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Integration of Computational Thinking in GeoGebra-Assisted Measurement Learning on Mathematical Problem Solving Skills

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A B S T R A K

Memecahkan teka-teki matematika adalah salah satu keterampilan yang pagar penting yang harus dimiliki siswa di buruk ke-21. Meskipun demikian demikian, kemampuan siswa Indonesia untuk memecahkan masalah masih cukup rendah. Berdasarkan hal tersebut, penelitian ini bertujuan untuk menganalisis pengaruh pengintegrasian berpikir komputasional dalam pembelajaran pengukuran berbantuan geogebra terhadap keterampilan pemecahan masalah matematis.Penelitian ini menggunakan pendekatan kuantitatif dengan tipe eksperimen. Sampel penelitian ini berjumlah 45 siswa sekolah dasar dengan menggunakan teknik simple random sampling. *Metode yang digunakan untuk mengumpulkan data adalah observasi dan tes. Instrumen yang digunakan untuk mengumpulkan data adalah soal tes. Teknik yang digunakan untuk menganalisis data adalah analisis kuantitatif dan statistik inferensial. Hasil penelitian menunjukkan bahwa ada variasi dalam kemampuan kelompok eksperimental dan kontrol untuk memecahkan teka-teki matematika. Hasil uji-t menunjukan terdapat perbedaan rata-rata antara hasil* pretest *dan* posttest *pada kelas kontrol dan eksperimen. Terdapat perbedaan kemampuan pemecahan masalah yang signifikan antara siswa yang mengikuti pembelajaran dengan pendekatan* computational thinking *berbantuan geogebra dan siswa yang mengikuti pembelajaran tanpa pendekatan* computational thinking *berbantuan geogebra. Disimpulkan bahwa pembelajaran dengan pendekatan* computational thinking *berbantuan geogebra dapat meningkatkan kemampuan pemecahan masalah.*

A B S T R A C T

Solving math puzzles is one of the most essential skills students should have in the 21st century. Despite this, Indonesian students' problem-solving ability still needs to improve. This research aims to analyze the effect of integrating computational thinking in geogebra-assisted measurement learning on mathematical problem-solving skills. This research uses a quantitative approach with an experimental type. The sample for this research consisted of 45 elementary school students using simple random sampling techniques. The methods used to collect data are observation and tests. The instrument used to collect data is test questions. The techniques used to analyze data are quantitative analysis and inferential statistics. The results showed that there was variation in the ability of the experimental and control groups to solve mathematical puzzles. The t-test results show an average difference between the pretest and post-test results in the control and experimental classes. There is a significant difference in problem-solving abilities between students who take part in learning using the computational thinking approach assisted by Geogebra and students who take part in learning without the computational thinking approach assisted by Geogebra. It was concluded that learning using a computational thinking approach assisted by Geogebra can improve problem-solving abilities.

1. INTRODUCTION

Education is an important pillar facilitating Indonesia's journey towards a prosperous future. In realizing this vision, the government is embracing the integration of contemporary competencies into the educational landscape. Education is expected to improve students' skills, such as critical analysis, innovative

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problem-solving, communication, and collaborative talents (Hidayatullah et al., 2021; Septikasari & Frasandy, 2018). The Merdeka Curriculum emphasizes the integration of technology and provides freedom so that students can think creatively and innovatively according to 21st-century problem-solving skills (Fitriyah & Wardani, 2022; Malikah et al., 2022). One of the essential things that must be implemented in their curriculum is integrating computational thinking or CT in learning, especially in Indonesian language, science, and mathematics subjects at the primary school level. This activity is a process of solving problems through phases of the mind, such as computer systems, known as computational thinking (Boom et al., 2022; Soboleva et al., 2021). Students are expected to be able to solve problems and have critical thinking. Computational thinking involves many processes in problem resolution, including decomposition, pattern detection, abstraction, and algorithmic thinking (Kjällander et al., 2021; Wang et al., 2021).

At the elementary school education level, the computational thinking approach can be applied to form students who have a structured way of thinking and can understand syntax or semantics in Indonesian language lessons, can take the form of a logical thinking pattern in mathematics, and can interpret science data in Science. Learning mathematics requires this skill because it is essential for developing thinking skills to solve problems (Chevalier et al., 2020; Soboleva et al., 2021). Learning mathematics is not just the goal of memorizing formulas but mathematics forms creative thinking to solve problems (Malikah et al., 2022; Primadewi & Agustika, 2022; Ulhusna et al., 2020). Mathematics learning aims to improve students' mathematical problem-solving abilities (Giantara & Astuti, 2020; Rahmata et al., 2020). Mathematics learning in elementary schools plays a vital role in helping students build the essential knowledge and skills needed for various fields of Science and technology (Utari et al., 2019; Wiryanto, 2020).

