Indonesian Journal of Teaching and Learning

e-ISSN 2964-1446, p-ISSN 2962-0570
https://journals.eduped.org/index.php/intel

The Impact of the Discovery Learning Model on Mathematical Communication Skills and Study Habits of Junior High School Students

Iva Faridayanti[1], Anton Nasrullah[2*], Amat Hidayat[3], Nia Kania[4]

[1,2,3]Universitas Bina Bangsa, Indonesia
[4]Universitas Majalengka, Indonesia

Corresponding author: anton.nasrullah@binabangsa.ac.id

Article Info

Revised November 17, 2024
Accepted December 12, 2024

Abstract

This study investigates the impact of the discovery learning model on students' mathematical communication skills and learning habits in junior high school. Motivated by low mathematical communication abilities and limited use of varied teaching methods. Using an experimental design (One Group post-test design), 26 seventh-grade students from SMP Negeri 2 Cinangka were selected via simple random sampling. Data were collected through a mathematical communication skills test (5 questions) and a learning habits questionnaire. Prerequisite tests (normality and homogeneity) and hypothesis testing (Independent Sample t-test) were conducted for analysis. Results revealed that the experimental class achieved an average mathematical communication score of 66.83, compared to 60.00 in the control class. Hypothesis testing showed a significant effect ($p = 0.04 < \alpha = 0.05$). Additionally, the learning habits questionnaire indicated a 65% positive response. The findings demonstrate that the discovery learning model significantly enhances students' mathematical communication skills and fosters strong study habits. This study highlights the effectiveness of discovery learning in improving educational outcomes and suggests its potential for broader application in mathematics education.

Keywords: Discovery learning model; Mathematical communication skills; Study habits; Junior high school students.

How to Cite: Faridayanti, I., Nasrullah, A., Hidayat, A., and Kania, N. (2025). The Impact of the Discovery Learning Model on Mathematical Communication Skills and Study Habits of Junior High School Students. *Indonesian Journal of Teaching and Learning, 4*(1) 16-29. doi: https://doi.org/10.56855/intel.v4i1.1330

1. Introduction

Education is crucial for human development and societal progress. It enhances critical thinking, knowledge acquisition, and personal growth, enabling individuals to better understand their environment and rights. (Shavkidinova et al., 2023). Education develops innate potential, both physically and spiritually, aligning with societal and cultural values (Zuhdi et al., 2021). It satisfies human curiosity, cultivates creativity, broadens knowledge, and fosters responsible behavior (Wahidah Z & Adhar, 2024). Moreover, education is essential for leading a successful and meaningful life, helping individuals distinguish between right and wrong, and awakening them from ignorance (Haderani, 2018). It provides practical knowledge and self-awareness, giving people an identity in society. Education is fundamental for personal and national development, improving job opportunities and contributing to overall quality of life.

Mathematics is widely recognized as a crucial subject in education, yet many students find it difficult and uninteresting (Angraini et al., 2024). Factors contributing to this perception include challenges in remembering previous content, rapid forgetting, and difficulty understanding concepts (Weldon et al., 2021). Teachers attribute students' struggles to lack of effort, prerequisites, and motivation (Eriana et al., 2023). To address these issues, innovative approaches are being explored, such as Android-based educational quiz applications for junior high school students (Muryanti, 2023). Cultivating interest in mathematics is crucial, as it directly affects students' initiative and learning efficiency (Parindang et al., 2024). Educators are encouraged to make mathematics more engaging and relevant to daily life, emphasizing its practical applications and importance in understanding the world. By focusing on interest cultivation and innovative teaching methods, educators can potentially improve students' attitudes toward mathematics.

Mathematical communication skills are crucial in learning and applying mathematics effectively. These skills involve using mathematics as a language to express ideas, thoughts, and feelings, as well as a tool for interaction (Alsina et al., 2024). Proficiency in mathematical language enables students to better understand concepts, especially in areas like algebra, and can increase their interest in learning (Putri et al., 2024). However, research indicates that students' mathematical communication abilities are often underdeveloped, particularly in connecting real objects to mathematical ideas and expressing daily events using mathematical symbols (Loska et al., 2024). Developing these skills is essential as they allow students to organize their mathematical thinking both orally and in writing, respond appropriately to others, and adapt more easily in various communities. Therefore, teachers play a vital role in fostering students' mathematical communication abilities to enhance their overall mathematical understanding and application.

