25 (1), 2024, 223-235

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Discovery Learning Model Assisted by Geogebra-based Napier Bones on Students' Division Problem Solving Ability

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Abstract: Problem-solving ability is a basis that students must have in the learning process. This research aims to analyze the influence of the Discovery Learning model with Geogebra-based Napier Bones on improving students' division problem-solving ability. The population in this study was fourth-grade students of SDN Gugus Diponegoro. Sampling was done using the cluster random sampling technique. The sample in this research was fourth-grade students of SDN 1 Kalen and SDN 2 Nglandeyan. This research was carried out using quantitative research methods with experimental research types. The research design used a Quasi-experimental design. Data collection in this research was carried out by test techniques. The data analysis techniques used were normality test, homogeneity test, independent t test, and N-gain. The result of the research showed that there was a difference in division problem-solving ability in the experimental class which is higher than the control class. Based on the independent sample t-test, the significance value obtained 0,038 < 0,05. The N-Gain results show that the value in the experimental class was 0.501, which is in the medium category, while the value of the control class was 0.235 in the low category. This research concludes that the Discovery Learning model with Geogebra-based Napier Bones media has a significant influence on students' division problem-solving abilities.

Keywords: discovery learning, geogebra-based napier bones, problem solving ability.

▪ INTRODUCTION

Learning is an important process to improve education quality and achieve educational goals that will improve the quality of Indonesia's human resources. Learning is a positive change in behavior, mental activity, abilities, and the acquisition of new information and skills (Sehic, 2020). Learning is experienced by every human being throughout their lives and can happen anytime and anywhere. The learning process at school includes various fields, one of which is Mathematics. The traditional definition of mathematics is the systematic study of quantities, involving their relationships, operations, and measures, represented by symbols and numbers (Yadav, 2017). Mathematics plays a role in achieving the goals of mathematics learning. Mathematics teaches students to think rationally. Students are taught to judge decisively about the situation they are facing, draw the right conclusions, and make the most appropriate decisions (Ibrokhimovich & Abduraxmonova, 2022). Mathematics education is the develops students' abilities, students operate with various forms of concepts, assessments, and conclusions (Feruza & Sharofutdinova, 2020).

Mathematics is a very important field to be taught to students in elementary school because it is the foundation for developing numeracy skills that are useful in their daily lives. Mathematics learning is an effort to help students build concepts with their abilities through the process of interaction with the surrounding circumstances (Kamid et al., 2024). The Mathematics learning process in elementary school is an important factor in the success of learning mathematics at a higher level. Mathematics in elementary school trains students to do careful reasoning about precisely defined objects and concepts.

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DOI: http://dx.doi.org/10.23960/jpmipa/v25i1.pp223-235
Received: 25 June 2024
Accepted: 29 July 2024
Published: 04 August 2024

Students must be able to formulate and solve problems in mathematical language appropriately so that students are familiar with mathematical concepts (Sergejeva et al., 2018). Mathematics in elementary schools certainly has principles and standards that characterize the progress in education. NCTM outlines five content standards and five process standards for school mathematics that describe the mathematical knowledge, understanding, and abilities that students should acquire in the process of learning mathematics. The content standards include numbers and operations, geometry, algebra, measurement, data analysis and probability, the process standards include problem-solving, thinking and evidence, communication, connection, and representation. (NCTM, 2000) in (Yohanes, 2020).

The success of students in participating in Mathematics learning activities is different. This is certainly influenced by the student's ability to learn. Achievement in mathematics learning is the extent to which students acquire knowledge and skills through the mathematics learning process by using their abilities in solving mathematical problems (Jawad et al., 2021). Through an active problem-solving process, students can build their understanding and ultimately develop higher-order thinking skills. High-level thinking skills in the classroom must be considered so students can use higher-order thinking skills to solve problems (Singh et al., 2018). The process of solving problems requires planning the steps that must be completed so that the problem-solving process can be carried out systematically. Student are considered capable of solving a problem if he has gone through several problems and can go through them well (Arruan, 2023). In solving problems, students do not easily give up. They need to think critically to find a good solution to solve their problem (Moneva et al., 2020). Problem-solving skills are indispensable because it is a basis for surviving in daily life (Ellah et al., 2019). Problem-solving ability is very important to learn because it can hone cognitive abilities and skills needed to overcome problems in an organized, thorough, and logical manner. Through this activity, students are involved in rationalizing the use of mathematical concepts learned in various situations (Suseelan et al., 2022).