However, there are still many students who need help learning mathematics. Previous research findings also reveal that students get learning outcomes below standard (Buchori & Rahmawati, 2017; Mirnawati & Basri, 2020). Other research also states that students experience difficulties in learning mathematics due to inappropriate media or learning models (Anjarsari et al., 2020; Wulandari et al., 2020).. Low mathematical literacy will impact students' low mathematical problem-solving abilities (Janah et al., 2019; Widiantari et al., 2022). This problem also occurred in one of the elementary schools in the Dirgantara Wilcambidik Cluster in Bener, Purworejo Regency. Based on information obtained through observations and interviews, there were obstacles to learning mathematics in class V of Jolodoro Elementary School, especially in students' ability to solve problems. Teachers still often use traditional learning methods, so they are less able to develop problem-solving skills in students. Apart from that, the lack of mathematics learning media also impacts low student learning outcomes.

Based on this, increasing students' mathematical problem-solving abilities is necessary. The ability to solve problems is the ability to provide solutions based on existing knowledge using thinking (Hidayah & Aulia, 2015; Rahmata et al., 2020). This ability involves critical, creative, and systematic thinking to formulate effective and efficient strategies and solutions. Problem-solving is a student's effort to find a way out of the search for an idea, creativity, knowledge, and application in life to achieve the target (Utami & Wutsqa, 2017; Winata & Friantini, 2018). Problem-solving skills are a prerequisite for accurate world handling, so improving them is essential (Darmawan et al., 2020; Hidayat & Ayudia, 2019). One of the strategies to improve mathematical problem-solving skills is to integrate the computational thinking approach into the learning process. A computational thinking approach can help students form a framework for solving a problem (Kjällander et al., 2021; Soboleva et al., 2021). When problems and solutions are formulated so that they can be represented in the form of processing information, it is referred to as computational thinking.

The rapid development of technology means that someone must realize that computing thinking is critical (Kert et al., 2020; Yağcı, 2019). Utilizing the example of How computers operate, computational thinking is used to reduce complex problems to something simpler. There are four stages in computational thinking: abstraction, decomposition, algorithm, and generalization (Kert et al., 2020; Maharani et al., 2020; Yağcı, 2019). Using computational thinking will increase a person's logical and analytical thinking capacity. Combining computational thinking is an effort to simplify students' understanding of concepts and problems related to the flat building domain; therefore, learning media is needed to support learning activities. Learning media is needed to support it (Crismono, 2017; Lestari et al., 2020; Nendasariruna et al., 2018). Learning media that integrates computational thinking can create an exciting learning atmosphere so that learning runs more effectively. Geo Gebra is one of the learning media that can be used. An artificial intelligence (AI) computer program called GeoGebra can be used as a means of learning mathematics, especially those related to geometry and algebra content. GeoGebra can be used as a tool in building, demonstrating, and visualizing abstract problems in the field of mathematics, especially in the context of geometry, which are difficult or impossible to solve manually (Japa et al., 2017; Sao et al., 2021).

Previous research findings also reveal that a learning media is needed for mathematics learning to improve student learning outcomes (Febrian et al., 2019; Fonda & Sumargiyani, 2018; Hidayah &

Fathimatuzzahra, 2019). Other research also reveals that Computational Thinking (CT) learning helps students develop better logical thinking and analytical skills, enabling them to solve problems more effectively (Kjällander et al., 2021; Soboleva et al., 2021; Wang et al., 2021). Integration of Computational Thinking in GeoGebra-Assisted Measurement Learning can help students learn mathematics. One way to help students become better problem solvers is to incorporate GeoGebra computational thinking into studying classroom mathematics. Learning with a Computational Thinking (CT) approach helps students build better problem-solving skills, enabling them to solve complex and abstract problems more effectively. However, there has been no study regarding integrating computational thinking in geogebra-assisted measurement learning for mathematical problem-solving skills. Based on this, this research aims to analyze the influence of integrating computational thinking in geogebra-assisted measurement learning on mathematical problem-solving skills.

