AL IBTIDA: JURNAL PENDIDIKAN GURU MI (2024) VOL 11 (1): 141- 152
DOI: http://dx.doi.org/10.24235/al.ibtida.snj.v11i1.18340

Al Ibtida: Jurnal Pendidikan Guru MI
ISSN: 2442-5133, e-ISSN: 2527-7227
Journal homepage: http://syekhnurjati.ac.id/jurnal/index.php/ibtida
Journal email: alibtida@syekhnurjati.ac.id

The Influence of Discovery Learning on the Mathematical Problem-Solving Ability of Elementary School Students

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Received: May 11th, 2024. Accepted: June 04th, 2024. Published: June 30th, 2024.

Abstract

This research aims to determine the influence of discovery learning on the mathematical problem-solving ability of elementary school students. The research used a quasi-experimental method with two classes, namely the experimental class and the control class. The population used in this research was 64 fifth-grade elementary school students. The sampling technique was random, while data collection was carried out using pretest and posttest instruments. The research results show that the influence of discovery learning in mathematics learning has a significant impact on improving students' problem-solving abilities. The discovery learning model with competitive and collaborative group learning concepts creates an interesting and motivating learning environment for students. By implementing discovery learning, students become more involved and enthusiastic in learning mathematics. They participate actively in group games that involve discussion, teamwork, and joint problem-solving.

Keywords: *discovery learning, problem solving abilities, elementary school students.*

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh discovery learning terhadap kemampuan pemecahan masalah matematika siswa sekolah dasar. Penelitian ini menggunakan metode quasi eksperimen dengan dua kelas, yaitu kelas eksperimen dan kelas kontrol. Populasi yang digunakan pada penelitian ini adalah siswa kelas V sekolah dasar yang berjumlah 60 orang. Teknik pengambilan sampel secara acak, sedangkan pengumpulan data dilakukan dengan menggunakan instrumen pretest dan posttest. Hasil penelitian menunjukkan bahwa pengaruh discovery learning dalam pembelajaran matematika memberikan dampak yang signifikan terhadap peningkatan kemampuan pemecahan masalah siswa. Model discovery learning dengan konsep pembelajaran kelompok kompetitif dan kolaboratif menciptakan lingkungan belajar yang menarik dan memotivasi siswa. Dengan menerapkan discovery learning, siswa menjadi lebih terlibat dan antusias dalam pembelajaran matematika. Mereka berpartisipasi aktif dalam permainan kelompok yang melibatkan diskusi, kerja sama tim, dan pemecahan masalah bersama.

Kata kunci: *pembelajaran discovery, kemampuan pemecahan masalah, siswa sekolah dasar.*

INTRODUCTION

During the learning process happen transformation knowledge, values and interactions between teachers and students. Interaction the allows teachers to recognize characteristics and potential student at a time student can develop and optimize the potential it has (Dewi & Alam, 2020; Keengwe, 2017). Therefore that 's education provide stimulus and effort together For build knowledge student . The low problem-solving ability of students in Indonesia is a significant issue in the world of education. Various international survey results and studies, such as the Programme for International Student Assessment (PISA) show that the mathematics ability of Indonesian students is often below the global average (Amini et al., 2022).

One of the main causes is the learning approach that still tends to be conventional, with a focus on memorizing formulas and solving procedural problems. This approach ignores the development of critical thinking skills, analysis, and application of concepts in real contexts, which are the core of solving mathematical problems. The ability to solve mathematical problems at the elementary school level is generally still relatively low. This can be seen from the results of studies and observations that show that many students have difficulty in applying mathematical concepts to solve problems that require in-depth analysis. Most students tend to only be able to answer routine or procedural questions, but experience obstacles when faced with non-routine questions that require conceptual understanding, creativity, and solution strategies.

