

THE IMPACT OF GEOGEBRA MEDIA APPLICATION ON MATHEMATICAL PROBLEM-SOLVING SKILLS IN CIRCLE SUBJECT

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Abstrak. Penelitian ini mendesak dilakukan karena penggunaan aplikasi GeoGebra mampu menaikkan keterampilan memecahkan permasalahan matematika pada materi lingkaran, yang termasuk kompetensi kunci pada kurikulum pendidikan. Selain itu, perolehan riset ini bisa menciptakan referensi penting untuk pendidik dalam mengadopsi teknologi untuk meningkatkan efektivitas pembelajaran matematika. Riset ini berguna dalam mengungkap kemampuan memecahkan permasalahan matematis materi lingkaran yang memperoleh pembelajaran memakai media aplikasi GeoGebra dan mengetahui perbedaan kemampuan pemecahan permasalahan matematis materi lingkaran siswa yang memperoleh pembelajaran memakai media aplikasi GeoGebra dengan siswa yang memperoleh pembelajaran tradisional di kelas XI SMK Negeri 1 Kisaran. Metode yang diaplikasikan pada riset ini berbentuk quasi eksperimen. Sampel yang digunakan pada riset ini ialah kelas XI Tata Kuliner 2 dengan total 33 murid sebagai kelas eksperimen dan kelas XI Tata Kuliner 1 dengan total 33 murid sebagai kelas kontrol. Penelitian ini dilakukan dengan mengukur keterampilan awal siswa melalui pretest dan pengukuran keterampilan akhir setelah pembelajaran yaitu posttest. Perolehan riset menampilkan bahwa tingkatan kemampuan memecahkan permasalahan matematis kelas eksperimen lebih tinggi dibandingkan tingkat pembelajaran konvensional kelas kontrol pada materi melingkar yang diajarkan menggunakan media aplikasi Geogebra. Adanya perbedaan yang signifikan antara keterampilan memecahkan permasalahan matematis materi lingkaran yang mendapatkan pembelajaran menggunakan media aplikasi Geogebra pada kelas eksperimen lebih tinggi dibandingkan keterampilan memecahkan permasalahan matematis pembelajaran konvensional pada kelas kontrol. Maka dari itu, pendidik hendaknya mengaplikasikan taktik pembelajaran yang bervariasi dan optimal dalam proses pembelajaran yang dilaksanakan khususnya dalam pembelajaran matematika.

Kata Kunci: GeoGebra, Matematika, Media Pembelajaran, Pemecahan Masalah.

Abstract. This research is urgently carried out because the use of the GeoGebra application can improve skills in solving mathematical problems in circle material, which is a key competency in the educational curriculum. In addition, the results of this research can create important references for educators in adopting technology to increase the effectiveness of mathematics learning. This research is useful in revealing the ability to solve mathematical problems in circle material who received learning using the GeoGebra application media and knowing the differences in the ability to solve mathematical problems in circle material of students who received learning using the GeoGebra application media and students who received traditional learning in class XI of SMK Negeri 1 Kisaran. The method applied in this research is in the form of a quasi-experiment. The samples used in this research were class XI Culinary 2 with a total of 33 students as the experimental class and class This research was conducted by measuring students' initial skills through a pretest and measuring final skills after learning, namely posttest. Research findings show that the level of ability to solve mathematical problems in the experimental class is higher than the level of conventional learning in the control class on circular material taught using the Geogebra application media. There is a significant difference between the skills in solving mathematical problems in circular material which are learned using the Geogebra application media in the experimental class, which is higher than the skills in solving mathematical problems in conventional learning in the control class. Therefore, educators should apply varied and optimal learning tactics in the learning process carried out, especially in mathematics learning.

Keywords: GeoGebra, Learning Media, Mathematics, Problem Solving.



A. Introduction

Education is the fundamental basis that plays a vital part in the development of students. Students, as the central element in education, need to be equipped with logical, critical, systematic, analytical, and creative thinking skills to endure the challenges of the future. These attitudes and thinking abilities can be nurtured through the learning of mathematics. Mathematics is a subject not only related to numbers and calculations but also helps sharpen our thinking abilities. This adjusts with James's definition that arithmetic is the science of rationale concerning shapes, courses of action, amounts, and different related concepts, partitioned into three areas, variable based math, investigation, and geometry.