2. METHOD

This research uses a quantitative approach with an experimental type. The quantitative approach is a type of research approach that aims to test hypotheses on a sample using statistical research instruments (Sugiyono, 2015). This research uses a type of experimental research that aims to determine the causal relationship between the independent variable and the dependent variable. In this research, experimental quantitative research aims to determine the effect of the integration of computational thinking and the use of GeoGebra as an independent variable on students' mathematical problem-solving abilities as the dependent variable in class V of the Gugus Dirgantara Wilcambidik Bener Elementary School, Purworejo Regency, which is the sample of this research. This research uses a proper experimental design in the form of a pretest-posttest control group design. This research will be conducted at Jolodoro Public Elementary School and Kedungloteng Public Elementary School, Gugus Dirgantara Wilcambidik Bener, Purworejo Regency, Central Java.

The population in this study is the Gugus Dirgantara Wilcambidik Bener elementary school, Purworejo Regency, which includes five elementary schools, including SDN Kaliurip, SDN Kedung Pucang, SDN Jolodoro, SDN Kaliwader, and SDN Kedungloteng. This research used a simple random sampling technique. Simple random sampling is a simple sampling technique done randomly without paying attention to strata in a population. This research used a simple random sampling technique. Simple random sampling is a simple random sampling technique without paying attention to the strata of a population (Sugiyono, 2015). The results from simple random sampling were obtained by two schools, SDN Jolodoro as the experimental class totaling 29 students and SDN Kedungloteng as the control class totaling 16 students. The methods used to collect data are observation and tests. This research will use two tests, namely a pre-test and a post-test, to determine the level of students' mathematical problem-solving abilities in class V of Jolodoro State Elementary School and Kedungloteng Wilcambidik Bener State Elementary School, Purworejo Regency. The instrument used to collect data is test questions. The test question grid is presented in Table 1.

Table 1. Test Question Research Instrument

Question Indicator	Mathematical Problem Solving Indicators	Cognitive Domain
Presented with a problem related to the area of a rectangle, students can describe the pair of lengths and widths of a rectangle whose area is already known	1. Understand the problem 2. Design a mathematical model 3. Running the model 4. Interpret the results and conclusions	C4
Presented with a problem related to the area of a square, students can solve problems related to the length of its sides	1. Understand the problem 2. Design a mathematical model 3. Running the model 4. Interpret the results and conclusions	C4
Presented with a problem related to the area of a square, students can solve the problem	1. Understand the problem 2. Design a mathematical model 3. Running the model 4. Interpret the results and conclusions	C4
Presented with a problem related to a combination of flat shapes, students can solve the problem	1. Understand the problem 2. Design a mathematical model 3. Running the model 4. Interpret the results and conclusions	C4

Question Indicator	Mathematical Problem Solving Indicators	Cognitive Domain
Presented with a problem related to two flat shapes, students can solve the problem	1. Understand the problem 2. Design a mathematical model 3. Running the model 4. Interpret the results and conclusions	C4

The techniques used to analyze data are quantitative analysis and inferential statistics. Analysis prerequisite tests are carried out as a condition for parametric statistical tests. The prerequisite tests for analysis are the normality test and the homogeneity test. The normality test uses the Kolmogorov-Smirnov normality test because the samples are >50. The homogeneity test uses SPSS Statistics software version 27. Hypothesis testing uses the paired sample t-test to determine each class's average pretest and posttest scores. Then, the independent sample t-test will be tested to determine whether variable X influences variable Y.

3. RESULT AND DISCUSSION

Result

This section discusses statistical descriptions of research results, analysis of prerequisite test results, and hypothesis test results. This research has two data sets for mathematical problem-solving abilities: pretest and posttest score data. The pretest score is obtained from the initial test results before treatment, while the posttest score is obtained after treatment. The pretest score aims to determine students' initial abilities, while the posttest aims to determine whether there has been an increase in students' mathematical problem-solving abilities. Researchers used SPSS Statistics software version 27 to carry out descriptive statistical analysis. Data from descriptive statistical analysis are presented in Table 2.

Table 2. Data from Descriptive Statistical Analysis Results

Data	N	The highest Score	Lowest Value	Average	Range	Standard Deviation
Control Class Pretest	16	30	0	12	30	8.959
Control Class Posttest	16	65	0	27.19	65	15.065
Experimental Class Pretest	29	19	0	7.38	19	6.422
Experimental Class Posttest	29	100	37	70.52	63	18.552

The results of the data analysis showed that the lowest score for the control group's pretest was 0, while the highest score was 30. Meanwhile, for the control group's post-test score, the lowest was 0, and the highest was 65. The average pretest score reached 12, and the post-test scored 27.19. The standard deviation for the control class pretest was 8.959 and post-test, 15.065. In the experimental group, the average pretest score was 7.38, and the post-test score was 70.52. The experimental class had the lowest score of 0, the same as the control class, and the highest was 19. Meanwhile, the post-test score for the experimental class has the lowest score of 37 and the highest score of 100. The experimental class's average pretest and post-test scores are 7.38 and 70.52. Next, prerequisite analysis tests are carried out before hypothesis testing, including normality tests and homogeneity tests. The normalization test results are presented in Table 3.