This limitation is often caused by a learning approach that is still centered on the teacher, where students only passively receive information without much opportunity to explore problems independently. In addition, a less supportive learning environment, such as minimal group discussion activities or opportunities for critical thinking, also contributes to students' low problem-solving abilities (Halawa & Harefa, 2024). Another influencing factor is the lack of student motivation towards mathematics, because they often feel that this subject is difficult and boring. As a result, students not only have difficulty solving math problems at

school, but also fail to link mathematical concepts to real-life situations that require creative and logical solutions (Li & Wu, 2023).

In addition, a dense curriculum often makes teachers more focused on completing the syllabus rather than providing space for students to explore and explore mathematical problems independently (Amelia & Sukma, 2021). Another factor is the lack of training for teachers in adopting innovative learning methods, such as discovery learning or problem-based approaches. Many teachers are not used to encouraging students to discuss, collaborate, and develop creative problem-solving strategies (Parra Cordova & González Peña, 2020).

Not only that, the cultural factor of education also plays a role. In many cases, students tend to be afraid of making mistakes or feel pressured by high expectations, so they are reluctant to try new strategies in solving problems. This is exacerbated by the lack of interactive learning facilities and infrastructure, especially in remote areas. As a result, Indonesian students often fail to understand that mathematics is not only about numbers and operations, but also about logical thinking that can be applied in various real-life situations. Efforts to improve this problem-solving ability require comprehensive improvements, including teacher training, curriculum updates, and the development of interesting and relevant learning methods.

In the modern era of education, the role of the teacher is not Again limited give information to student. Teachers also play a role as facilitator encouraging learning student For involved active in the learning process (Keengwe, 2017; Tejasvee et al., 2021). Through interaction between teachers and students, teachers can more understand characteristics individual students, like intelligence, interests, style learning, and needs special. In context education , learning is factor key in increase results Study students (Munawir & Hasbi, 2021; Sanova et al., 2022; Tegeh & Budiartini, 2017).

One of the lessons that have role important in form insight and understanding student to the world around him is knowledge social mathematics own very important role in develop ability solve problems and thinking logical participant educate. Besides that 's math is tools and servants science, no only for himself Alone but also for sciences others, p the Good For importance theoretical and practical as application mathematics. Objective education mathematics is realize learning students at the highest level. But mostly student get difficulty moment Study mathematics student own different views; Student No OK own draft same understanding in learning mathematics when they are in elementary school, mathematics secondary, or tertiary (Khiat, 2012). *National Council for Excellence in Critical Thinking* define think as a disciplinary process intellectual from in a way active and skilled make concept, apply, analyze, synthesize, or evaluate the information produced from observation, experience reflection, reasoning, or communication as guide. Conceptualization think originate from Bloom's Taxonomy has been revised (Hauro et al., 2021). Way of thinking this even is prerequisite in the demanding global situation of the 21st century complexity and rapid change. One of the strategies used in skills the 21st century is solution problem. Ability solve problem is part from curriculum very important mathematics, because in the learning process as well as the solution, students possible can get it experience use existing knowledge and skills owned for implemented in solve the problem is not there's a routine (Prismana, Kusmayadi, & Pramudya, 2018). A number of skills the must owned in face challenge century to 21. With Thus, the essence of skills solution problem is we can think about method think,

analyze and understand so that we can take right decision and finish problem with more effective (Herman et al., 2024). Based on the results of the 2018 PISA study, the average mathematics score earned 379 with OECD average score 487 (Felianti et al., 2022a).

Discovery learning is an approach that emphasizes the active role of students in discovering concepts or principles of learning through direct experience and exploration. In the context of elementary school mathematics learning, discovery learning can have a significant impact on students' problem-solving abilities. With this approach, students are not only given formulas or procedures to memorize, but are invited to construct their own knowledge through investigations, conversations, and practical activities that stimulate critical and creative thinking.