Mathematics is a subject that not only deals with numbers and calculations, but also helps us hone our thinking skills. This is in line with the definition of mathematics according to James, specifically Mathematical is the science of rationale around shape, structure, size and other relationship concepts that are various and separated into three areas, specifically polynomial math, investigation and geometry. Based on its sort, Mathematical skills can be clarified in five fundamental competencies, to be specific: 1) Mathematics understanding; 2) Mathematics problem solving; 3) Mathematics communication; 4) Mathematics association; 5) Mathematics reasoning. One of the main competencies in learning mathematics is problem solving (Laia, et al., 2021: 465).

Problem-solving ability is the learner's capacity to solve unpredictable and non-routine problems. Students can comprehend the problem and then develop procedures to handle it, determining the goals of complex and non-routine problems. As expressed by Polya in Agustami et al. (2021: 224), handling problems involves several stages that students can take, namely: (1) being aware of the issues; (2) organizing strategies for resolving issues; (3) putting solutions to problems into practice, and (4) reviewing the obtained solution. Thus, someone can be considered to have good problem-solving skills under the assumption that the person understands the data used to develop a problem-solving procedure to overcome the problem.

The circle equation is a basic material that introduces algebraic and geometric connections simultaneously. A solid understanding of this subject will facilitate students' acquisition of related ideas at a higher level, including tangents, circles, and quadratic equations. This circle equation material will usually be related to culinary majors, especially in making culinary food. Based on the criteria for achieving learning objectives, students are expected to be able to make desserts, process traditional Indonesian cakes, make pastry and bakery products that are in accordance with industry needs and standards.

In learning mathematics, some students consider that mathematics is a very difficult subject, this is because in learning mathematics there are many formulas and calculations that can be used as methods to solve problems. Math is also considered a boring subject because it can only find numbers, formulas, graphs and images. Therefore, it is necessary to have a learning tool, namely learning media. Learning media is a learning resource that can offer assistance teachers enrich students experiences, with different sorts of learning media by teachers can be material in providing knowledge or information to students. The purpose of this is to facilitate pupils' comprehension of arithmetic lessons. GeoGebra is one of the computer applications (software) that can be utilized as a learning tool for mathematics, particularly algebra and geometry.

GeoGebra is a learning media that can be used to meet the criteria in stimulating students' understanding through visualization of objects or a mathematical concept. The development of GeoGebra software is expected to improve students' concept interpretation. The use of GeoGebra media is able to train students in constructing knowledge independently so that they can get out of the problems they face. This assertion is in line with Sari's (2019: 331) findings, which demonstrate the significant influence that GeoGebra-assisted learning has on students' ability to solve mathematical problems.



According to Ratuanik and Feninlambir (2022: 1107), GeoGebra software can be used by teachers to evaluate or compare students' work, because in GeoGebra software there are tools to calculate the length of line segments or the area of a circle. Therefore, a solution that can help students in the learning process related to geometry concepts, especially circular material, is to implement learning with geoalgebra software.

To address the aforementioned issues, a new innovation is needed, namely the use of digital-based learning media, specifically software. The hope is that the assistance of GeoGebra software can help students become more active during learning, visualize abstract concepts more concretely, and thereby enhance their problem-solving abilities in mathematics, leading to more satisfactory learning outcomes.

The following are the goals of this study, which are based on the challenges that were previously formulated: to unveil the mathematical problem-solving abilities in circle-related topics among students and to identify any differences in the mathematical problem-solving abilities in circle-related topics between students who receive instruction using the GeoGebra application and those who receive conventional instruction in Grade XI at SMK Negeri 1 Kisaran.