Weak problem solving skills can cause students to have difficulty in learning. Therefore, efforts to improve students' ability to solve problems are very necessary, namely by use the right learning models and media. The use of appropriate learning models and media can greatly enhance the learning experience. The use of appropriate models and media can make students realize that other appropriate forms of thinking can improve their abilities. (Vale & Barbosa, 2023). Appropriate learning models and media to improve the problem-solving ability on division material are the Discovery Learning model and Geogebra-based Napier Bones media. Discovery Learning is a learning model in which students are encouraged to explore and investigate independently, leading to meaningful and long-lasting learning outcomes. (Erman et al., 2019). The Discovery learning model encourages students to take an active and critical role in discovering knowledge through direct investigation (Inde et al., 2020). Besides the learning model, the use of appropriate media is also very influential in the learning process. Napier Bones media is a bar-shaped Mathematics teaching aid that can be used for multiplication, division, and square rooting in practice (Filiz & Gur, 2024). The rapid development of technology also provides innovation in the field of learning media development. The use of Geogebra can be combined with various media, one of which is the Napier bones media which aims to describe the media visually and learning material practically and quickly.

The integration of Geogebra media creates a learning environment where students can explore, surmise, and visualize. Students can develop a conceptual understanding of the concepts of the material being studied (Mokotjo & Mokhele, 2021).

Several research show that the implementation of the Discovery Learning model and Geogebra-based Napier Bones media has an influence on students' problem-solving skills. According to the Nasution's (2022) research, the students problem-solving ability who were treated using the Discovery Learning model was improved than students who used conventional learning models. These results show that learning with the Discovery Learning model has an effect on students' mathematics problem-solving skills. Research from Armin & Ulu (2022) shows that the use of Napier Bones media has a positive influence on student learning achievement. This is indicated by the average learning achievement of students in the experimental class, which is higher than the students in the control class.

Based on the above research, it can be seen that the Discovery Learning model and Napier Bones media are effectively applied in learning and can improve students' problem-solving skills and learning outcomes. The distinctions between this research and the above research is that in previous research using the Discovery Learning model and Napier Bones media separately, in this study we will see the interaction of the Discovery Learning learning model with Napier Bones media on students' problem-solving ability which are also used with Geogebra. There are also other differences in the scope of the material. This study was conducted to analyze the influence of the Discovery Learning model assisted by Geogebra-based Napier Bones media on improving students' division problem-solving ability.

▪ METHOD

Participants

This research was conducted at SDN Gugus Diponegoro in the 2023/2024 academic year. This research population were fourt-grade students of SDN Gugus Diponegoro, which consists of 19 cluster members. Sampling in this study was carried out by Probability sampling with cluster random sampling technique. Using this technique, researchers select groups that are homogeneous and representative. This research's sample was 28 fourth-grade students of SDN 1 Kalen and 17 fourth-grade students of SDN 2 Nglandeyan. SDN 1 Kalen was the experimental class while SDN 2 Nglandeyan was the control class.

Research Design and Procedures

This research uses quantitative research methodologies with experimental research type. The experimental design utilized was quasi-experimental. This design has a control group, but it cannot fully control the external factors that exert influence on the conduct of the experiment (Sugiyono, 2015). This research uses a nonequivalent control group design. Namely, two groups that are not randomly selected. The homogeneous group was then subjected to a pre-test before being treated and a post-test after being treated. The influence of the treatment can be determined accurately by comparing the results of the pre-test with the post-test. This research was conducted by implementing the Discovery Learning model assisted by Geogebra-based Napier Bones media in learning Mathematics division material. Researchers focused on the implementation of the Discovery Learning model assisted by Geogebra-based Napier Bones media on students'

division problem-solving ability. The implementation of the Discovery Learning model assisted by Geogebra-based Napier Bones media is used in core learning activities to increase students' active participation to improve problem-solving ability. Napier Bones media is presented based on GeoGebra in a projector display that is presented to encourage the active involvement of students. The use of this media is used to instill the concept of division and help students in calculating division operations. The research procedures is summarized in Figure 1

