

Mathematical Communication Skills of Class III Student by Using Discovery Learning Model Assisted with Individual Manipulative Teaching Aids Reviewed from Student Responses

Uli Umaroh¹, Isti Hidayah², Mulyono³

¹Master Program Student of Primary Education, ²Master Program of Mathematics and Natural Sciences, ³Master Program of Mathematics and Natural Sciences, Universitas Negeri Semarang, Semarang City, Indonesia

Corresponding Author: Uli Umaroh

ABSTRACT

The purpose of this study was to determine the effectiveness of discovery learning model assisted with individual manipulative terms of student responses and to determine the description of students' mathematical communication skills class III based on student responses. The method used in this study is a mixed method. The data collected through test, questionnaire, interview, and documentation. The result showed that (1) Discovery learning model assisted with individual manipulative is effective on mathematical communication skills which can be seen from the results test mathematical communication skills of the experimental class is greater than the control class, (2) The pattern of mathematical communication skills in terms student responses variety. Of the 30 subjects there were students who entered the less positive, positive and very positive categories. Therefore, this research can be an alternative in learning mathematics especially use individual manipulative and mathematical communication skills can be applied in learning with assisted model individual manipulative.

Keywords: Mathematical Communication Skills, Discovery Learning, Student Responses, Individual Manipulative Teaching Aids

INTRODUCTION

Mathematics one of the subjects in formal education is obtained from elementary school to high school. Mathematics is a subject that has an important role in education because it can equip students to think logically, analytical, systematically, critically and creatively (Herdini et al., 2019).

According to Khoerunnisa et al (2016) students should learn mathematics on the grounds that mathematics is a very powerful and influential communication tool, thorough and exactly, and not confusing. So in this case students must study mathematics seriously so that mathematics can be used a communication tool for everyday life.

Based on the results of field observations and interviews with third grade teachers at SD Negeri Lawatan 02, it was found that the level of students' mathematical communication skills was still lacking or low. Because students in solving story problems do not appear mathematical language, so there are still many students in working on problems that are assisted by the teacher. This is evidence by the results of student work during field observations can be seen in figure 1.

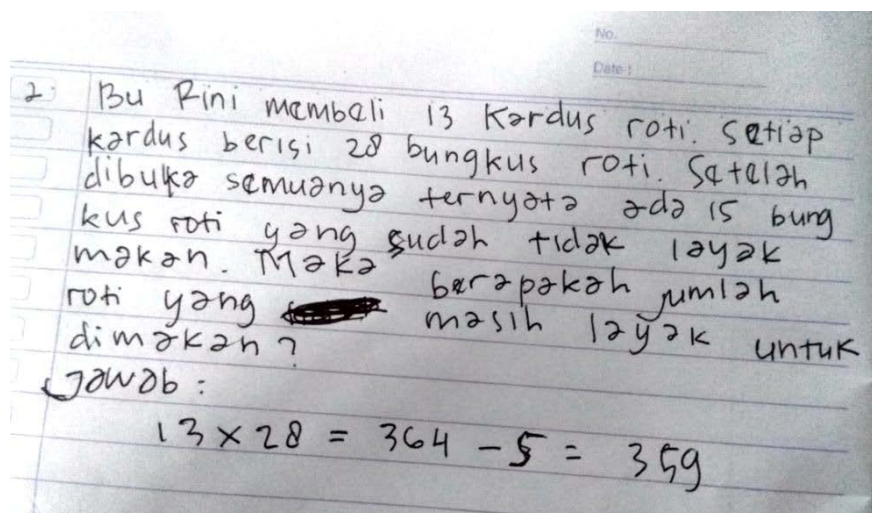


Figure 1. Results of Student Work

The third scores pretest of SD Negeri Lawatan 02 which was held on January 27, 2021 showed that the mathematical communication skills of third grade students in solving story questions were still low and there was no mathematical language, so there were still many students working on the questions assisted by the teacher and even their parents. Of the 30 students, only 50 % of the students whose grades reached the minimum completeness criteria (KKM), with the determined KKM grade of 65. The pretest score of the third graders at SD Negeri Lawatan 02 were 40 there 1 student, 44 there 1 student, 52 there 4 students, 54 there 1 student, 56 there 1 student, 60 there 5 students, 64 there 5 students, 68 there 5 students, 70 there 1 students, 72 there 5 students, and 76 there 1 student.