One of the main strengths of discovery learning is the ability to encourage students to think independently in solving mathematical problems. When students are involved in exploration activities and discover for themselves the relationship between mathematical concepts, they can more easily understand and remember the concept, compared to if they are only given information directly. For example, in geometry learning, students can be asked to compose and draw various shapes, so that they understand more deeply about the properties of flat and spatial shapes. The process of finding and testing their own ideas helps them solve problems in a more creative and flexible way (Xue et al., 2015). In addition, discovery based learning also improves students' critical thinking skills. In dealing with mathematical problems, students are encouraged to ask questions, formulate hypotheses, conduct experiments, and draw conclusions based on the evidence they encounter. In this way, students learn how to identify problems, formulate problem-solving strategies, and evaluate their results (Kasa et al., 2024).

This process is very important in learning mathematics because it helps students develop the ability to solve problems effectively, not just memorize existing procedures. Active involvement in discovery learning also provides opportunities for students to work collaboratively with their peers, thus enriching their learning experience. Group discussions that occur during the solution-finding process often generate new ideas that can help them solve more complex problems (Boham & Domu, 2021). This not only improves their mathematical understanding but also important social and communication skills.

Overall, discovery learning is a very effective approach in improving elementary school students' mathematical problem-solving abilities, because it allows them to build knowledge through direct experience, critical thinking, and collaboration with their peers. This approach encourages students to become independent and creative problem solvers in mathematics.The average mathematics score of Indonesian students is 379, far below the OECD average. NCSM (*National Council of Supervisors of Mathematics*) states that learning to solve problems is the number one reason children should learn mathematics (Felianti et al., 2022b). This is in line with Ministry of Education and Culture Regulation no. 37 of 2018 contains a statement that the Ministry of Education and Culture oblige participant educate own ability solution problem as basic competencies. Previous research conducted by Ariyanto & Santoso (2017) focused on the application of problem-based learning and discovery learning on students' mathematical problem-posing abilities. The results of the study showed that problem-based learning and discovery learning had a significant effect on students' mathematical problem-posing abilities.

This study aims to know the influence application of the discovery learning model to improve students' mathematical problem-solving ability. This method stands out Because the approach is not only interactive but also collaborative and competitive (Matitaputty et al., 2023). In alignment with various methods of abundant learning, Discovery learning brings the potential to create a landscape triggering learning involvement in active students, spurring spirit learning, and shaping skills social. The research result can produce more insight deep about the effectiveness of deep discovery learning to increase the understanding of the students' mathematics, as well as identify the possibility of repair method teaching that can be implemented by teachers and institutions of education.

METHODS

The research conducted utilized a quasi-experimental method to investigate the impact of discovery learning as a teaching approach. This method was chosen because it allows researchers to explore causal relationships between the learning method and the students' problem-solving abilities in a structured yet flexible manner. By implementing a quasi-experimental design, the study was able to examine the effects of the intervention in a real-world classroom setting without random assignment, making it feasible for educational environments where fully randomized experiments are often impractical.

The specific design used in this study was the non-equivalent control group design, which involved two groups: an experimental group and a control group. The experimental group consisted of students who were taught mathematics using the discovery learning approach, while the control group received instruction through conventional teaching methods. This design enabled the researcher to compare the mathematical problem-solving abilities of the two groups, thereby evaluating the effectiveness of discovery learning. The non-equivalent control group design is particularly suitable for educational research where randomization is not possible due to ethical or logistical constraints, as it allows for comparisons between naturally formed groups.

Data collection was conducted using pre-tests and post-tests to measure the students' problem-solving abilities before and after the intervention. The pre-test was administered to both groups to assess their initial mathematical problem-solving skills and ensure a baseline comparison. Following the intervention, a post-test was given to evaluate the improvement in their problem-solving abilities. The difference in scores between the pre-test and post-test provided a measure of the effectiveness of the discovery learning approach. By comparing the results of the experimental and control groups, the study aimed to determine whether discovery learning had a significant impact on students' problem-solving performance.

