Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES
P-ISSN 2581-1657
E-ISSN 2581-2203

Implementation of the Discovery Learning (DL) Model to Enhance the Mathematical Communication Skills

Aulya Revicka Dwi Syadevi, Susda Heleni*, Syarifah Nur Siregar
Mathematic Education, Riau University, Pekanbaru, 28292, Indonesia

ARTICLE INFO

Article history:

Received: 12 Nov 2025
Revised: 24 Nov 2025
Accepted: 12 Dec 2025
Published online: 20 Dec 2025

Keywords:

Discovery Learning,
Mathematical Communication Skills,
Pythagorean Theorem

* *Corresponding author:*

E-mail: susda.heleni@lecturer.unri.ac.id

Article Doi:

https://doi.org/10.31258/jes.9.6.p.6559-6569

This is an open access article under the CC BY-SA license.

A B S T R A C T

This study aims to improve the quality of the learning process and enhance students' Mathematical Communication Skills (MCS) through the implementation of the Discovery Learning (DL) model in teaching the Pythagorean Theorem. The participants of this study consisted of 28 eighth-grade students (class VIII_6) from SMPN 3 Tambang. A Classroom Action Research (CAR) design was employed, conducted in two cycles. Each cycle consisted of four phases: planning, implementation, observation, and reflection. The instruments used in this study included the Learning Objectives Flow (LOF), teaching modules, observation sheets, and tests. Data were analyzed using both narrative descriptive analysis and descriptive statistics. The findings indicated that the application of the Discovery Learning model effectively enhanced the quality of the instructional process and significantly improved students' Mathematical Communication Skills. This was evidenced by an increase in the average MCS score from 72.52 in the first cycle to 87.80 in the second cycle. In conclusion, the Discovery Learning model is proven to be effective in improving students' learning outcomes and developing their Mathematical Communication Skills in class VIII_6 at SMPN 3 Tambang during the first semester of the 2024/2025 academic year on the topic of the Pythagorean Theorem.

1. Introduction

BSKAP Kemendikbudristek No. 033/H/KR/2022 outlines one of the learning objectives of mathematics in the Merdeka Curriculum, which is to enable students to communicate ideas through symbols, tables, diagrams, or other media to clarify situations or problems, and to represent situations using mathematical symbols or models. In line with this objective, mathematical communication skills are considered one of the essential competencies that students need to develop during the teaching and learning process (Melinda & Zainil, 2020). Mathematical communication skills refer to the ability to express ideas or concepts both orally and in writing, as well as the ability to understand and critically, analytically, and

evaluatively respond to the ideas or concepts presented by others in order to deepen understanding (Hidayat, et al., 2023).

The researcher conducted an observation by administering a pre-test on the topic of linear equations in one variable to assess students' mathematical communication skills. The open-ended questions used in the test were adapted from a study conducted by Hermawanti, et al., (2024). The results of the pre-test administered to students of class $VIII_6$ at SMPN 3 Tambang revealed that their mathematical communication skills were at a low level across all assessed indicators. This finding is based on the overall mean score of the pre-test, which was only 46.73, a value that falls at or below the threshold of 50. Upon detailed analysis, the indicator for "Formulating generalizations" showed the most concerning result, scoring significantly low at 29.46. While the other two indicators performed relatively better—"Explaining mathematical ideas in written form (figures)" scored 57.14, and "Expressing ideas using mathematical symbols and models" scored 53.73—the poor performance in formulating generalizations heavily contributed to the low overall mean.

This clearly underscores the need for targeted interventions to improve all facets of mathematical communication skills for students in class $VIII_6$, particularly their ability to generalize mathematical concepts. Based on this analysis, it is necessary to implement a learning model that can enhance students' mathematical communication skills. The discovery learning model encourages students to work collaboratively, share ideas, and discuss solutions throughout the learning process, thereby enabling them to construct knowledge more effectively and improve their mathematical communication abilities (Amelia et al., 2024). This is supported by research conducted by Muyassarah et al. (2024), which concluded that classroom action research employing the discovery learning model facilitates the advancement of students' competencies in mathematical discourse.