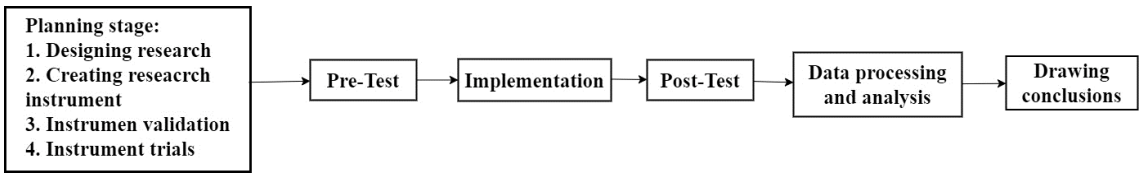

Figure 1. Research procedures

This research begins with a planning stage that includes various preliminary data needed in the implementation of research, namely designing research, creating research instruments, validating research instruments, and instruments trials. After the preparation is carried out, it is then continued with pre-tests in the experimental class and control class. After the results of the pre-test were obtained, the implementation of learning was carried out with the Discovery Learning model assisted by Geogebra-based Napier Bones media in the experimental class and the conventional learning model in the control class. The post-test is conducted after the learning activity to measure the student's problem-solving ability following the treatment. The test results that have been obtained are then analyzed to draw conclusions. This research was conducted on May 2024 and took 3 weeks until research data was obtained.

Instrument

This research use quantitative data collection instrument techniques through test techniques. Students are given a pre-test before being given treatment and a post-test after being given treatment. The form of questions used in this research is essay questions. The test questions presented were made by researchers which are designed to measure students' division problem-solving ability. Based on Polya's theory, there are four steps in the problem-solving process, namely understand the problem, devise a plan, carry out the plan, and look back (Shodiqin, et al., 2020). The essay questions on this research instrument were made with a total of 12 items that were developed by researchers and represented the existing indicators. The questions indicator are presented in table 1.

Table 1. Question indicator

Question Indicator	Question Number
Examining the correct number to complete the result of the division operation	1. 2
Calculating the results of the division operation based on the story problem	3. 4
Analyze existing stimuli to obtain the results of the division operation	5. 6
Calculate the result of division operations that related to daily activities	7. 8. 9
Calculating the result of the division operation (3-digit number: 2 numbers)	10

Break down the results of the division operation to determine the remainder of the quotient	11. 12

The instruments were then tested to measure whether the instruments were good and adequate with content and construct validity tests, reliability tests using Cronbach Alpha, difficulty test, and differentiability test. The results of the instrument validity test are presented in table 2.

Table 2. Instrument validity test

	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
Pearson Correlation	0.597	0.648	0.735	0.779	0.767	0.836	0.748	0.814	0.685	0.792	0.794	0.534
Sig. (2-tailed)	0.002	<0.001	<0,001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007

The results of the validity test of essay questions with 12 trial statements are all statement items declared valid, this is evident from the significance value which shows a value <0.05. The reliability test was carried out using Cronbach Alpha and received a value of 0.914, which is > 0.60, so the essay questions on the instrument are reliable. The results of the analysis of the difficulty level of the questions show that there is 1 question that is included in the easy category, 9 questions in the medium category, and 2 questions in the difficult category. Then the results of the question differentiation test showed that 7 questions were on the good criteria and 5 questions were on the very good criteria.

Data Analysis

The data obtained from this research are the pre-test and post-test scores of the experiments and control classes. The data from the pre-test and post-test were then analyzed to see the influence of the learning model used on the students' problem-solving ability. The data analysis techniques used in this research are the normality test, homogeneity test, independent sample t test, and the N-gain test. Initial data analysis includes a normality test and a homogeneity test. The normality test in this research used the Shapiro-Wilk test at the 0.05 significance level and the homogeneity test was carried out through the Levene test of homogeneity at the 0.05 significance level. The final data analysis was conducted using the independent sample t-test and N-gain test. The N-gain criteria according to Hake are presented in table 3.