B. Research Method

Research on the effect of GeoGebra application media will be carried out at SMK Negeri 1 Kisaran, North Sumatra, which is located at the address Jalan Akasia No. 44, Mekar Baru Village, West Kisaran City, Asahan, North Sumatra. The research time will be carried out in April to June 2024 in class XI even semester T.A. 2023/2024. Quasi-experimental methodology is applied in this study. The study's population consisted of all XI students at SMK Negeri 1 Kisaran, and its samples included 33 students from class XI Culinary 2, which served as the experimental class, and 33 students from class XI Culinary 1, which served as the control class. This research was conducted by measuring the initial skills of students through pretest, then the research continued with classroom learning using GeoGebra application media in experimental classes and conventional learning in control classes to study circle material. After that the research continued by measuring the final skills after learning, namely the posttest. For the pretest and posttest, 4 types of questions were given which in total amounted to 10 items related to the circle material.

C. Result and Discussion

Result

Drawing from the aforementioned description, Table 1 presents the findings of the descriptive table about problem-solving abilities for math problems from the preliminary ability test (pretest).

Table 1. Problem Solving Skills on the Initial Skills Test (Pretest)

Class	Descriptive Statistic					Stand. Dev.
	Value	Category	f	%	Ave	
Experiment Class (Pretest)	<32	Low	6	18,2	42,67	11,044
	32 – 54	Medium	20	60,6		
	>54	High	7	21,1		
	Total		33	100,0		
Control Class (Pretest)	<35	Low	5	15,1	46,67	11,807
	35 – 58	Medium	23	69,8		
	>58	High	5	15,1		
	Total		33	100,0		



Table 1 presents the pretest findings with an average score of 42.67 for the experimental class and 46.67 for the control group in terms of mathematical problem solving ability. Specifically, 18.2% of the experimental class and 15.1% of the control class had poor category values. In the experimental class, the value of problem-solving abilities fell into the middle group at 60.6%, whereas in the control class, it was 69.8%. In addition, 21.1% of the experimental class and 15.1% of the control class achieved the high category value. The pre-test results table on the attached page provides more detailed information about students early proficiency in problem solving in mathematics learning.

After the researchers conducted an initial ability test (pre-test), then the researchers and students carried out the learning process using GeoGebra learning media with the same circular material as the previous pre-test. The results of problem solving skills through the use of GeoGebra learning media in math learning are described as follows:

- 1) Implementation of the learning process using GeoGebra learning media
- 2) After the researchers conducted a pretest or identification of initial problem solving skills through the math test given, then the researchers carried out the learning process activities using GeoGebra learning media. The series of activities carried out include:
- 3) Researchers provide initial understanding by repeating mathematics learning that has been studied in class X and will be studied next in even semester, namely circle material.
- 4) The researcher then began to discuss the basic problems contained in the circle material and then divided the students into several discussion groups. With this group division, the researcher motivates and directs students to be more active and better understand the problem by exchanging ideas and cooperating with their respective group mates.
- 5) Furthermore, after being divided into several groups, students are directed to identify the problems given which are related to the circle material and the pre-test that has been given before. Each group must understand the problem given with all group members must understand the problem and find a solution to the problem.
- 6) After conducting discussions in groups, researchers directed some representatives to explain the results of their analysis to other groups about the problems that had been given by researchers previously to each group. The group that explains the results appoints a group representative to explain the results of its analysis of existing mathematical problems with previously learned mathematical problem solving skills.
- 7) After the discussion ended, the researcher asked representatives of the learners to give conclusions about the material or problems that had been discussed previously. With the conclusion of the student representatives, it is hoped that other students will better understand the results of the discussions that have been carried out with the explanation of these students.
- 8) Finally, the researcher summarizes the learning outcomes and re-explains the problems given with simple explanations or adds explanations that students have discussed before.