The researcher also conducted observations during the mathematics learning activities in class $VIII_6$ at SMPN 3 Tambang. According to the Kepmendikbudristek Number 56/M/2022 regarding the learning process, it was found that the teacher had not provided adequate learning motivation, resulting in students showing a lack of interest in the material being studied. The learning objectives were also not clearly communicated to the students. Furthermore, students had not engaged in discussions with peers to exchange ideas or thoughts, nor had they used learning media (Student Worksheets) during the session. There was no evidence of students summarizing the results of their discussions. Additionally, formative assessments to measure students' mathematical communication skills had not been implemented. Therefore, the objective of this study is to improve the learning process and enhance the mathematical communication skills of students in class $VIII_6$ of SMPN 3 Tambang during the odd semester of the 2024/2025 academic year by implementing the Discovery Learning model in the context of the Pythagorean Theorem content.

2. Methodology

The research design is Classroom Action Research (CAR), which was conducted in two cycles. Each cycle consisted of two learning sessions and one session for testing. The procedures implemented at each stage of the Classroom Action Research cycle are as follows:

a. Planning. The researcher designed the research instruments by implementing the Discovery Learning model on the Pythagorean Theorem, which included the Learning Objectives Flow (LOF), teaching modules, and a mathematical communication skills test (including the test blueprint, questions, and alternative answers). The data collection instruments included teacher and student activity sheets for each session, as well as a test sheet for assessing students' mathematical communication skills.
b. Action. The researcher acted as the teacher in implementing the learning process, following the prepared teaching modules.
c. Observation. The mathematics teacher of class $VIII_6$ at SMPN 3 Tambang, acting as Observer I, was responsible for observing the researcher in terms of how the learning process was carried out, based on the teacher and student activity sheets.
d. Reflection. The researcher, together with the teacher, conducted a thorough review of the actions taken during each session. An evaluation was then carried out to refine the actions for the next cycle.

The research instruments used in this study included learning tools consisting of the Learning Objectives Flow (LOF) and teaching modules, as well as data collection instruments in the form of observation sheets (for both teacher and student activities) and a mathematical communication skills test. The data analysis techniques employed are as follows:

a. The analysis of teacher and student activities was conducted using narrative descriptive analysis, which includes data reduction (the researcher filters and summarizes the findings from observations of teacher and student activities obtained from the observation sheets), data presentation (the data is presented in tables and narratives to facilitate analysis and comparison), and drawing conclusions (the researcher concludes how the development of teacher and student activities progresses from one cycle to the next).
b. The analysis of the students' mathematical communication skills test results was conducted using descriptive statistical analysis. The steps used in data processing, according to Syafira et al. (2025), are as follows:

assigning scores to students' answers based on a scoring guide, then converting the raw scores into mathematical communication skill scores on a scale of 0 to 100. The conversion of these scores was conducted using the following formula:

$$\bar{x} = \frac{\sum x_i}{j} \times 100$$

Ket:
$\bar{x}$: the average (MCS) score per indicator
$\sum x_i$: the total score obtained by students per indicator
j : the maximum possible score per indicator were calculated

The mathematical communication skill scores obtained from these calculations were then classified according to Table 1.

Table 1. The Criteria for Mathematical Communication Skills

Score Intervals	Categories
$90{,}00 \leq \bar{x} \leq 100$	Very good
$80{,}00 \leq \bar{x} < 90{,}00$	Good
$65{,}00 \leq \bar{x} < 80{,}00$	Adequate
$55{,}00 \leq \bar{x} < 65{,}00$	Poor
$0 \leq \bar{x} < 55{,}00$	Very poor

Source: Lestari & Utami (2023)

To determine the overall improvement in students' mathematical communication skills at the class level, the following formula was used to calculate the classical percentage score.

$$P = \frac{JM}{JS} \times 100$$

Ket:
P : percentage of students achieving the maximum score
JM : number of students who achieved the maximum score
JS : number of research subjects

Based on the criteria for improving the MCS, the achievement of an increase in students' mathematical communication skills on a class-wide scale is considered successful if 80% of the students achieve a "good" rating according to the study conducted by (Nabila et al., 2024).