According to Zevenbergen (2004) the difficulty of mathematical communication skills is in the use of mathematical language where mathematical communication also involves very exact language so that mathematics is communicated correctly. To develop mathematical communication skills, what teachers can do is change the way students interact with their work with other students (Lee, 2017). Therefore, teachers should try to encourage their students to be able to interact or communicate with other students.

To develop students mathematical communication skills, students need to

focus on learning mathematics and students are able to convey their mathematical ideas. According to Lestari & Yudhanegara (2015) mathematical communication skills are conveying mathematical ideas/ideas, both orally and in writing as well as the ability to understand and accept other people's mathematical ideas/ideas carefully. Mathematical communication skills is very important for students so that they can complete mathematical problems by using good reasoning, illustrating mathematical ideas into mathematical models, and connecting processes into various mathematical concepts in the context of everyday life (Tinungki, 2015). Therefore, students are able to communicate mathematics into ideas with symbols, tables, diagrams, or other media to clarify mathematical situations or problems.

In addition to the problem of low mathematical communication skills, the above problems are also caused by the use of learning models that have not improved mathematical communication skills. Therefore, a learning model is needed that is able to improve mathematical communication skills. The learning model applied is the discovery learning model. Discovery learning was chosen because it is in accordance with the implementation of the 2013 curriculum and as a model that is able to solve problems. According to Sinambela et al., (2018) in discovery learning, students are encouraged to learn

on their own, that is through active involvement with concepts and principle. Meanwhile, according to Cahyani, in Prestika et al., (2018) discovery learning is a learning model that maximally involves all students ability to search and systematically, critically, and logistically so that they can find their own knowledge. This model is expected that students will be active in found concepts and solutions to improve their own mathematical communication skills related to cognitive processes and be able to help students train the mindset.

Learning mathematics in find a concept needs manipulative teaching aids that are able to clarify the material. It can be said that learning mathematics is obtained from students experience of concrete objects and gives them the opportunity to connect abstract mathematical concepts to the real world (Kadir et al., 2018). In the use of manipulative teaching aids not only contribution to the cognitive aspect but can improve the psychomotor aspect (Kontas, 2016).

Developing students' mathematical communication skills is not easy, so it needs to be explained using concrete manipulative teaching aids. The use of manipulative teaching aids is able to solve the reasoning process into steps to guide students, provide reasoning, and build conceptual understanding (Hidayah et al., 2018). Manipulative teaching aids that will be used by students in this study are individual manipulative teaching aids. The manipulative teaching aids used by each child are relatively smaller than the classical/group manipulative props. By facilitating teaching aids students, mathematics learning is expected to strengthen students' competencies, especially aspects of knowledge, attitudes, and skills in solving the problems of daily life. In the use of manipulative teaching aids, an activity sheets are needed so that students are able to manipulate individual manipulative teaching aids independently and are able to improve their mathematical communication skills. Manipulative

teaching aids provide opportunities for students to play and learn math at the same time (Kanastren et al., 2018).

In addition, the discovery learning model assisted by individual manipulative teaching aids is expected to be used to increase student response, namely through learning activities. According to Purniati in Fachrurazi (2011) states that students responses to mathematical communication problems are generally still lacking. This is because the story questions for grade III students are new, so students have difficulty working on the questions.

A response appears when students are able to observe and pay attention to an object. There are several factors that influence the existence of a response, namely experience, learning process, and personality values (Hidayati, 2013). In this case the student's response is able to give an impression or response after participating in learning activities.

Currently the world is shocked by an outbreak of disease caused by a virus. The virus is known as corona or by another name Covid-19. The spread of this virus has an impact in the political, economic, social and cultural fields (Setiadi, 2020). The impact of this virus has resulted in restrictions on all existing activities, such as school activities, work activities, worship activities, and public facilities activities.