The series of learning implementation using GeoGebra learning media above indicates that then the researchers conducted a final test (post-test) in measuring the level of problem solving skills of students in understanding the math problems that had been given to students before. The posttest results of problem solving skills in learning mathematics in experimental classes using GeoGebra learning media and conventional learning in control classes can be seen in Table 2 below:



Table 2. Posttest of Mathematical Problem Solving Skills of Experimental Class (GeoGebra Learning Media) and Control Class (Conventional)

		Statistic Description				
Class	Value	Category	F	%	Ave	Stand. Dev.
Experiment	<76	Low	6	18,2	84,58	8,113
Class (Posttest)	76 – 93	Medium	21	63,6		
	>93	High	6	18,2		
	Total		33	100,0		
Control Class	<73	Low	8	24,3	79,85	7,181
(Posttest)	73 – 87	Medium	20	60,6		
	>87	High	5	15,1		
	Total		33	100,0		

Based on Table 2 above, the experimental class's average score on the pretest for mathematical problem solving was found to be 84.58, while the control group's score was 79.85. Specifically, 18.2% of the experimental class and 24.3% of the control class had poor category ratings. In the experimental class, the value of problem-solving abilities fell into the middle group at 63.6%, whereas in the control class, it was 60.6%. Additionally, the experimental class achieved a high category score of 18.2%, whereas the control class received a high category rating of 15.1%. The post-test results table on the attached page provides more detailed information on the students' first performance on problem-solving abilities in mathematics learning.

The normality test is used to determine whether the data obtained from the results of this study are normally distributed or not. Normality testing is carried out on the distribution of data for each experimental class and control class separately which aims to determine whether the samples taken from the experimental class and control class are normally distributed or not. The statistical analysis used is the Kolmogorov Smirnov test using the SPSS 16.0 for windows program.

Table 3. Normality Test Results for Experimental Classes and Control Classes

Class	Data	Taraf Sig.	α	Conclusion
Experiment	Pretest	0.096	0.05	Normal
	Posttest	0.154		Normal
	Pretest	0.095		Normal
Control	Posttest	0.077	0.05	Normal

Based on the data in Table 3 above regarding the normality test of the initial ability data (pretest) obtained information that the sig level $> \alpha$ Where $0.096 > 0.05$ so that the experimental class pretest is normally distributed. Then the initial ability (pretest) in the control class obtained information that the sig level $> \alpha$ Where $0.096 > 0.05$ so that the control class pretest is also normally distributed.

Furthermore, regarding the normality test of the final ability data (posttest) obtained information that the sig level $> \alpha$ Where $0.154 > 0.05$ so that the experimental class pretest is normally distributed. Then the final ability (posttest) in the control class obtained information that the sig level $> \alpha$ Where is $0.077 > 0.05$ so that the control class pretest is also normally distributed.

Homogeneity test is used to determine the similarity (homogeneity) of uniform or not the samples taken from the same population. If the variance of the samples is not much different then the samples are homogeneous. The results of the homogeneity test calculation using the SPSS 16.0 for windows program can be seen in the following table.

Table 4. Homogeneity of Variance

Data	Levene Statistic	df2	Taraf Sig.	α	Conclusion
Pretest	0.021	64	0.886	0.05	Homogeneous
Posttest	0.841	64	0.363		Homogeneous

In Table 4, the sig level value $> \alpha$ is obtained, where the pretest data is $0.886 > 0.05$. Thus, it may be said that there is homogeneity in the pretest findings between the experimental and control classes. This is also observed in the posttest data, which had a sig level value $> \alpha$, whereas the pretest data had a value of $0.363 > 0.05$. Therefore, it can be said that the pretest findings between the experimental and control classes are homogeneous.

Hypothesis testing on the difference in problem solving ability of experimental class and control class. Significance testing of the average difference is taken if the probability (p) < 0.05 and insignificant if the probability (p) > 0.05 . Briefly, the results of the calculation of independent sample t test for experimental and control classes in terms of mathematical problem solving skills can be seen in table 5.