Mathematical communication skills (MCS) are crucial for students' problem-solving abilities and interaction with teachers (Brumbaugh et al., 2013). Studies have shown that students face various challenges in MCS, including difficulties in explaining ideas orally or in writing, using mathematical notations, and evaluating problems (Hasan, 2020). Research indicates that MCS levels vary based on students' mathematical abilities, with higher-ability students generally demonstrating better communication skills (Susilo et al., 2023). However, even among eighth-grade students, only a small proportion can effectively express, interpret, and use mathematical ideas and symbols (Maulyda et al., 2020). Common difficulties include concluding, interpreting mathematical ideas, performing calculations, and composing explanatory statements (Pratiwi & Rianto, 2023). To address these issues, teachers should focus on developing students' MCS through creative and innovative learning activities that target specific areas of difficulty.

Research indicates that students often struggle with mathematical communication skills, particularly when solving story problems. Many students have difficulty interpreting questions into mathematical forms, using appropriate symbols, and explaining their answers clearly (Samawati, 2021). A study found that only 21.43% of students demonstrated high writing and mathematical communication skills, while 64.29% showed moderate skills, and 14.29% exhibited low skills (Nur Azizah et al., 2020). Factors affecting these skills include students' ability to interpret problems and their understanding of the material (Turmuzi et al., 2021). Another study revealed that students' mathematical communication skills align with their problem-solving abilities and are influenced by their overall mathematical ability (Sari & Aripin, 2018). Research also shows that students often struggle with explaining problem ideas orally or in writing (Purnamasari & Afriansyah, 2021). Additionally, students' verbal communication skills tend to be better than their written skills when solving word problems (Maulyda et al., 2020).

Mathematical communication skills (MCS) are crucial for students' success in mathematics and other subjects (Siregar, 2018). MCS involves the ability to express, interpret, and assess mathematical ideas using appropriate language and symbols (Rohid et al., 2019). Developing these skills allows students to organize their mathematical thinking both orally and in writing (Umar, 2012). However, research indicates that students' MCS are often underdeveloped, with only a minority demonstrating proficiency in expressing and interpreting mathematical ideas (Kania & Juandi, 2023). To address this, teachers should design creative and innovative learning activities that stimulate MCS development (Fitriani et al., 2021). Building a mathematical community through open communication in the classroom is essential for fostering these skills (Mera et al., 2022). Ultimately, strong MCS contributes to students' overall academic success and adaptability in social interactions.

Study habits significantly influence students' academic performance and can be categorized as good or bad (Solihatun, 2019). Good habits include maintaining consistent study schedules, effective note-taking, and regular review of materials, while bad habits involve procrastination and poor time management (Lillah & Ilyas, 2020). Research indicates that a majority of students exhibit good study habits, with 54.29%

falling into the "good" category and 36.19% in the "good enough" category (Aulia & Megawanti, 2024). These habits can impact various assessments, from daily tests to major exams (Kania et al., 2024). In full-day school settings, students demonstrate varying levels of proficiency across different aspects of study habits, with reading and note-taking being particularly strong (54.0% in the very good category) (Lillah & Ilyas, 2020). Understanding students' study habits is crucial for educators in developing targeted guidance and counseling services to support and improve learning outcomes.

The study habits of grade VII students at SMP Negeri 2 Cinangka remain inconsistent, as reported by one of the teachers. For instance, students often fail to take notes during lessons, do not review materials at home after receiving low grades, and neglect to prepare for upcoming lessons by reading textbooks the night before. These behaviors highlight the need for effective strategies to improve both mathematical communication skills and study habits. Implementing an appropriate and engaging learning model is crucial to encourage students to actively practice and develop their communication abilities (Hamzah et al., 2024). A shift from teacher-centered approaches to student-centered models is essential, as it fosters active participation and allows students to express their ideas, thereby achieving learning objectives (Roessingh & Chambers, 2011). However, the current lack of varied teaching methods has resulted in limited student engagement. One promising model that could positively influence mathematical communication skills is discovery learning, which emphasizes active exploration and problem-solving, potentially addressing these challenges effectively.