On March 24, 2020, the Minister of Education and Culture of the Republic of Indonesia issued Circular Letter Number 4 of 2020 concerning the Implementation of Education Policies in the Emergency Period for the Spread of Covid19, in the circular it was explained that the learning process was carried out at home through online/distance learning. The existence of Covid-19 has brought offline learning experiences to online learning. Online learning that is applied to improve mathematical communication skills is to provide learning at home or in other terms home based learning (HBL).

Based on the problems that have been described, this study aims to determine

the effectiveness of discovery learning assisted by individual manipulative teaching aids in terms of student responses with indicators (1) Mathematical communication skills students in discovery learning assisted by individual manipulative teaching aids can achieve mastery learning, (2) Mathematical communication skills students in discovery learning assisted by individual manipulative teaching aids can achieve classical mastery, (3) The average mathematical communication skills of students in discovery learning assisted by individual manipulative teaching aids is more than the average mathematical communication skills of students with conventional models assisted by activity sheets, (4) The proportion of students' mastery in discovery learning assisted by individual manipulative teaching aids is more than the proportion of students' mastery with conventional models assisted by activity sheets, (5) The effect of student responses on the results of the mathematical communication skills tests and for knowing the description of the mathematical communication skills of class third grade students' based on student responses.

METHOD

The type or research method used was Mixed Methods research, is a combination of quantitative and qualitative research. The research design used is a sequential explanatory design. This design is a research procedure that combines the use of quantitative methods and qualitative methods.

Quantitative research is used to obtain students mathematical communication skills. This quantitative data was obtained through a test of mathematical communication skills. The design used in quantitative research is the non-equivalent control group design. Mathematical communication skills will be tested on the effectiveness of the discovery learning model assisted by individual manipulative teaching aids in term of student responses. Analysis of the data used in this study used

a learning mastery test, classical mastery test, average difference test, different proportion test, simple linear regression test, and an increase in the average pretest and posttest of the experimental class.

Qualitative research is used to obtain an overview of mathematical communication skills in terms of student responses. Data obtained from qualitative research conducted with the results of mathematical communication skills tests and interviews. The research subjects in this study were three students who were selected based on the results of the mathematical communication skills test which were taken from the responses levels of very positive, positive, and less positive. Student responses criteria can be seen in table 1.

Table 1. Student Responses Criteria

Percentage %	Category
$85 \leq RS$	Very Positive
$70 \leq RS < 85$	Positive
$50 \leq RS < 70$	Less Positive
$RS < 50$	Not Positive

Data collection technique used in this study were tests, questionnaires, interview guidelines, and documentation. The test is used to determine the value of students' mathematical communication skills. Questionnaires are used to determine student responses after learning is complete. The responses questionnaire consisted of 4 aspects, namely interest, motivation, seriousness, and pleasure. Interviews were used to find out more about mathematical communication skills and student responses in learning mathematics. The interview technique in this study used semi-structured interviews. Documentation is used to obtain student data needed in research.

RESULTS AND DISCUSSION

Quantitative Data Analysis

Based on the results obtained from the mathematical communication skills test, the following tests were carried out.

(1) Normality Test

The normality test used in this study was the results of the pretest and posttest of

mathematical communication skills in the experimental and control classes. This test uses Kolmogorov-Smirnov with the help of the SPSS 22 application program. Below are the results of the pretest and posttest normality tests of mathematical communication skills in table 2.

Table 2. Normality Test Results

Class	The Calculation Results	
	Pretest	Posttest
Experimental	0,114	0,156
Control	0,159	0,126

Based on table 2. shows that the normality test on the pretest and posttest data of students' mathematical communication skills is said to be normally distributed.

(2) Homogeneity Test

Homogeneity test was conducted to find out whether the data had the same variance (homogeneous) or not. This test uses Levene Statistics with the help of the SPSS 22 application program. The results of the homogeneity test analysis for pretest data are 0,687 while for posttest data are 0,231. this shows that the homogeneity test on the pretest and posttest data of the experimental class and control class is the same or homogeneous.

(3) Test the Similarity of Two Averages

This test was conducted to see the ability of the initial data (pretest) owned by students. This test uses the Independent Samples Test with help of the SPSS 22 application program. The result of the analysis can be seen in table 3.

