a long time.

In order for Problem Based Learning to be more interesting, innovation in utilizing learning media is needed, one of which is a computer program, namely Geogebra software. Utilization of mathematics application software media is a solution for educators to be able to build students' thinking about mathematics. Alternative mathematics learning media that can facilitate students to visualize problem solving, one of which is the Geogebra application.

The utilization of learning media using Geogebra software provides an immediate feedback process to students. The media provided is seen as a stimulus. Any changes that occur when students use this media will be immediately given feedback by the computer. With the direct feedback provided by the computer when using Geogebra-assisted media, students will also respond so that the learning process occurs in line with the 2013 Curriculum Process Standards. The Geogebra program is useful for providing visual experiences to students to interact with geometry material (Asngari, 2015). In line with research (Septian, 2017; Oktaria et al., 2016) states that improving students' mathematical problem solving skills utilizing the geogebra application is better than students with expository learning.

Based on the results of the researcher's interview with one of the teachers at SMKN 2 Kendari said that the learning media used only used Mathematics books. Therefore, the researcher offers to use Geogebra learning media for learning Mathematics with a Problem Based Learning learning model that can help students solve problems in SPtLDV material. Based on the curriculum, one of the materials taught in SMA / SMK is the Two-Variable Liner Inequality System (SPLtDV). Based on the results of researcher interviews with mathematics teachers at SMKN 2 Kendari when classroom learning takes place, it is often found that some students experience learning difficulties including in SPtLDV material, especially when presented in the form of story problems and drawing graphs. Students find it difficult to understand problems and story problems and interpret them into mathematical models.

In SPtLDV material, students are required to represent mathematical problems related to everyday life into mathematical models. In SPtLDV material, students are not only required to make mathematical models but also to find solutions to the given mathematical models. In SPtLDV there are three methods that can be used to find solutions related to mathematical model problems, namely, the graph method, the elimination method and the substitution method. The graph method is one way to solve SPtLDV problems by describing the given mathematical model into graphical form and finding the intersection point of the given mathematical model so that the solution set is obtained, mathematical model given so as to obtain a solution set that fulfills as a solution to problems related to SPtLDV.

Using the use of Geogebra software media is one method of learning materials that can graphically depict mathematical models or SPtLDV. Geogebra is dynamic math software that integrates geometry, algebra, and calculus, claims (Hohenwarter, 2008). In the meantime, Geogebra is math software that is simple to use for geometry, algebra, and calculus content, according to (Wulandari, 2015; Nur, 2016). Because geogebra has properties that support and are ideal for communicating mathematical concepts, it can be used as a tool to make abstract mathematical material concrete. Additionally, by allowing students to manipulate these items, Geogebra can provide them the chance to make discoveries that will expand their knowledge and help them comprehend ideas.

The goal of this study is to ascertain the impact of the Geogebra-assisted Problem Based Learning Model on the Mathematical Problem Solving Ability of Class X Students of SMKN 2 Kendari on the Subject of SPtLDV based on data gathered from observations and some prior research.

METHODS

This kind of study is known as quasi-experimental. All pupils in classes X T.MA and X T.MB made up the study's population. Two classes served as the study's sample: one served as the experimental class and the other as the control class. Using this strategy, two classes are chosen at first from a list of eighteen courses. The posttest-only control design, which has two groups—the experimental and control groups—was employed in this investigation. The Problem-based Learning model was utilized with the experimental class, while the Problem-based Learning model without Geogebra was used with the control class. Using the same measuring tool (Post Test), the two classes were evaluated at the conclusion of the teaching and learning process.

RESULTS AND DISCUSSION

The results of observations of the implementation of mathematics learning using the Problem Based Learning learning model on SPtLDV material can be seen in Table 1 as follows:

Table 1. Description of the Success of Learning Management by Teachers in Experimental Classes

Meeting	Total Score	Percentage	Criteria
First	20/24	83%	Good
Second	21/24	87%	Good
Third	22/24	91%	Good
Fourth	23/24	95%	Good

Based on Table 1, the percentage of successful learning management at the first meeting reached 83%. At this meeting, the teacher is still finalizing the stages of the Problem Based Learning learning model, as well as students are just starting to adapt to the Problem Based Learning learning model. The implementation of learning in the second meeting reached 87% and the third achievement of 91% aspects while in the last meeting, namely the fourth meeting, it reached 95%.