The discovery learning approach implemented in the study encouraged students to actively explore, analyze, and solve mathematical problems independently or collaboratively. This method emphasizes critical thinking, creativity, and student autonomy, aligning with contemporary educational theories that advocate for student-centered learning. By contrast, the control group was taught using traditional methods, which typically involve teacher-centered instruction and rote learning. The study's design allowed for a clear distinction between the two instructional approaches, making it possible to isolate the impact of discovery learning on problem-solving skills.

To ensure the validity and reliability of the research, appropriate statistical analyses were applied to the collected data. Descriptive statistics were used to summarize the pre-test and post-test results, while inferential statistics, such as t-tests or ANOVA, were employed to determine whether the differences between the groups were statistically significant. These analyses provided a robust foundation for drawing conclusions about the effectiveness of discovery learning in enhancing mathematical problem-solving abilities.

Overall, the quasi-experimental method, particularly the non-equivalent control group design, was a suitable choice for this study as it allowed for the practical examination of the impact of discovery learning in a real-world classroom setting. By incorporating pre-tests, post-tests, and rigorous data analysis, the study ensured that its findings were both reliable and meaningful, contributing valuable insights into the effectiveness of discovery learning in elementary mathematics education.

RESULTS AND DISCUSSION

The implementation of the research during six meetings was carried out systematically using the discovery learning method in the experimental class and the flipped classroom in the control class, each designed to improve students' problem-solving abilities. In the experimental class, the discovery learning method was applied with the stages of exploration, problem identification, data collection, analysis, and reflection. In the first meeting, students were introduced to the basic concepts of problem solving through exploration activities. The teacher provided interesting mathematical problem situations, such as contextual case studies, to stimulate students' curiosity. In this stage, students worked in groups to identify what was known, what to look for, and how to solve it (Voskoglou & Salem, 2020).

In the second to fifth meetings, students were given various more complex mathematical problems. They were directed to collect data, try various solution strategies, and discuss in groups to find the best solution. The teacher acted as a facilitator, providing minimal guidance to ensure students stayed on the right track without disrupting their discovery process. This activity encouraged collaboration, critical thinking, and student creativity. At the end of each meeting, students were invited to reflect on the process and results they achieved, so that they could learn from their mistakes and improve their solution strategies (Hake, 1998).

In the control class with the Flipped Classroom model, students were given learning materials in the form of videos or modules before the meeting began (Ríos-Lozada et al., 2022). In the first meeting, the teacher explained how to use the learning materials effectively at home. The second to fifth meetings were used for group discussions and solving problem-solving questions in class. In these discussions, the teacher helped answer students' questions and directed them to understand more difficult material. Class activities focused on reinforcing concepts that had been learned at home and their application in problem-based questions.

In the sixth meeting, a final test (posttest) was conducted in both classes to evaluate students' problem-solving abilities. The results showed that the experimental class with Discovery Learning experienced a significant increase in problem-solving abilities compared to the control class. Students in the experimental class showed better analysis and synthesis skills, and were more confident in solving non-routine problems. This confirms that active

discovery-based learning is more effective in encouraging deep understanding and mastery of problem-solving strategies than flipped classroom-based learning (Cleynen et al., 2020).

Implementation study it's two months with time of the month January 2024 until February 2024, there will be 6 meetings. Two months time the aim for analyze and describe in a way comprehensive about achievement ability solution problem with students who earn discovery learning for elementary school students. Ability problems you have child Elementary school already visible, however Not yet impact in life daily. Dreyfuss and Eisenberg, 1996, Goos, 2002, Teong, 2003 confirm Schoenfeld's findings. Student conclude that solution strong problem capable represent situation problem in various form: sketch, graph, table, or example numeric. During the plan episode solution, solution strong problem often use more formal representations and algorithms. Solution strong problems are also flexible in approach them and usually monitor the solution process they. Beginners on the other hand spend Lots time do procedures (eg calculation) without question adequacy plan solution. Student use up A little time For read text questions and thinking suitability their procedures use. Opinion Erhardt & Lim (2020) that solution problem is also a form interpretation a situation in a way usual systematic involve a number of cycle repeated for a expression, test, and revise interpretation mathematics, integrating, modifying and revising draft mathematics from various source other. Solution problem is a thought process student start confronted with problem until with resolved the problem. Based on a number of opinion expert related solution problem, then, there is summary several solution models problem as following (Rizky & Surya, 2017)