3. Results and Conclusion

Analysis Results of Teacher and Student Activities

The activities of both the teacher and the students were analyzed to identify any shortcomings, which could be addressed through the planning of new actions as a corrective effort for the implementation of the learning process in subsequent sessions. The alignment between the application of the Discovery Learning model and the implementation of actions can be observed through the teacher and student activity observation sheets for each session. The planned stages in the implementation of the Discovery Learning model were in accordance with the actions carried out during the learning process, as evidenced by the teacher and student activity observation sheets for each session. The activities of the teacher

and students in cycle II showed improvements from the shortcomings identified in the previous cycle according to Table 2.

Table 2. Analysis of Teacher and Student Activities During the Preliminary Activities

No	Learning Activities	Analysis Results	
		Cycle I	Cycle II
1	Providing motivation	The students were not yet focused on the researcher during the explanation of the motivation and the importance of the topic to be discussed.	The students began to focus and pay close attention when the researcher provided motivation that explained the benefits of learning the material for everyday life.
2	Conducting apperception	The students were not focused, resulting in their failure to understand the presented apperception.	The students have listened to and understood the apperception provided
3	To pose prompting questions	The students were not very enthusiastic in answering the prompting questions.	The students became enthusiastic when answering the prompting questions provided.
4	Presenting information	The teacher delivered the learning objectives briefly.	The teacher delivered the learning objectives clearly and effectively.

The stages of Discovery Learning were well implemented in cycle II. This is evident from the teacher and student activities in cycle II, which showed improvements based on the shortcomings that had been identified according to Table 3.

Table 3. Analysis of Teacher and Student Activities During the Core Activities

No	Learning Activities	Analysis Results	
		Cycle I	Cycle II
1	Stimulation	The students were not sufficiently stimulated.	The students were well stimulated.
		The teacher instructed the students to read the given stimulus exclusively within their respective groups.	The teacher asked one of the students to represent the group and read the stimulus, while the other students listened attentively.
2	Problem statement	The students were able to identify the problem but were not yet able to propose a temporary solution.	the students were able to identify the problem and propose a temporary solution.
3	Data collection	The students were able to write mathematical ideas in symbolic, but some groups made mistakes in writing their answers.	The students showed progress by writing mathematical ideas in symbolic correctly and accurately.
4	Data prosessing	The students were able to explain mathematical ideas through writing; however, some groups were found to have copied answers from other groups.	The students demonstrated improvement by being able to explain mathematical ideas through writing correctly and accurately.

5	Verification	The students were not yet able to prove the correctness of their answers in the preliminary solution. The teacher asked the students to write down their answers.	The students were able to prove the correctness of their answers in the preliminary solution. The teacher checked whether the students could prove the correctness of the solutions they had found.
6	Generalization	The students were not yet able to formulate a generalization as a conclusion.	The students were able to formulate a generalization as a conclusion.

The students did not engage in reflection during the first meeting of cycle I due to the researcher's insufficient ability to manage time effectively. In cycle II, the researcher conducted a structured closing activity and was able to manage time more effectively according to Table 4. The results of the formative test completed by the students showed good achievement.

Table 4. Analysis of Teacher and Student Activities During the Closing Activities

No	**Learning Activities**	**Analysis Results**	
		Cycle I	**Cycle II**
1	Reflection	The teacher did not conduct a reflection or summarize the learning activities.	The teacher conducted a reflection, summarized the learning activities, and managed time optimally.
2	Formative test	The students who completed the formative test with the help of a classmate (not independently). The results of the formative test completed by the students indicate that their scores were not yet optimal.	The activity was carried out, and the students showed improvement by completing the formative test independently. The results of the formative test completed by the students indicate that they achieved optimal scores.