The results of observations of student activity in the experimental class during learning can be seen in table 2:

Table 2. Description of Experimental Class Student Activity

Meeting	Total Score	Percentage	Criteria
First	58/80	72,5%	Good Enough
Second	63/80	78,75%	Good
Third	75/80	93,75%	Good
Fourth	78/80	97,5%	Good

Based on this table, the percentage of student activeness at the first meeting of the achievement of all aspects observed was 72.5%. The second meeting, the achievement of the observed indicators was 78.75%. In the third meeting, the achievement of the observed indicators was 93.75%. Meanwhile, in the fourth meeting, it reached 97.5%. In general, the achievement of all aspects observed in the first to fourth meetings has improved for the better. Data obtained from observations of teacher activities during the learning process using the direct learning model can be seen in table 3 below.

Table 3. Description of Successful Learning Management by Teachers In the Control Class

Meeting	Acquisition Score	Percentage
First	18	72%
Second	21	84%
Third	23	88%
Fourth	23	92%
Average	21,25%	84%

Based on table 3 above, mathematics learning using the Problem Based Learning learning model without Geogebra on the material of the linear inequality system 2 variables for the first meeting the success of learning management is in the good category with a success rate of 71%. The success of learning management at the second meeting reached 84% not much different from the first meeting. The success of learning management at the third meeting reached 88%, an increase from the previous meeting and the success of learning management at the fourth meeting reached 92%, an increase from the previous meeting.

Based on table 4, the percentage of student activity in learning mathematics using a direct learning model on the material of a system of linear equations of three variables, for the first meeting the achievement of all indicators observed was 52.5%, which means that student activeness at the first meeting was classified as moderate. The second meeting, the achievement of the indicators observed was 62.5%, experiencing an increase compared to the previous meeting. The percentage of student activeness at the third meeting reached 68.75%. Experienced an increase compared to the previous meeting and the last meeting the implementation of all aspects of student activeness in learning was good, this was seen from the percentage level which was 87.5%.

Table 4. Descriptions of Student Activity in the Control Class

Meeting	Acquisition Score	Percentage
First	42	52,5%
Second	50	62,5%
Third	55	67,5%
Fourth	70	87,5%
Average	54,25%	67,5%

The results of descriptive analysis in the experimental class as presented in table 4.5 obtained the lowest value of 46.15 and the highest value of 100, an average value of 75.35, median or middle value of 73.07, mode or value that often appears is 92.31, standard deviation 16.67 and variance 277. And the results of descriptive analysis in the control class obtained the lowest score of 34.61 and the highest score of 100, an average value of 64.14, median or middle value of 61.53, mode or value that often appears is 61.54, standard deviation 16.23 and variance 263.

Table 5. Descriptive of Mathematical Problem Solving Ability of Experimental and Control Class Students

Descriptive Statistics	Experiment Class	Control Class
Average	75,35	64,14
N	27	31
Standard Deviation	16,67	16,23
Sample Variance	277	263

The comparison between the experimental and control classes' descriptions of the students' mathematical problem-solving skills amply demonstrates that the experimental class's students have superior problem-solving skills to those of the control class. This demonstrates that the experimental class's students' ability to solve mathematical puzzles at Postestt is more varied than that of the control group.

Table 4 shows that, of the experimental class students taught using the Geogebra-assisted Problem Based Learning learning model, 8 students have an excellent category percentage of 29.6%; 9 students have a good category percentage of 33.3%; 6 students have a sufficient category percentage of 22.2%; 3 students have a poor category percentage of 11.1%; and 1 student has a very poor category percentage of 3.7%. The control class students' ability to solve mathematical problems using the Problem Based Learning learning model is described as follows: 4 students have a percentage of 12.90%; 1 student has a percentage of 13.3%; 9 students have a percentage of 29.03%; 5 students have a percentage of 16.1%; and 12 students have a percentage of 38.7% where they are classified as very less.It is possible to conclude from the analysis's findings that

The analysis's findings lead to the conclusion that, when it comes to the two-variable linear inequality system, the experimental class's descriptive mathematical problem-solving skills, which were taught using the Problem Based Learning model with the help of Geogebra, outperformed those of the control group, which was taught using the Problem Based Learning model alone. Table 6 displays the distribution of data on students' posttest scores on their ability to solve mathematical problems.