Table 1. Stages solution problem according to a number of source

Polya (1981),	**Krulick & Rudnick (1996)**	**(NCTM, 2000)**
1) Understand problem; 2) Planning; 3) Carry out plan; 4) Confirmation answer (MZ Aydoğdu , 2014b)	1) Reading and Thinking; 2) Analyzing and planning; 3) Developing strategy; 4) Confirmation Answer.	1) Build knowledge new through solution problem, 2) Solve problem with involve mathematics in context other, 3) Apply various the right strategy for solve problems and reflect on inner processes solution problem mathematics.

Organized problems with Good will makes it easier in strategy preparation as solution. Based on (NCTM, 2000b), there is a number of indicator solution problem that is build knowledge new through solution problem, solve problem with involve mathematics in context else, apply various the right strategy for solve problems and reflect on inner processes solution problem mathematics. As for the breakdown indicators problem in use refers to stages ability solution problems on Polya 2012 as following:

Table 2. Stages Ability Solution Problem

Stages Solution Problem	**Indicators**	**Descriptor**
Understand problem	1. Write what has known. 2. Write What will asked. 3. Make sketch description from problem.	Participant educate capable understand problem. So that participant educate capable analyze and present with own writing style.

Make a plan (plan Solution Problem)	1. Able to use appropriate mathematical models as appropriate For solve problem. 2. Able to use known information For adjust information new. 3. Type stage error This No There is error.	Participant educate capable designing a completion problem with The method poured himself in table form or existing image in thought or the idea.
Solve problem (execute plan solution)	1. Able to substitute known value in the mathematical model. 2. No capable do calculation solution problem with appropriate. 3. Type stage error This is error operation.	Participant educate capable implement all existing plans He plan previously. So that implementation planning the capable solve problems and as form follow carry on the solution.
Inspect return	Check whether the results obtained are in accordance with the provisions and there is no contradiction with what was asked. There are four important things that can be used as guidelines in carrying out this step, namely: a) Match the results obtained with the things asked. b) Interpret the answers obtained. c) Identify whether there are other ways to get a solution to the problem. d) Identify whether there are other answers or results that are satisfactory.	Participant check return what has implemented, participants educate compare and think repeat to solution problem with what 's there in thoughts and experiences previously.

Indicators that can prove whether somebody participant educate mathematics already have a master strategy ability solution problem, p the visible in activity through: (1) Practicing as well as adapt various approach and strategies for solving them problems, (2) Tidying up problems that arise in mathematics or in other related conditions mathematics, (3) Making outlook the latest mathematics through road go out problems, and (4) Monitoring as well as reflect in method road go out problem mathematical (Sriwahyuni & Maryati, 2022).

Data about achievement ability solution problem through test ability solution problem to student class V in academic 2023-2024 in one Majalengka Region Elementary School. Before test given to students, questions are validated moreover first by experts. All validators rate that ability solution problem Already fulfil validity face and validity contents. the Q-Cohran test to evaluation. Besides That's a matter of trial and error ability solution problem as much six question moreover formerly tested on students class VI who have obtain material blocks and cubes. Trials the done for know validity and reliability. Question ability solution problem consists from six question. After done trials obtained $r_{calculated}$ results > r_{table} (0.05.31) = 0.3440. Table under This is results acquisition r value $_{count}$.