Table 3. N-gain criteria (Hake, 1998)

N-gain Score	**Criteria**
≥ 0.7	High
0.30 – 0.70	Medium
0.00 – 0.29	low

▪ RESULT AND DISSCUSSION

This research was conducted in two classes, namely grade IV of SDN 1 Kalen as experimental class and grade IV of SDN 2 Nglandeyan as a control class. The experimental class was treated using the Discovery Learning model assisted by

Geogebra-based Napier Bones media, while the control class was given learning using the conventional model. Students' division problem-solving ability is measured by giving pre-tests and post-tests. The pre-test is carried out before students are given treatment to measure the initial ability of students, while the post-test is carried out after the students are given treatment to measure students' final ability levels in experimental and control classes after being given treatment. The results of the pre-test and post-test of the problem-solving ability of fourth-grade students of SDN 1 Kalen and SDN 2 Nglandeyan are presented in table 4.

Table 4. Pre-test and post-test results

No	Description	Pre-Test		Post-Test	
		Experiment	Control	Experiment	Control
1	Average	51.36	52.47	74.21	63
2	Highest score	83	82	97	86
3	Lowest score	22	19	41	20
4	Percentage of completeness	21.43%	23.53%	75.00%	52.94%

Based on table 4, The pre-test average in the experimental and control classes are nearly identical. The average score in the experimental class was 51.36 and the average score in the control class was 52.47. Then after the treatment, the post-test results revealed that the experimental class had a higher average rise than the control group. After calculating the average acquisition in the experimental class and control class, a normality test was conducted. The normality test in this research was carried out using the Shapiro-Wilk test. The normality test results are presented in table 5.

Table 5. Normality test results

Tests of Normality							
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Class	Statistic	df	Sig.	Statistic	df	Sig.
Test results	PreTest Experimet	.098	28	.200*	.971	28	.619
	PostTest Experiment	.185	28	.015	.927	28	.052
	PreTest Control	.142	17	.200*	.952	17	.493
	PostTest Control	.206	17	.054	.902	17	.074

The normality test in this research is using the Shapiro-Wilk test. The results of the pre-test and post-test data normality test calculations using the Shapiro-Wilk test in table 2 above show that the significance value on the pre-test and post-test data of both classes is > 0.05, so it can be concluded that the pre-test and post-test data of the experimental class and control class are normally distributed. After the normality test was conducted, the researcher also conducted a homogeneity test on the pre-test and post-test data of the

experimental class and control class to see if the samples had the same variant. If the samples have the same variance, the data is then considered homogenous. The homogeneity test results are presented in table 6 and table 7.

Table 6. Pre-test homogeneity test results

		Levene Statistic	df1	df2	Sig.
Test results	Based on Mean	1.008	1	43	.321
	Based on Median	.818	1	43	.371

Table 7. Post-test homogeneity test results

		Levene Statistic	df1	df2	Sig.
Test results	Based on Mean	1.205	1	43	.278
	Based on Median	.911	1	43	.345

The homogeneity test was conducted using the Levene test. Based on the homogeneity test, the significance value based on mean pre-test and post-test is > 0.05. So it can be concluded that the pre-test and post-test data of the experimental class and control class have similar variances so that the data is homogeneous. Preliminary data analysis reveals that the pre-test data and post-test data, as well as the outcomes of the experimental and control classes are normal and homogeneous. Then it was continued with hypothesis testing using parametric data analysis techniques, namely the independent sample t-test and the N-gain test. Table 8 below shows the results of the independent sample t-test.