Table. 6 data distribution of posttest results of students' mathematical problem solving skills

Value	Qualification	Experiment Class		Control Class	
		Frequency	Percentage	Frequency	Percentage
0-39,99	Very Less	1	3,7%	12	38,7%
40.00 – 54,99	Less	3	11,1%	5	16,1%
55,00 – 69,99	Simply	6	22,2%	9	29,03%
70,00 – 84,99	Good	9	33,3%	1	3,22%
85,00 -100	Verry Good	8	29,6%	4	12,90%
Total		27	100	31	100

Based on Table 6, it can be seen that students' mathematical solution skills for the experimental class on the indicator of understanding the problem are categorized as sufficient with a percentage of 80.24%, the indicator of planning a solution is categorized as good with a percentage of 74.69%, the indicator of implementing the solution plan is categorized as good with a percentage of 79.1% and the indicator of checking back is categorized as sufficient with a percentage of 63.5%. While the students' mathematical problem solving ability for the control class on the indicator of understanding the problem is categorized as sufficient with a percentage of 80.1%, the indicator of planning a solution is categorized as good with a percentage of 73.65%, the indicator of implementing the solution plan is categorized as good with a percentage of 77.41% and the indicator of checking back is categorized as sufficient with a percentage of 63.3%. The experimental class taught using the Problem Based Learning learning model assisted by Geogebra is better than the control class taught using the Problem Based Learning learning model alone on the material of the two-variable linear inequality system.

The distribution of students' mathematical problem solving ability per indicator of experimental and control classes can be seen in table 7:

Table 7. Comparison of students' mathematical problem solving skills per indicator of experimental and control classes

Indicator	Experimental Class Percentage	Category	Control Class Percentage	Category
Understanding the Problem	80,24%	Good	80,1%	Good
Planning for Completion	74,69%	Good	73,65%	Good
Solving the Problem	79,1%	Good	77,41%	Good
Looking Back	63,5%	Simply	63,3%	Simply

Table 8. Normality Test

Mathematical problem solving ability	Sig		Decision/Determination
	Experiment	Control	
Post-test	0,175	0.066	Terima / Normal

Then, Asympt. Sigma was approved based on the study of the normality test computation achieved for the experimental class. This indicates that the experimental class's student data on their aptitude for solving mathematical puzzles is regularly distributed. Conversely, the Asympt. Sigmaka is acknowledged for the control class. This indicates that the control class's data on pupils' proficiency solving mathematical problems has a normal distribution.

Table 9 Analysis Result of Homogeneity Test

Mathematical problem solving ability	Sig	Decision
Posttest	0,501	Accept

Based on the results of testing the homogeneity of variance on the posttest, the Sig value = 0.501 is obtained because the value is accepted. In conclusion, the average mathematical problem solving ability of students taught with the Geogebra-assisted Problem Based Learning model is higher than the students taught with the Problem Based Learning learning model without Geogebra. Therefore, it can be seen from the average experimental class higher than the control class which is 75.35 while the control class is 64.14 then the observation results of the experimental class and control class are higher in the experimental class with a score of 72.5, while the control class is 52.5, it can be said that there is a significant effect of the Geogebra-assisted Problem Based Learning learning model on the mathematical problem solving ability of students in class XSMKN 2 Kendari.

Table 10. Hypothesis Test Analysis Results

			Decision
2.591	0,012	0,05	Reject

The results of hypothesis testing obtained the value of t_{hit} = 2.591 It can be seen that tcount then H0 is rejected. In conclusion, the average mathematical problem solving ability of students taught with Geogebra-assisted Problem Based Learning learning model is higher than students taught with Problem Based Learning learning model. Thus, it can be said that there is

a significant effect of Geogebra-assisted Problem Based Learning learning model on the mathematical problem solving ability of students in class X SMK Negeri 2 Kendari.

The instructor encountered a number of challenges when putting the Problem Based Learning model with Geogebra's assistance into practice. First, it took a while to use the model. This is due to the fact that working on LKPD requires a lot of fundamental tasks, which take time in addition to group representatives' presentations of their responses. As a result, research employing the Geogebra-assisted Problem Based Learning learning model still exhibits flaws that are comparable to those of earlier studies by other researchers utilizing the same learning model. Additionally, the researcher chooses their materials carefully because not all of them can be used with ease to the Geogebra-assisted Problem Based Learning learning model.

Based on the presentation of the observed aspects' achievement from the first meeting to the fourth, it can be inferred that students' mathematics skills, when taught using the Problem Based Learning learning model with the assistance of Geogebra, are categorized as very good. the findings of observations of student activities conducted during four meetings in the experimental class using the Problem Based Learning learning approach supported by Geogebra. The success rate at the first meeting fell into the good range. However, because the researcher neglected to remind students of the previously taught material during the learning process, students ignored the teacher's perspective, the learning objectives, and the reinforcement of the material that they were required to record as homework. Additionally, students were still unable to adapt to the Problem Based Learning learning model that the researchers had implemented with the aid of Geogebra. As a result, students did not go through the question and answer process to remember the previously taught material.