Table 3. Normality Test Results

	Kolmogorov-Smirnov[a]		
	Statistic	**df**	**Sig.**
Pretest Kontrol	0.143	16	0.200
Postest Kontrol	0.177	16	0.194
Pretest Eksprimen	0.193	16	0.114
Postest Eksperimen	0.093	16	0.200

Normality test results use the Kolmogorov-Smirnova normality test. Based on this table, the sig value for 1) the control class pre-test is 0.200 ≥ 0.05; 2) post test control class 0.194 ≥ 0.05; 3) experimental class pre test 0.144 ≥ 0.05; and 4) experimental class post test 0.200 ≥ 0.05. It can be concluded that all the research results have a normal distribution because they meet the normality test requirements, namely a sig value ≥ 0.05. The homogeneity test results are presented in Table 4.

Table 4. Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Mathematical Problem Solving Ability	Based on Mean	1.350	1	43	0.252
	Based on Median	1.257	1	43	0.268
	Based on Median and with adjusted df	1.257	1	42.659	0.269
	Based on trimmed mean	1.327	1	43	0.256

The normality test results obtained a sig value based on a mean of 0.252 ≥ 0.05. This shows that this study's pre-testpretest and post-test data have the same or homogeneous variance. The data results showed normal and homogeneous results, so proceed with hypothesis testing. In this research, hypothesis testing uses the t-test and determination test (R) to determine how much influence the integration of computational thinking in geogebra-assisted measurement learning has on students' mathematical problem-solving abilities. The paired sample t-test aims to determine the average difference between the pre-test-retest and post-testt results in the control and experimental classes. In this study, the independent sample t-test was tested using SPSS Statistics version 27 software. The results of the independent sample t-test are presented in Table 5.

Table 5. Paired Sample T-Test Results

Data	Mean	Tcount	t_{table}	df	ρ	Explanation
Control Pretest	12	4.666	2.131	15	0.000	significant
Control Posttest	27.19					
Experimental Pretest	7.38	20.121	2.048	28	0.000	significant
Experimental Posttest	70.52					

Based on the table above, the average pretest result for the control class is 12.00 and the average posttest result is 27.19. The tcount value is 4.666, ttable 2.131, and degrees of freedom (df) 15. Meanwhile, the average pretest result for the experimental class is 7.38 and the average posttest result is 70.52. The tcount value is 20.121, ttable 2.048, and degrees of freedom (df) 28. Based on the data above, in the control class the tcount value is 4.666 > ttable 2.13. The resulting sig value. (2-tailed) average of control class pretest and posttest results 0.000 ≤ 0.005. From these two results, it can be interpreted that there is an average difference between the pretest and posttest results in the control class. In the experimental class, the tcount value is 20.121 > ttable 2.048. Meanwhile, the sig value. (2-tailed) the average pretest and posttest results are 0.000 ≤ 0.005, so it can be interpreted that there is an average difference between the pretest and posttest results in the experimental class.

The independent sample t-test aims to determine the average difference in posttest results between the control class and the experimental class. In this study, the independent sample t-test was tested using SPSS Statistics software version 27. The results of the Independent Sample T-test are presented in Table 6.

Table 6. Independent Sample T-Test Results

Data	Mean	t_{hitung}	t_{tabel}	df	ρ	Explanation
Control Class Posttest	27.19	7.989	2.017	43	0.000	Significant
Experimental Class Posttest	70.52					

The results of the data analysis show that the average post-test result for the control class is 27.19. Meanwhile, the average posttest result in the experimental class was 70.52. The count value is 7.989, the table value is 2.017, and the degrees of freedom (df) is 43. Based on these results, it shows that the t_{count} (7.989) > t_{table} (2.017). This shows that there is an average difference between the control class and the experimental class. This is reinforced by the results of the ρ-value or sig. (2-tailed) the average posttest score between the control class and the experimental class is 0.000 ≤ 0.005, so it can be interpreted that there is an average difference between the posttest results between the control class and the experimental class. It was concluded that there was a significant difference in problem-solving abilities between students who took part in learning using the computational thinking approach assisted by Geogebra and students who took part in learning without the computational thinking approach assisted by Geogebra..