The research papers collectively indicate that the discovery learning model has a positive impact on students' mathematical communication skills. Sab'ati et al. (2018) Found that students taught using discovery learning exhibited higher mathematical communication skills compared to those in conventional learning settings, although the model was not considered fully effective. Prasetyowati et al. (2022) reported significant improvements in Year 7 students' mathematical communication abilities through the application of the discovery learning model. Limbangan et al. (2022) further supported this by demonstrating that discovery learning not only enhances mathematical communication skills but also increases student learning activity in junior high school. Similarly, Pratiwi et al. (2024) observed notable improvements in students' mathematical communication skills, particularly in geometric transformation material, when using discovery learning. The effectiveness of this model is attributed to its structured approach, which includes stages such as stimulation, problem statement, data collection, data processing, and verification (Maulida et al., 2018). These stages encourage students to actively express their ideas and engage in the learning process, fostering both communication skills and deeper understanding. Overall, the findings suggest that discovery learning is a promising approach for enhancing mathematical communication skills in students.

Based on the findings of previous studies, the researcher is motivated to explore the use of the discovery learning model to enhance students' mathematical communication skills and learning habits. As highlighted by Zulkarnain (2021), discovery learning is an instructional approach where students are not provided with complete information but instead actively engage in discovering principles through

exploration. This model encourages independent learning and helps students develop a deeper understanding of concepts, enabling them to solve mathematical problems more effectively. Given its potential benefits, the researcher aims to investigate the impact of the discovery learning model on students' mathematical communication skills and learning habits at SMP Negeri 2 Cinangka. This study seeks to address the need for more varied and student-centered teaching methods, ultimately contributing to improved learning outcomes and student engagement.

2. Methods

Quasi-experimental research is a quantitative method commonly used in education and social sciences, particularly when true experiments are impractical (Park et al., 2020). It typically involves two groups: an experimental group and a control group (Syariful Akbar et al., 2022). This design allows researchers to examine the effects of interventions without full randomization or control (Kotronoulas & Papadopoulou, 2023). Quasi-experiments often employ pre-post-test approaches and are frequently used in sustainability and consumer behavior studies (Mahajan et al., 2023). In mathematics education, quasi-experiments are particularly useful for assessing problem-solving abilities (Akbar et al., 2022). While quasi-experimental research lacks the full control of true experiments, it remains a valuable tool for researchers, especially when ethical or practical constraints prevent randomized controlled trials. This method helps researchers control for external variables that may affect outcomes.

2.1. Time and Place of Research

This research was conducted from April to July in the Even Semester of the 2021/2022 academic year. This research took place at SMP Negeri 2 Cinangka, which is located at Jln. Palka Cibawang, Kubang Baros Village, Cinangka District, Serang Regency, Banten Province, Postal Code 42167.

2.2. Population and Sample

In this study, the population consists of all grade VII students at SMP Negeri 2 Cinangka. The sample, on the other hand, represents a portion of the population that retains its characteristics and is selected for investigation. Sampling in this research was conducted using a simple random sampling technique, where subjects were chosen randomly from the population without considering any stratification. From the two available grade VII classes at SMP Negeri 2 Cinangka, the researcher designated one class as the experimental group (VII A) and the other as the control group (VII B). The experimental class was taught using the discovery learning model, while the control class was taught using the conventional learning model. This approach allows for a comparative analysis of the effects of the discovery learning model on students' mathematical communication skills and learning habits.

2.3. Research Instruments

A research instrument is a tool used to collect data or measure objects from a research variable (Yusup, 2018). The instruments used in this study were tests and non-tests. The test questions used in this study were in the form of descriptions

2.4. Average Difference Test

Hypothesis testing in this study was carried out using a t-test (average difference test). How to calculate it using the independent samples t-test SPSS program. Hypothesis formulation for the t-test:

Ho = There is no difference in the average learning outcomes of students in the experimental and control classes
Ha = There is a difference in the average learning outcomes of students in the experimental and control classes.