When the researcher realized this, she took a number of steps to ensure that the students made progress from the second meeting to the fourth. These included: (1) students were able to adjust to the learning model and the Geogebra application used, and they realized their roles and responsibilities in their groups; (2) student activity in the group started to improve, as demonstrated by their cooperative and shared understanding in groups; and (3) students started to become more courageous in asking questions of the researchers when they were having trouble. When the achievement of the observed aspects is viewed from the presentation of the achievement of the observed aspects from the first meeting to the fourth meeting, it becomes clear that using the Problem Based Learning learning model with Geogebra support can boost student activity, with each meeting seeing students become more adept at adjusting to the applied learning model.

An explanation of the test findings for the mathematical problem-solving skills of the students in the experimental and control groups, beginning with the test instrument's preparation. In order to determine the validity and reliability of the posttest questions, they are first tested. Twenty-seven pupils from class X at TM BSMK Negeri 2 Kendari took the test. Additionally, data management was done in order to identify accurate and valid criteria. The computation's results indicate that both of the two elements were deemed valid. In order to assess pupils' aptitude for solving mathematical problems, two items are employed.

For the content of the two-variable linear inequality system, students' mathematical problem-solving skills in classes taught using the Problem Based Learning learning model supported by Geogebra are superior to those of the Problem Based Learning learning model without Geogebra. The distribution of students' aptitude for solving mathematical problems by experimental class indicator on the indicators of comprehending the problem is classified as sufficient, on the indicators of planning the solution as good, on the implementation of the plan as good, and on checking back as sufficient. The control class's mathematical problem-solving skills are classified based on four indicators: understanding the problem, planning the solution,

implementing the plan, and checking back. The understanding indicator is classified as good, the planning indicator as good, and the checking back indicator as sufficient.

This is consistent with the findings of (Elvianti et al., 2018; Hidayatsyah, 2021) The average score of students receiving instruction through a problem-based learning model aided by Geogebra media differs from that of students receiving instruction through a problem-based learning model aided by blackboard media, according to the posttest data. The surface area and volume of prisms differ between students who receive learning through a problem-based learning model assisted by Geogebra media and students who receive learning through a problem-based learning model assisted by blackboard media, according to calculations using the Mann-Whitney test, which yielded a significance value of 0.044 <0.05. Moreover, the effect size of using Geogebra media in prism material at SMP Negeri2 Segedong has an effect size of 0.52 in the medium category. This demonstrates how significantly the GeoGebra media affects students' learning outcomes when it comes to prism material.

When using the Problem Based Learning learning model in conjunction with Geogebra, students' average proficiency in solving mathematical problems is higher than when using the Problem Based Learning learning model alone. Therefore, it can be concluded that the Geogebra-assisted Problem Based Learning learning paradigm has a noteworthy impact on the class X pupils of SMKNegeri 2 Kendari's capacity to solve mathematical problems. Based on earlier studies, (Aisyah, 2016) came to the conclusion that students at AsSyafiiah 02 Islamic Junior High School who use the problem-based learning model with Geogebra software significantly outperform those who use the model without it when it comes to their ability to solve mathematical problems.

The study's findings, which indicate that the application of Geogebra-assisted Problem Based Learning affects students' capacity for solving mathematical problems, imply that this learning approach is more effective than direct learning at enhancing students' problem-solving skills. In terms of students' ability to solve mathematical problems, the learning strategy that Geogebra supports is better than direct learning. This is because the Geogebra-assisted Problem Based Learning paradigm has a higher level of student engagement. In addition, they are expected to solve problems independently and are given the chance to share their expertise by debating the problems the teacher provides to their groups.

A study by (Komariah, 2014) examines "the effect of problem-based learning assisted by Geogebra software on students' mathematical problem solving skills." Based on the data analysis, the researcher concluded that the Problem Based Learning model with support from Geogebra software has an impact on students' mathematical problem-solving abilities and that the learning interaction process that arises from using the problem-based learning model with support from Geogebra software yields positive outcomes. Teachers can also use the Geogebra-supported Problem Based Learning paradigm as an alternative or as input to assist students improve their ability to solve mathematical problems.

CONCLUSION

The study's findings indicate that: (1) Students in class X at SMK Negeri 2 Kendari who learn using the Problem Based Learning learning model with the assistance of geography have an average of 75.35, a minimum of 38.46, and a maximum of 100 when it comes to solving mathematical problems involving the two-variable linear inequality system.Of the 27 students, 1 (3.7%) falls into the very poor category (11.1%), and 3 less, 6 (22.2%) have the ability to solve mathematical problems based on the material in the very sufficient category, 9 (33.3%)

have the ability to solve mathematical problems based on the good category, and 8 (29.6%) have the ability to solve mathematical problems based on the.

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