Discussion

The data analysis results show a significant difference in problem-solving abilities between students who take part in learning using the computational thinking approach assisted by Geogebra and students who take part in learning without the computational thinking approach assisted by Geogebra. Several factors cause this. First, learning with a computational thinking approach assisted by Geogebra can improve problem-solving abilities. Computational thinking solves complex problems through four foundations: decomposition, looking for patterns, abstraction, and algorithms (Boom et al., 2022; Soboleva et al., 2021). By using this approach, students can learn how to break down problems into smaller parts, look for patterns in divided conflicts, and focus on the most important information contained in recognized patterns (Boom et al., 2022; Soboleva et al., 2021; Wang et al., 2021). This can help the problem-solving process be structured and efficient and increase students' problem-solving creativity. Computational thinking is the thought process involved in formulating problems and their solutions so that the solutions are represented in a form that can be implemented effectively by information processing agents (Boom et al., 2022; Kjällander et al., 2021). This can be applied to solve problems like mathematics problems at school. Through the integration of computational thinking in the learning process, students will be guided through ways of thinking, like computers, which have stages from abstraction to generalization. This makes it easier for students to analyze a problem into simpler parts and develop steps to solve it (Boom et al., 2022; Maharani et al., 2020).

Second, learning with a computational thinking approach assisted by Geogebra can improve students' understanding of learning. Support from GeoGebra learning media helps make the learning process easier because GeoGebra provides an accurate visual display that will make it easier for students to understand the problems presented (Bulut et al., 2016; Indah Perawansa et al., 2019; Nurdin et al., 2019). By other research, GeoGebra can be used to construct, demonstrate, and visualize abstract problems, especially in difficult or impossible contexts to solve manually (Rohmawati & Kristanto, 2018; Soboleva et al., 2021). Therefore, integrating computational thinking in geogebra-assisted measurement learning can improve students' mathematical problem-solving abilities. Computational thinking can be applied in various daily life situations, helping individuals to become more effective and efficient in solving problems and making the right decisions (Boom et al., 2022; Kjällander et al., 2021).

Third, learning using a computational thinking approach assisted by Geogebra can improve the student learning atmosphere. With the Computational Thinking approach, students can be more active and involved in learning because they have to think critically and find practical solutions (Fitriani et al., 2021; Tseng et al., 2018). This can increase students' awareness that they have an essential role in the learning process and can influence the results. By using a Computational Thinking approach, students can improve their ability to adapt to changes that occur (Rich et al., 2020; Tseng et al., 2018). This can help students to be more flexible and better prepared to deal with unexpected situations. Learning with a computational thinking approach assisted by Geogebra can improve the student learning atmosphere. Geogebra software allows students to model and visualize geometric and mathematical concepts interactively (Bulut et al., 2016; Nurdin et al., 2019). By using Geogebra, students can be more active and more involved in the learning process and can understand concepts better through interactive visualization and manipulation (Bulut et al., 2016; Indah Perawansa et al., 2019).

Previous research findings also state that Geogebra media can help students learn (Rohmawati & Kristanto, 2018; Zetriuslita et al., 2020). Other research also shows that the Computational Thinking approach can improve a pleasant learning atmosphere by increasing students' involvement, creativity, problem-solving abilities, critical thinking abilities, and adaptability (Maharani et al., 2020; Soboleva et al., 2021; Yağcı, 2019). It can be concluded that learning using the computational thinking approach assisted by Geogebra can improve problem-solving abilities. The limitation of this research is that it only examines learning using the geogebra-assisted computational thinking approach on students' problem-solving abilities, so an in-depth study is needed if we want to test other variables. The theoretical implication is the influence of the integration of computational thinking in GeoGebra-assisted measurement learning on the mathematical problem-solving abilities of fifth-grade students at SD Gugus Dirgantara Wilcambidik Bener, Purworejo Regency. The research results show a significant influence of integrating computational thinking in measurement learning assisted by Geogebra learning media on students' mathematical problem-solving abilities. These findings suggest that integrating a computational thinking approach into learning can improve students' mathematical problem-solving abilities.

4. CONCLUSION

The data analysis results showe is an average difference between the pretest and post-test results in the control and experimental classes. Apart from that, significant differences in problem-solving abilities were also found between students who took part in learning using the computational thinking approach assisted by Geogebra and students who took part in learning without the computational thinking approach assisted by Geogebra. It was concluded that learning using a computational thinking approach assisted by Geogebra can improve problem-solving abilities.

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