Table 5. Results of the calculation of the t-test of Mathematical Problem Solving Skills

Independent Samples Test						
Problem Solving Skills	Levene's Test for Equality of Variances		t-test for equality			α
	F	Sig	t	df	Sig. (2-tailed)	
	0.841	0.363	2.506	64	0.015	0.05

Based on the output in table 5 above, the results of Levene's Test for Equality of Changes, which show that the significant value is $0.738 > 0.05$, demonstrate that the data variance is homogenous or equal between the experimental and control class. So that the value in the "Equal variances assumed" table serves as a guide for interpreting the result table of the Independent Samples Test above. Since the "Equal variances expect" section's "Independent Samples Test" output table indicates that the two-tailed significance value ($0.015 < 0.05$), it may be inferred that H_a is accepted and H_0 is rejected when utilizing it as the establishment for the independent sample t test outcomes. Thus it can be concluded that there is a significant difference between the average results of problem solving skills utilizing GeoGebra learning media in mathematics subjects in experimental classes and conventional learning in control classes.

Furthermore, the obtained t-count value of 2.506 is known. Additionally, by using the formula ($\alpha/2$) to find the t-table value, (df) equals ($0.05/2$) and (64) equals (0.025); (64). The t-table value of 1.999 is then discovered. The t-count value of $2.506 > t\text{-table } 1.999$ indicates that there is an average difference in the students' problem-solving abilities between the experimental class using GeoGebra learning media and the control class using traditional learning in mathematics subjects circle material. Based on the basis of decision-making through the comparison of t-count with t-table, it can be concluded that H_a is accepted and H_0 is rejected.

Discussion

This study was conducted by researchers with the aim of knowing the problem solving skills in learning mathematics using GeoGebra learning media at SMK Negeri 1 Kisaran specifically in class XI where class XI Culinary 2 as the experimental class and class XI Culinary 1 as the control class. The experimental class was given treatment utilizing GeoGebra learning media, while the control class was given conventional learning treatment. The discussion of the results of research on the level of problem solving skills of students in learning mathematics through the utilize of GeoGebra learning media is depicted as takes after.



Problem solving skills in mathematics learning consists of four indicators, namely indicators of the skills to understand the problem, indicators of the ability to plan problem solving, indicators of problem solving skills and indicators of the ability to re-examine problem solving. As for knowing the initial skills regarding the problem solving skills of students, a pretest was given first consisting of 10 items of circle material related to the four indicators of problem solving skills.

The pretest data obtained shows that the average value of the problem solving skills of the experimental class is 42.67 with details of 7 students out of 33 students or 21.1% who have high abilities, 20 students out of 33 students or 60.6% who have moderate abilities and 6 students out of 33 students or 18.2% who have low abilities. While the average problem solving skills in the control class is 46.67 with details of 5 students out of 33 students or 15.1% who have high abilities, 23 students out of 33 students or 69.8% who have moderate abilities and 5 students out of 33 students or 15.1% who have low abilities.

The average pretest value of the control class math problem-solving skills is higher than that of the experimental class's students, agreeing to the pretest data that was collected. To strengthen the class's problem-solving skills, the experimental class gets diverse instruction than the control class.

Taking after the pretest, the control group received conventional instruction, while the experimental group received instruction utilizing GeoGebra learning resources. Furthermore, after being given different medications between the two classes, students are given a test in the form of the same posttest. The results of the final test of problem solving skills between the two classes, specifically the experimental classes and the control classes, are as follows.

The posttest data obtained shows that the average value of the problem solving skills of the experimental class is 84.58 with details of 6 students out of 33 students or 21.8% who have high abilities, 20 students out of 33 students or 63.6% who have moderate abilities and 6 students out of 33 students or 18.2% who have low abilities. While the average problem solving skills in the control class is 79.85 with details there are 5 students out of 33 students or 15.1% who have high abilities, 20 students out of 33 students or 60.6% who have moderate abilities and 8 students out of 33 students or 24.3% who have low abilities.

Based on the data obtained regarding the posttest of students' problem solving skills, it can be concluded that the average value of the experimental class utilizing GeoGebra learning media is higher than the average value of the control class that does not utilize GeoGebra learning media (conventional learning). Where the difference between the two average values of the two classes is 4.73. This proves that the mathematical problem solving skills of students' circle material taught by learning utilizing GeoGebra learning media is higher than the mathematics problem solving skills of students at circle material taught by conventional learning.