Table 3. Test the Similarity of Two Averages

Class	Sig.
Experimental	0,572
Control	0,572

Based on table 3 shows that the experimental class and control class have the same sig value of 0,572. So that the average result of the experimental class's mathematical communication skills test is the same as the control class.

(4) Learning Mastery Test

The learning mastery test was conducted to determine whether the experimental class achieved minimum mastery. The learning mastery test uses a one sample T-test with the help of the SPSS 22 application program with a minimum completeness criterion of 65. Based on the results of the posttest data analysis, the experimental class students mathematical communication skills show that the data is normally distributed and homogeneous, then a learning mastery test is carried out and the results obtained $t_{count} = 8,699$ whereas for $t_{table} = 1,699$. Because $t_{count} > t_{table}$, then H_0 is rejected meaning that the average value of students mathematical communication skills reaches the minimum completeness criteria.

(5) Classical Mastery Test

The classical mastery test was used to determine that the students' mathematical communication skills in the experimental class achieved classical mastery. In this study, learning is said to have achieved classical mastery if the number of students in the class achieve mastery 75 %. The test used is the proportion test of one sample on the right. Based on the results of the posttest data analysis, the experimental class students mathematical communication skills that exceeded the minimum completeness criteria score were 26 of the 30 experimental class students mastery individually. Based on the normality and homogeneity test, the data obtained are normally distributed and homogeneous, so that the results of the analysis calculated manually are obtained for $z_{hitung} = 1,47$ and for $z_{table} = 0,93$. Because $z_{count} > z_{table}$, then H_0 is rejected. This means that proportion of students who get test scores for mathematical communication skills is greater than 75 % in classes that use discovery learning models with the help of individual manipulative teaching aids, they had exceeded the KKM on the mathematical communication skills test, namely 26 of the

30 experimental class students' mastery classically by 75%.

(6) Average Difference Test

The average difference test in this study was used to determine whether students' mathematical communication skills in the discovery learning model assisted by individual manipulative teaching aids were better than students' mathematical communication skills in the conventional model assisted by student activity sheets. The test that was carried out was the t-test (Independent sample test) on the right side with the help of the SPSS 22 application program. Based on the results of the posttest data analysis of students' mathematical communication skills, the experimental class and control class showed that the data were normally distributed and homogeneous, then the average difference test was carried out and the results obtained $t_{count} = 4,199$ while for $t_{table} = 2,002$. Because $t_{count} > t_{table}$, then H_0 is rejected, meaning that the average mathematical communication skills of students in classes using discovery learning models assisted by individual manipulative teaching aids is better than students' mathematical communication skills in classes using conventional models assisted by activity sheets student.

(7) Proportion Difference Test

The different proportion test was used to determine that the proportion of students who completed individually on the posttest of students' mathematical communication skills. This proportion difference test uses the right side test. Based on the results of posttest data analysis of the experimental class and control class students' mathematical communication skills in the previous test the data was normally distributed and homogeneous and then tested with manual calculations obtained $z_{hitung} = 1,1$ while for $z_{table} = 0,94$. Because $z_{hitung} > z_{table}$ then H_0 is rejected. That is, the proportion of students' mathematical communication skills in

classes using discovery learning models assisted by individual manipulative teaching aids is more than the proportion of students' mathematical communication skills in classes using conventional models assisted by student activity sheets.

(8) Simple Linear Regression Test

Simple linear regression test was used to determine the effect of student responses on students' mathematical communication skills in classes using discovery learning models. This test uses the help of the SPSS 22 application program. The results of the calculations obtained the value of sig. 0,009 which is less than 0,05 then H_0 is rejected. That is, students' responses affect mathematical communication skills with a simple linear regression equation obtained: $Y = 38,756 + 0,51X_1$.

(9) Increase In the Pretest and Posttest of The Experimental

After the data is said to be normally distributed, a homogeneity test is carried out to determine whether the data are the same or not. Based on the results of calculations using the SPSS 22 application program, a significance value of > 0.05 was 0.621 so that the pretest and posttest data showed that the data were the same or homogeneous.