Referring to the activities outlined in the implementation of actions in cycles I and II, it is evident that both the teacher and student activities showed significant improvement throughout the learning process. By conducting reflection in cycle I, the identified shortcomings in the learning process were progressively reduced, leading to continuous improvement in the learning process towards better outcomes by the end of cycle II. Based on the description of the actions taken in Cycle I and II, it can be concluded that both teacher and student activities improved during the learning process. The shortcomings identified in the previous cycle were increasingly minimized, leading to more optimal learning implementation by the end of Cycle II. The analysis results show that the learning activities in class $VIII_6$ at SMPN 3 Tambang, regarding the Pythagorean Theorem content for the odd semester of the 2024/2025 academic year, have shown significant improvement.

Analysis of Mathematical Communication Skills Data

Along with the improvements in the learning process, the students' scores in mathematical communication skills also increased for each indicator of mathematical communication skills.

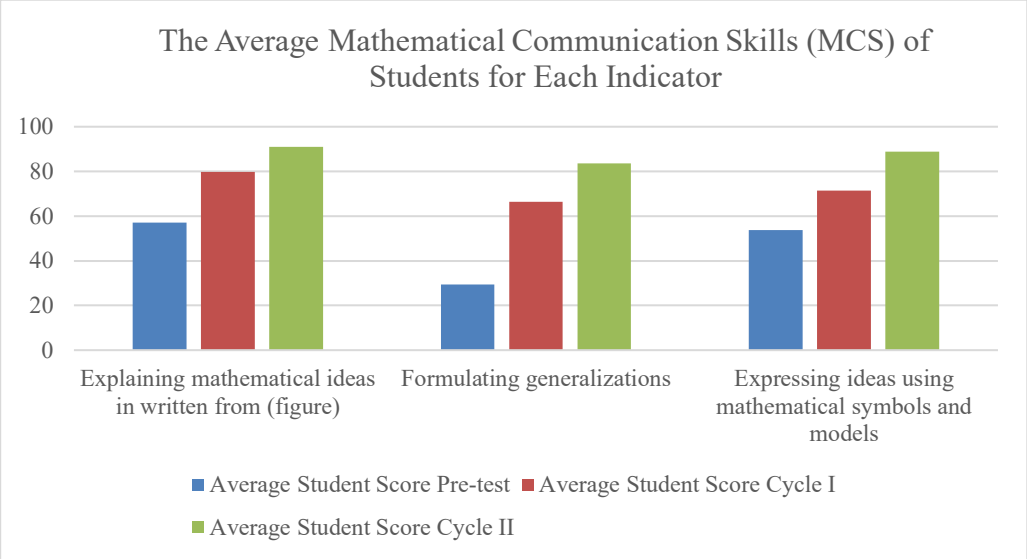

Figure 1. A bar chart illustrating the improvement in scores for each indicator

Based on Figure 1, the scores obtained by students on each indicator of mathematical communication skills improved from the pre-test, cycle I, and cycle II. The indicator of formulating generalizations showed significant improvement, as students were trained during the conclusion-drawing phase to formulate generalizations logically and correctly. The improvements observed in each indicator demonstrate that the Discovery Learning model implemented is effective in enhancing students' mathematical communication skills.

The students' responses in completing the mathematical communication skills test in cycle II are described as follows:

Explaining mathematical ideas in written from (figure)

Here is an example of a student's response on the indicator of explaining mathematical ideas through writing.