The findings of a study by Muliani, P., L., Sumandya, W., & Purwati (2021) titled "The Impact of Utilizing GeoGebra Learning Media on Intrigued and Mathematical Problem Solving Skills" revealed that seventh grade students at SMP Negeri 8 Denpasar in the 2020–2021 school year differed in their skills to solve mathematical problems and in their interest in learning.

According to Rustella (2023), 8 students met the 10% score threshold with a score of less than 79.43, indicating that the students' general ability to solve mathematical problems falls into the high category. In the intermediate category, 42 pupils had a 52.5% percentage and an initial score ranging from 36.56 to less than 79.43 for their mathematical problem solving skills. In contrast, thirty pupils with a percentage of 37.5% and an initial score of less than 36.5 fall into the low category of math problem solving.

Meanwhile, research conducted by Nurfadilah U., Suhendar U., (2018), entitled "The Effect of Using GeoGebra on Students' Problem Solving Ability on the Topic of Lines and Angles", the results showed that GeoGebra learning media in experimental classes had a



positive effect on students' problem solving abilities compared to control learning on Line and Angle material at SMP Negeri 2 Pulung.

- a. The research conducted and previous research have several similarities or differences, namely:
- b. The categories of solving ability levels in the research conducted by researchers have similarities with 3 levels in Rustella's research (2023).
- c. The intervals used from the three studies described above have different intervals in each category of problem solving ability levels.

Based on the description above, the results of research conducted in this study show similarities and differences from previous research. The results of this study indicate that the level of problem solving ability of students in learning mathematics circle material using GeoGebra learning media is high, which means that students are able to solve the problems faced by developing their knowledge through the learning process through GeoGebra learning media, this is in line with Ishak (2020), which says that some of the advantages of GeoGebra in learning mathematics are: (a) Compared to using pencils, rulers and compasses, GeoGebra can produce geometric and algebraic images quickly and accurately. (b) There are animation and motion manipulation (dragging) functions in the GeoGebra program, which can provide a clearer visual experience to learners and help them understand geometry and algebra concepts. (c) Can be used as feedback or evaluation to ensure that the completed drawings are correct. (d) Makes it easier for teachers or learners to learn or demonstrate attributes that can be applied to algebra courses.

D. Conclusion

Based on the results of the investigation or research that has been conducted, the level of problem solving ability of students in learning mathematics at SMK Negeri 1 Kisaran can be concluded as follows:

1. The experimental class's level of mathematical problem solving skills is higher than the control class's level of conventional learning when it comes to circular material that is taught utilizing Geogebra application media. With details of the posttest data obtained, it shows that the average value of the problem solving skills of the experimental class is 84.58 with details of 6 students out of 33 students or 218.2% who have high abilities, 20 students out of 33 students or 63.6% who have moderate skills and 6 students out of 33 students or 18.2% who have low skills. While the average problem solving skills in the control class is 79.85 with details of 5 students out of 33 students or 15.1% who have high skills, 20 students out of 33 students or 60.6% who have moderate skills and 8 students out of 33 students or 24.3% who have low skills.
2. There is a significant difference between the mathematical problem solving skills of circle material that gets learning utilizing Geogebra application media within the experimental class higher than the mathematical problem solving skills of conventional learning within the control class. Where $t\text{-count} > t\text{-table}$ is $2.056 > 1.999$ or significant level $= 0.015 < \alpha = 0.05$.

Based on the results of investigation or research that has been conducted by researchers regarding the level of problem solving skills of students in learning mathematics at SMK Negeri 1 Kisaran, the following suggestions can be made:

1. Teachers should use varied and optimal learning strategies for the learning process carried out, especially in mathematics learning. With the existence of variations or optimal strategies, it can make students able to develop problem solving skills and activeness in the learning process. So that the learning process carried out can achieve predetermined goals. Teachers should also prioritize student-focused learning. The purpose of a learning strategy



that focuses on students is so that they are able to develop their potential so that learning also does not become monotonous on the teacher alone.

2. Students must be more active in participating in the learning process that takes place in order to improve problem solving skills in working on problems given by teachers, especially in mathematics learning. Learners should also motivate themselves more to like all learning so that they can make the learning process more comfortable and enjoyable.

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