Table 8. Independent sample t-test results

Independent Sample T-Test	Equal variances assumed
T count	2.146
(sig) Two-Sided p	0.038
α	0.05
Conclusion	H_a is accepted

Based on the results of the independent sample t-test in table 8, it can be seen that the the significance value is 0,038 < 0,05, which means that there is a significant influence between the application of the Discovery Learning model with Geogebra-based Napier Bones media on students' division problem-solving ability. The use of the Discovery Learning model with Geogebra-based Napier Bones media and media has an impact on students' better abilities. This is in line with research by Andrillah, Sayidiman, dan Nurhaedah (2023) which shows that the use of Napier Bones media has an influence on students' learning. Research conducted by Rahma and Masniladevi (2020) also shows that there is an influence of the use of the Discovery Learning learning model on students' understanding of Mathematics.

The N-gain test was conducted to determine the average increase between the pre-test and post-test scores in the experimental class that applied the Discovery Learning model assisted by Geogebra-based Napier Bones media and the control class that applies

the conventional learning model. The N-gain test results for pre-test and post-test scores are presented in figure 2.

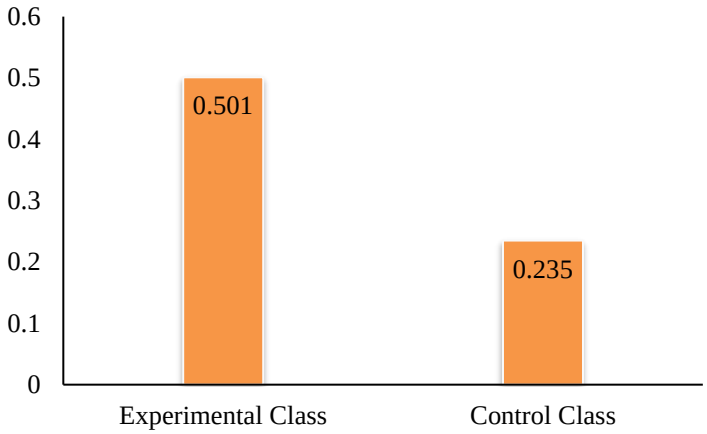

Figure 2. Result of n-gain test

The n-gain test results indicate that there is a difference between the increase in the value of the experimental class and the control class. According to figure 2, it can be seen that the problem-solving ability of students in the experimental class was higher than the control class. The N-gain value in the experimental class was 0.501 in the medium category and the N-gain value in the control class was 0.235 in the low category.

Table 9. Comparison of N-gain per indicator of problem solving ability

No	Indicator	N-gain	
		Experiment	Control
1	Understand the problem	0.54	0.21
2	Devise a plan	0.73	0.33
3	Carry out the plan	0.40	0.25
4	Look back	0.42	0.11

Based on N-gain data per indicator in table 9, it can be seen that the N-gain value of students' division problem-solving ability per indicator in the experimental class is higher than the control class. Based on the test result, it can be concluded that there is a higher average increase in students' problem-solving skills in the experimental class compared to the control class. The highest increase in both classes was in the indicator of developing problem-solving strategies.

Result of this research show that the division problem-solving ability of students in the experimental class that applied the Discovery Learning model assisted by Geogebra-based Napier Bones media was higher than the control class that applied the conventional learning model. This can be seen from the increase in the average score of students' problem-solving ability. The increase that occurred in the pre-test to post-test scores in the experimental class was 22.85, while in the control class, the increase that occurred in

the pre-test to post-test scores was 10.57. The increase in the pre-test and post-test average of fourth-grade students is presented in the following diagram:

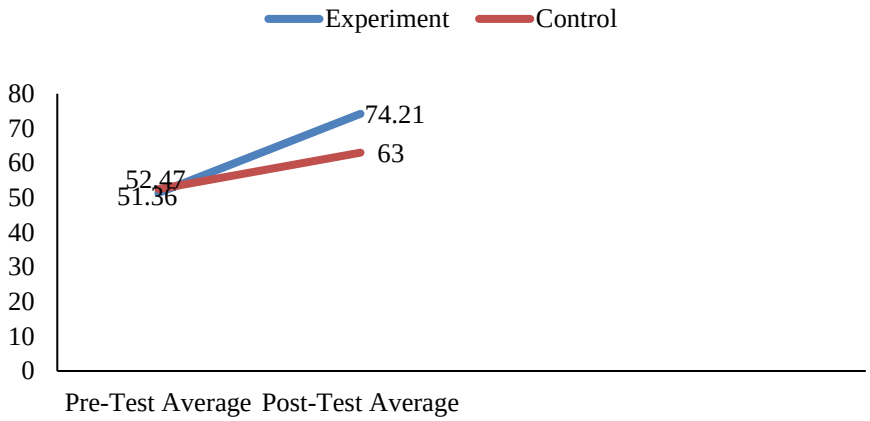

Figure 3. Increase in average pre-test and post-test scores

The results of the research show that the discovery learning model assisted by Geogebra-based Napier Bones media has an influence on the students' division problem-solving ability. This occurred because the application of the Discovery Learning model assisted by Geogebra-based Napier Bones media was based on the needs and cognitive development of students in learning. This development is in line with the concrete operational stage of fourth-grade students, who are starting to develop logical and systematic thinking ability. This is in accordance with the theory of constructivism, namely that students are given freedom to think and build knowledge that already exists in themselves. Jean Piaget, one of the constructivism figures argues that students acquire knowledge through actions that involve assimilation and accommodation according to the schemes they already have (Nurlina, Nurfadilah, & Bahri, 2021). Learning with the Discovery Learning model assisted by Geogebra-based Napier Bones media encourages students to build their knowledge and understanding during the learning process of division material. This is in line with research conducted by Pacelli et al., (2022). The research result shows that the use of Napier Bones media in learning helps students to determine the results of the operation correctly by connecting to previous knowledge. Research conducted by Murni et al., (2017) also shows that the mathematical problem solving ability of students taught using the Discovery Learning model assisted by Geogebra media was better than learning using conventional models.

The Discovery Learning steps are systematically organized and can guide students to discover concepts independently (Ellizar et al., 2018). In this research, students are also given the opportunity to engage in constructing their understanding of division material using Geogebra-based Napier Bones media. With Geogebra-based Napier Bones media, students are faced with learning something new and learning to understand the concept of division material. Students learn by connecting the concept of division with the concept of multiplication so that it is easier for students to understand, prepare solution strategies, and solve existing problems. In learning division operations material using this Napier Bones media, students contribute directly to the practice. Students apply this media by adjusting the indices so that the result of the problem is obtained. In long division, the

bones are used to determine the product of the divisor and each number in the quotient (Gardner, 2020).The application of the Discovery Learning model assisted by Geogebra-based Napier Bones media encourages students to apply the knowledge they have. This certainly develops problem-solving ability that will contribute to better learning outcomes.

The advantages of the Discovery Learning model are students learns to discover the concept of the material being studied, helping students become more adept at thinking independently and systematically, arousing students' enthusiasm from the process of conducting investigations to successfully gaining knowledge, and allowing students to learn according to their abilities in their way of learning (Inde et al., 2020). The advantage of Geogebra-based Napier Bones media is can make it easier for students to solve division problems. Napier Bones is used as a computational tool to simplify and speed up mathematical calculations (Kale et al., 2023). The use of Geogebra-based Napier Bones media can provide a visual experience through various interesting displays and manipulation of various objects intended to increase students' focus, learning effectiveness, and learning creativity.

▪ CONCLUSION

This research shows that there are differences in the division problem-solving abilities of students in the experimental class who apply to learn with the Discovery Learning model assisted by Geogebra-based Napier Bones media and students in the control class who apply to learn with conventional learning models. Based on the analysis data, the average score in the experimental class was higher than the average in the control class. The results of the independent sample t-test with a significance level of 5% obtained a value of < 0.05 which means that there is a significant influence on the application of the Discovery Learning model assisted by Geogebra-based Napier Bones media on students' division problem-solving ability. The N-gain test results also show that the problem-solving ability of students in the experimental class is higher than the control class. This happens because learning in the experimental class applying the Discovery Learning model assisted by Geogebra-based Napier Bones a media makes learning more meaningful and makes students more active in solving the problems given. Students also gain new experiences by learning to explore concepts with innovative models and media. The suggestion that can be given for this study is that the Discovery Learning model assisted by Geogebra-based Napier Bones media needs to be applied in the learning process as an effort to improve students' division problem-solving ability.

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