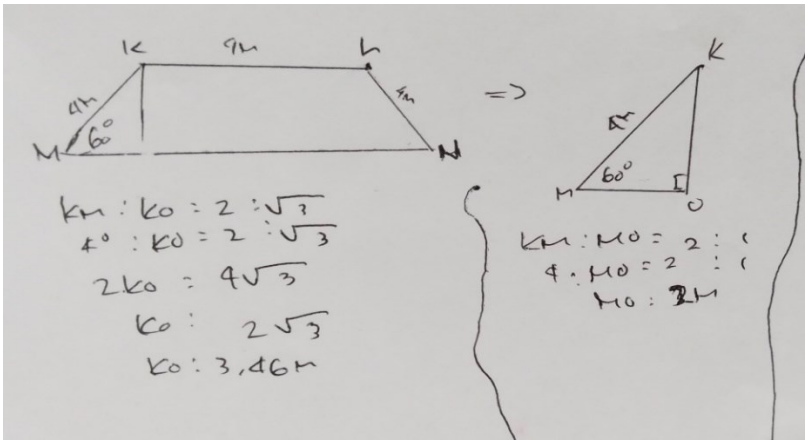

Figure 2. The answer to question number 2

Based on Figure 2, the students are able to explain mathematical ideas comprehensively and correctly. The students were able to draw accurate diagrams and solve the problems correctly.

Formulating generalizations

Here is an example of a student's response on the indicator of formulating generalizations.

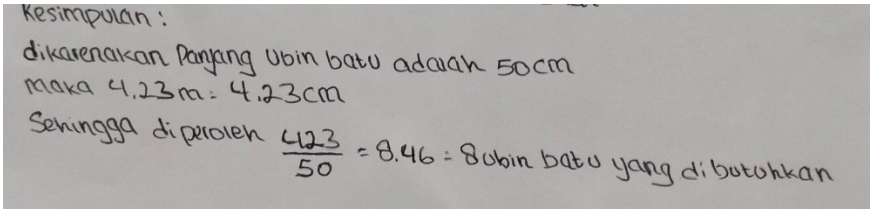

Figure 3. The answer to question number 1

Based on Figure 3, the students are able to explain the conclusion in writing rationally and correctly. The students were able to draw conclusions by explaining how many stone tiles are needed.

Expressing ideas using mathematical symbols and models

Here is an example of a student's response on the indicator of writing ideas into mathematical symbols and models.

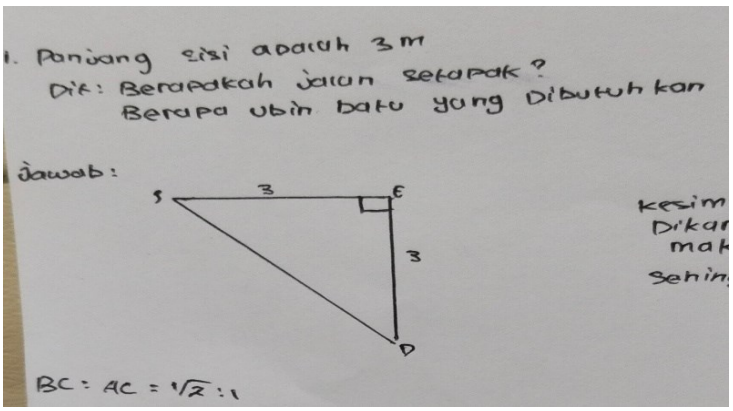

Figure 4. The answer to question number 1

Based on Figure 4, the students are able to correctly write ideas into symbols, but the mathematical model is incomplete. The students have not written "let a = the hypotenuse and b = c = the legs," thus stating "b = c = 3 meters."

The standards for assessing students' mathematical communication skills, both prior to and following the implementation of the discovery learning model on Pythagorean Theorem content, are presented in Table 5 below.

Table 5. Criteria for Students' Mathematical Communication Skills

Score Intervals	Total Number of Students			Criteria for Mathematical Communication Skills
	Pre-test	Cycle I	Cycle II	
$90{,}00 \leq np \leq 100$	-	-	8	Very good
$80{,}00 \leq np < 90{,}00$	-	5	19	Good
$65{,}00 \leq np < 80{,}00$	8	19	1	Adequate
$55{,}00 \leq np < 65{,}00$	3	4	-	Poor
$0 \leq np < 55{,}00$	17	-	-	Very poor