The significance level used is 5% (α = 0.05). With the following testing criteria:

If sig <, then Ho is rejected
If sig > then Ho is accepted

The Likert scale is used to measure the level of user satisfaction. The Likert scale test in this study aims to determine the results of the questionnaire on the learning habits of grade VII students at SMP Negeri 2 Cinangka.

$$\text{Likert scale formula} = T \times Pn$$

Description:
T: Total number of respondents who chose
Pn: Choice of Likert score numbers

To obtain interpretation results, the highest score (*X*) and the lowest score (*Y*) for the assessment item must first be known with the following formula:

Y = highest Likert score x number of respondents
X = lowest Likert score x number of respondents

Table 1 - Likert Scale Interpretation Criteria

Percentage Assessment (%)	Criteria
0-20	Very Weak
21-40	Weak
41-60	Fair
61-80	Strong
81-100	Very Strong

(Source: Banar and Martiani, 2020)

3. Results and Discussion

3.1. Results

The normality test in this study was used to determine the distribution of data on the results of the instrument between the experimental class and the control class both before and after treatment, whether the data was normally distributed or not. This test was carried out using SPSS Software. The normality test of the student post-test data used Shapiro-wilk, the following are the results of the data obtained:

Table 2 - Normality Test

		Sig.
Shapiro-Wilk	df	23
	Experiment Posttest	0.353
	Control Posttest	0.013

Based on the output above, it is known that the significance value (Sig) for all post-test learning outcomes of the experimental class is 0.200, the post-test of the control class is 0.024 in the Shapiro-Wilk test> 0.05, so it can be concluded that the data of the experimental and control classes are normally distributed.

The homogeneity test aims to determine whether a variant (diversity) of data from two or more is homogeneous (same) or heterogeneous (not the same). The results of the homogeneity test are as follows:

Table 3 - Homogeneity Test Results

Levene Statistic	df1	df2	Sig.
0. 146	1	44	0.704

Based on the output above, it is known that the significance value (Sig) is 0.704 > 0.05, so it can be concluded that the variance of the pretest data for the experimental class and the control class is the same or homogeneous.

Based on the results of the prerequisite test of data analysis from two groups, namely the experimental class using the discovery learning model and the control class using the conventional learning model, it is known that both classes have normally distributed samples, and both classes are homogeneous. So that by fulfilling the prerequisite test, the hypothesis test can be carried out.

After conducting the Independent Sample t-test on the post-test of mathematics learning outcomes, the following results were obtained:

Table 4 - Results of Independent Sample t-Test of Mathematical Communication Ability

	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	0.146	0.704	2.073	44	0.044
Equal variances not assumed			2.073	43.964	0.044

Based on the output results of the independent sample t-test equal variance assumed, the Sig (2-tailed) value was obtained at 0.044 <0.05, which means that there is a difference in the average mathematical communication skills of students in the experimental class and the control class. So, it can be concluded that there is an influence

of learning using the Discovery Learning model on students' mathematical communication skills.

After knowing the results of the problem-solving test given, the next step is to know the questionnaire test on students' learning habits. This questionnaire test uses a Likert scale assisted by Microsoft Excel 2010 with the following results:

Table 5 - Results of Likert Scale Test of Experimental Class

Aspect	Score Percentage (%)	Average Criteria
How to follow the learning	68	Strong
How to study in groups	57	Strong enough
How to study individually	60	Strong enough
Learning tools	79	Strong
Making a schedule and	76	Strong
its implementation	65	Strong
Reading and taking notes	64	Strong
Repeating learning materials	61	Strong
Study time	59%	Strong enough
Carry out a task	61%	Strong

Based on the results of the Likert Scale Test calculations it shows that the ten aspects of students' learning habits have a percentage value of 65%, with this percentage value indicating that there are strong learning habits in students in experimental classes using the discovery learning model.

3.2. Discussion

Research consistently demonstrates that the Discovery Learning model significantly enhances students' mathematical communication skills compared to conventional approaches (Dani & Zubaidah, 2020; Nurhasanah et al., 2018). This model enables students to express ideas effectively, both orally and in writing (Pratiwi et al., 2024) . It improves students' ability to present mathematical information, compose arguments, and analyze mathematical thinking. The Discovery Learning approach not only enhances communication skills but also positively impacts mathematical disposition and self-esteem (Dina et al., 2018). Furthermore, it facilitates better retention of learned material, integration of self-concept, and long-lasting knowledge transfer (Rohyana et al., 2024). These findings underscore the importance of implementing Discovery Learning in mathematics education to foster critical 21st-century skills and improve overall mathematical competence.