Table 3.The Ability Solution Problem Mathematics Results $_{Calculated}$ r value

Question No.	Validity		Decision
	r_{count}	Conclusion	
1	0.393	Valid	Used
2	0.524	Valid	Used
3	0.391	Valid	Used
4	0.469	Valid	Used
5	0.570	Valid	Used
6	0.569	Valid	Used

Validity item question No. 1 through with 6 consecutive r1= 0.393, r2= 0.524 r3= 0.391 r4= 0.469 r5= 0.5701 r6= 0.569, based on results calculation mark validity each item question can interpreted that all item valid question. Through research that has been implemented that is there is result, that discovery learning is influential in a way significant to achievement ability solution problem mathematical. Formally, a hypothesis the statistics (H0) and hypothesis research (H1) as following:

$$H_0 : \mu_1 = \mu_2$$
$$H_1 : \mu_1 = \mu_2$$

For test hypothesis the used related SPSS software assistance with the Paired Samples t test and its output is as following :

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	skor_prestes_DC	61.67	30	7.581	1.384
	skor_postes_DC	80.83	30	7.666	1.400

Paired Samples Correlations

		N	Correlation	Significance One-Sided p	Significance Two-Sided p
Pair 1	skor_prestes_DC & skor_postes_DC	30	-.040	.418	.836

Paired Samples Test

		Paired Differences					t	df	Significance One-Sided p	Significance Two-Sided p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper				
Pair 1	skor_prestes_DC - skor_postes_DC	-19.167	10.992	2.007	-23.271	-15.062	-9.550	29	<,001	<,001

Paired Samples Effect Sizes

			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	95% Confidence Interval Upper
Pair 1	skor_prestes_DC - skor_postes_DC	Cohen's d	10.992	-1.744	-2.310	-1.165
		Hedges' correction	11.287	-1.698	-2.249	-1.135

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference.
Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

From the output above obtained there is notes important following : From paired correlation (0.836) and value This noticed No there is correlation significant positive between score pretest and score mathematical problem solving skills posttest . From the Pair sample test it turns out known sig value <0.001 and value more small of 0.05 (α) which means that H_0 rejected , and can concluded that learning with DC effect in a way significant to KPM achievement . From Paired samples effect sizes are known the point estimate value is -1.744 or -1.698, and second mark This more small of 0.2 which means that big influence learning

with DC in the low category . Research result This show success deep discovery learning achievement ability solution problem mathematics. That matter can proven from exists influence in a way significant to achievement ability solution problem mathematics (Pebriyanti & Siagian, 2024).

The influence of Discovery Learning in ability solution problem mathematics can visible to the students involved active in learning (Harianti, 2018) . student will do discussion in a way group with student others (Prasrihamni et al., 2022). pushing process student in ability solution problem mathematics that is Work with team (Herman, 2007). Novianty et al (2023) conducted a study on undergraduate mathematics education study program students in Central Java. The study found no significant difference in mathematical problem-solving, critical thinking skills, and resilience achievements, except for high early mathematical abilities categories. However, there was an increase in critical thinking skills in high, medium, and overall early mathematical abilities categories, and interaction between learning based problems and discovery learning was found.

CONCLUSION

Discovery learning enables students to actively engage with the learning material, fostering a deeper understanding of mathematical concepts. This active engagement contrasts with traditional teacher-centered approaches, where students often rely on memorization and passive learning. The findings of this study support the idea that discovery learning provides a conducive environment for students to develop higher-order thinking skills and gain confidence in solving mathematical problems. These skills are particularly important in elementary education, as they lay the foundation for more complex mathematical reasoning in higher grades. The success of discovery learning in this study underscores the importance of integrating innovative and student-centered teaching methods in the classroom. Teachers play a critical role in facilitating this approach by designing meaningful tasks, guiding students through the discovery process, and encouraging collaborative learning. By doing so, they can help students build a strong mathematical foundation while fostering a positive attitude toward problem-solving.

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