Based on the data in Table 5, it is evident that by applying the discovery learning model, students' communication abilities improved from the pre-test to the first cycle. There was also an improvement from the first cycle to the second cycle. In the pre-test, no students achieved the "very good" or "good" criteria. A total of 8 students achieved the "sufficient" criterion, 3 students achieved the "poor" criterion, and 17 students achieved the "very poor" criterion. In the first cycle, no students achieved the "very good" criterion, 5 students achieved the "good" criterion, 19 students achieved the "sufficient" criterion, and 4 students achieved the "poor" criterion. In the second cycle, 8 students achieved the "very good" criterion, 19 students achieved the "good" criterion, and 1 student achieved the "sufficient" criterion. From the pre-test to the second cycle test, the average score increased because the number of students who achieved the "good" and "very good" criteria increased, while the number of students in the "sufficient" category decreased.

The analysis of the improvement in students' mathematical communication skills in class VIII_6 at SMPN 3 Tambang, before and after the implementation of the Discovery Learning model on the Pythagorean Theorem, shows that the percentage of achievement in the pre-test for mathematical communication skills was 0%. After the Discovery Learning model was applied, there was an increase in the percentage of students' mathematical communication skills achievement on a class-wide scale. This can be seen from the percentage increase in students' mathematical communication skills achievement in cycle I, which rose by 10.71%. In cycle II, the percentage of achievement in mathematical communication skills on a class-wide scale also increased by 96.42%. Based on the criteria for improvement in the learning process in class VIII_6 as shown in Table 5, the average score for mathematical communication skills reached ≥ 80, with 27 students achieving this by the end of the cycle, thus indicating that the improvement in the learning process on a class-wide scale has been successfully achieved.

The discovery learning model is a teaching model designed to encourage students to discover and investigate learning material, so that the information they learn will be retained longer in their memory (Pratiwi et al., 2024). The discovery learning model motivates students to actively find and understand mathematical concepts through exploration and discussion. This allows students to answer questions and confidently demonstrate their abilities, which positively impacts their learning outcomes (Qodriati et al., 2023). Recent studies have demonstrated that the application of the discovery learning model can significantly improve students'

mathematical communication skills. This improvement stems from the model's emphasis on independent problem-solving combined with collaborative interaction among peers. These collaborative exchanges stimulate active participation and support the development of students' communication abilities (Hakim et al., 2024). This is supported by research conducted by Muyassarah et al. (2024), who concluded that classroom action research using the discovery learning model can improve students' mathematical communication abilities. In conclusion, this teaching model has shown potential in enhancing both the quality of the learning process and students' skills in mathematical communication. The findings from the analysis of teacher-student interactions and students' mathematical communication performance indicate that the implementation of the discovery learning model positively impacted classroom learning and strengthened the communication skills of class $VIII_6$ students at SMPN 3 Tambang during the first semester of the 2024/2025 school year, specifically in learning the Pythagorean Theorem.

4. Conclusion

The results and discussion, the objective of this Classroom Action Research was successfully achieved, as the implementation of the Discovery Learning (DL) model was proven effective in improving both the classroom learning process and the Mathematical Communication Skills (MCS) of students in class $VIII_6$ at SMPN 3 Tambang. The research initially confirmed that students' MCS was at a low level, highlighting the necessity for a targeted intervention. The most significant finding is the observable and continuous enhancement in the quality of the instructional process and student activities across the two cycles. The shortcomings identified during the first cycle were successfully minimized and corrected, leading to a more optimal learning environment by the end of Cycle II. Correspondingly, students' MCS showed a marked improvement across all assessed indicators following the application of the DL model. This success affirms that the Discovery Learning model is a suitable strategy for strengthening students' mathematical discourse competence. For future work, it is recommended that this model be continuously integrated into the curriculum to further solidify these communication competencies. Additionally, subsequent research should focus on exploring the long-term impact of the Discovery Learning model on other essential mathematical skills and complex problem-solving abilities.