Research indicates that the Discovery Learning model positively influences student learning outcomes across various educational levels. Multiple studies have shown that this approach leads to higher academic achievement compared to conventional methods

(Puspitasari & Nurhayati, 2019). The model emphasizes active student participation, encouraging learners to discover information independently and develop critical thinking skills (Kania et al., 2023). Implementation of Discovery Learning has resulted in increased student engagement and improved learning effectiveness (Fajri, 2019). In one study, the experimental group using Discovery Learning achieved a 93.33% completion rate compared to 60% in the control group (Zendrato et al., 2024). Additionally, students have responded positively to this teaching approach, with over 90% rating it as good or very good. These findings suggest that Discovery Learning is an effective pedagogical strategy for enhancing student performance and engagement across different subjects and grade levels.

This meta-analysis examines the effectiveness of various learning models on students' mathematical thinking and communication skills. Discovery Learning was found to be the most effective model for enhancing critical thinking skills in elementary students (Mahmudah, 2020). When combined with GeoGebra, Discovery Learning showed a high positive effect on students' mathematical critical thinking abilities (Anjarwati et al., 2022). For secondary school students, Discovery Learning implementation resulted in good mathematical communication skills (Limbangan et al., 2022). However, a comparative study between Problem-Based Learning (PBL) and Discovery Learning revealed that PBL had a more significant impact on improving elementary students' critical thinking skills (Aprilianingrum & Wardani, 2021). These findings suggest that while Discovery Learning is generally effective, its impact may vary depending on the educational level, context, and specific skills being targeted. Further research is needed to determine the most suitable learning model for different educational settings and student backgrounds.

The results of a questionnaire using a Likert Scale show that the study habits of students in the experimental class using the Discovery Learning model have an average percentage of 65%, indicating that students' study habits are generally relatively strong. This is a supporting factor in the successful implementation of this learning model. Students show a strong habit of participating in learning (68%), which may be influenced by the interactive and participatory nature of the Discovery Learning model. However, when it comes to group learning (57%), students still have room to improve their collaboration skills. Meanwhile, individual study habits (60%) and study time management (59%) fall into the "fairly strong" category, indicating that students are able to manage the learning process independently although they still need to improve discipline and consistency. On the other hand, the use of learning tools (79%) and the ability to create schedules and implement them (76%) recorded the highest percentages, indicating that students are very used to utilizing resources and have good time management skills. The habits of reading and taking notes (64%), repeating learning material (61%), and carrying out assignments (61%) are also included in the strong category, which shows that students understand the importance of these activities in supporting understanding and responsibility for learning.

This collection of papers explores the application of constructivist learning theory and discovery learning in education. Constructivism emphasizes active learning through students' own knowledge construction (Angraini et al., 2024). The theory shifts

classroom orientation from teacher-centered to student-centered approaches, positioning students as active participants rather than passive recipients of information (Huliatunisa et al., 2022). Discovery learning, which aligns with constructivist principles, encourages students to engage in observation, experimentation, and scientific inquiry to draw their own conclusions (Suryana et al., 2022). These approaches are particularly relevant in primary education, where thematic learning based on constructivist philosophy allows students to form knowledge through direct experiences Implementation of these methods can lead to improved learning outcomes and increased student achievement. The integration of constructivist theory and guided inquiry models offers practical implications for enhancing educational effectiveness (Pramana et al., 2024).

Although the questionnaire results indicated strong study habits, this study had several limitations. First, the questionnaire was only carried out in the experimental class, so there was no comparison with the control class. Second, the questionnaire data is self-reported, which may contain subjectivity bias. For further research, it is recommended to use triangulation methods, such as observation or interviews, to obtain more comprehensive data. Thus, it can be concluded that students' learning habits in experimental classes that use the Discovery Learning model are at a strong level, which contributes to learning success. However, there is still room for improvement, especially in aspects of collaboration and time management, which could be the focus of future interventions.

4. Conclusions

Based on the research that has been conducted, it can be concluded that: (1) There is an influence of the use of the discovery learning model on the mathematical communication skills of class VII students at SMP Negeri 2 Cinangka. This is based on the data from the hypothesis test results through the Independent Sample t-test with a value of 0.04, which means a significance value <0.05, which means that students' mathematical communication skills using the discovery learning model are better than conventional learning; (2) There are learning habits of students in the experimental class as seen from the average percentage results of 65% which states that the ten aspects of learning habits are strong or well owned by class VII students at SMP Negeri 2 Cinangka.

Conflict of Interest

The authors declare no conflicts of interest.

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