References

Amelia, R., Hendriana, H., & Amelia, R. (2024). Efektivitas Penerapan Model Discovery Learning Terhadap Kemampuan Komunikasi Matematis Siswa Kelas VIII. *Jurnal Pembelajaran Matematika Inovatif*, *7*(4), 711–724. https://doi.org/10.22460/jpmi.v7i4.24841

Hakim, F., Fitriani, N., & Nurfauziah, P. (2024). Peningkatan Kemampuan Komunikasi Matematis Siswa Kelas VIII di MTSN 04 KBB Menggunakan Model Pembelajaran Discovery Learning Pada Materi Lingkaran. *Jurnal Pembelajaran Matematika Inovatif (JPMI)*, *7*(2), 435–444.

https://doi.org/10.22460/jpmi.v7i2.22038

Hermawanti, Khisan, F. C., & Amelia, R. (2024). Analisis Kemampuan Komunikasi Matematis Siswa Kelas VII Pada Materi PLSV Ditinjau Berdasarkan KAM. *Jurnal Pembelajaran Matematika Inovatif*, *7*(1), 273–284. https://doi.org/10.22460/jpmi.v7i1.21671

Hidayat, T., Darhim, & Herman, T. (2023). Kemampuan Komunikasi Matematis Dan Kemandirian Belajar Siswa Dalam Pembelajaran Matematika. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(2), 1812–1828. https://doi.org/10.24127/ajpm.v12i2.6628

Lestari, E. P., & Utami, N. S. (2023). Analisis Kemampuan Komunikasi Matematis Tertulis Siswa Berdasarkan Gaya Belajar Siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(3), 2501–2516. https://doi.org/10.31004/cendekia.v7i3.2315

Melinda, V., & Zainil, M. (2020). Penerapan Model Project Based Learning untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa Sekolah Dasar (Studi Literatur). *Jurnal Pendidikan Tambusai*, *4*(2), 1526–1539. https://doi.org/10.31004/jptam.v4i2.618

Muyassarah, Af'idah, S., Pratowo, B. P., & Khusen, M. (2024). Penerapan Model Discovery Learning Berbantuan LKPD Untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa Kelas IX F Di SMPN 1 Diwek. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *09*(02), 3868–3880. https://doi.org/10.23969/jp.v9i2.13999

Nabila, R. F., Susanti, V. D., & Nartini. (2024). Peningkatan Kemampuan Komunikasi Matematis Siswa Melalui Pembelajaran Discovery Learning Berbasis "Gallery Walk" Dengan Pendekatan Culturally Responsive Teaching. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, *10*(2), 165–176. https://dx.doi.org/10.24853/fbc.10.2.165-176

Pratiwi, A. S. R., Sari, C. K., & Burhanudin, B. A. (2024). Apakah Discovery Learning Dapat Meningkatkan Keterampilan Komunikasi Matematis Siswa? *FARABI : Jurnal Matematika Dan Pendidikan Matematika*, *7*(1), 83–90. https://doi.org/10.47662/farabi.v7i1.710

Qodriati, A., Nugraha, U., & Sofwan, M. (2023). Meningkatkan Hasil Belajar Matematika Dengan Menggunakan Model Discovery Learning Berbantuan LKPD. *DIKDAS: Jurnal Pendidikan Tematik*, *8*(1), 25–30. https://doi.org/10.22437/jptd.v8i1.23874

Syafira, H., Sakur, Armis, & Anum, A. W. (2025). Penerapan Problem Based Learning Untuk Meningkatkan Kemampuan Komunikasi Matematis Peserta Didik Fase D Pada Konten Statistika. *SIGMA : JURNAL PENDIDIKAN MATEMATIKA*, *16*(2), 605–617. https://doi.org/10.26618/sigma.v16i2.16089

How to cite this article:

Syadevi, A. R. D., Heleni, S., & Siregar, S. N. (2025). Implementation of the Discovery Learning (DL) Model to Enhance the Mathematical Communication Skills. *Journal of Educational Sciences*, *9(6)*, 6559-6569.