Next is to do a paired t test (paired sample test). Based on the calculation results, the sig value is 0.000, which means it is less than 0.05 so that H_a is accepted. This means that the average posttest results in the experimental class are higher than the pretest results.

The n-gain test is used to find out more about the increase from the pretest to the posttest value. The results of the analysis were calculated manually and can be seen in Table 4.

Table 4. N-Gain Test for Experimental class and Control Class

Class	Mean		N - Gain	Criteria
	Pretest	Posttest		
Experimental	62,2	77,86	0,41	Sedang
Control	60	69,86	0,24	Rendah

Based on Table 4. the average N-gain for the class that uses the discovery learning model assisted by individual manipulative teaching aids is 0.41. This means that mathematical communication skills are in the medium category and for the control class an average of 0.24 is obtained,

which means that mathematical communication skills are in the low category. The graphic form between the increase in the pretest posttest in the experimental class and the control class can be seen in figure 2.

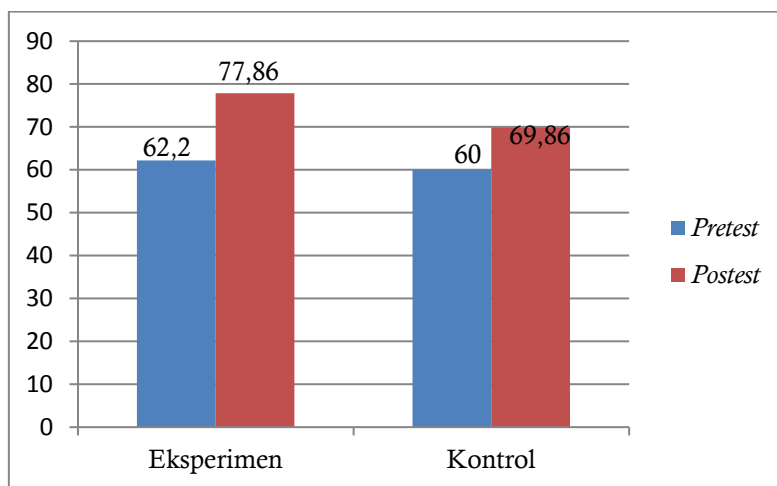


Figure 2. Graph of the experimental and control class pretest posttest scores

Qualitative Data Analysis

The result of the mathematical communication skills test consists of five questions that are assessed with a scoring guide based on the mathematical communication skills carried out by the indicator. After knowing the achievement of mathematical communication skills, then based on posttest data on indicators of mathematical communication skills and the results of interviews with selected research subjects, triangulation technique can be applied. Triangulation technique is a research effort to obtain in-depth data.

Filling Out Student Response Questionnaires and Determining Research Subjects

Student response questionnaires were given to the experimental class after the learning was completed. The questionnaire used in this study refers to Khairiyah (2019) which consists of 4 aspects, namely interest, motivation, seriousness, and pleasure.

To find out students' responses to mathematical communication skills in

fractional material, a questionnaire instrument consisting of 20 statements with answers "Yes" or "No" was used. The results of student responses can be seen in Table 5.

Table 5. The Result of Student Responses

Aspect	Interval (%)	Response Category
Interest	80	Positive
Motivation	86	Very Positive
Seriousness	76	Positive
Pleasure	88	Very Positive
Rata-rata	82,5	Positive

In the aspect of interest, the percentage score is 80% with a positive response category that after participating in learning with the discovery learning model assisted by individual manipulative teaching aids makes students interested in learning. As in Suwarti's research (2015) which states that by using manipulative teaching aids students are more interested in participating in learning activities and do not feel bored.

In the aspect of motivation, the percentage score of 86% with a very positive response category indicates that learning using individual manipulative teaching aids provides a new experience for students to be motivated in learning.

In the seriousness aspect, the percentage score is 76% with a positive response category. shows that seriousness can make students serious and concentrate on learning.

In the aspect of pleasure, the percentage score is 88% with a very positive response category indicating that learning if followed by manipulative teaching aids students feel happy and satisfied. As in Binangun's research (2016), students who study mathematics can happily explore themselves to understand the subject matter.

Based on the results of tests of mathematical communication skills and student response questionnaires, it was found that some students got different results with different criteria. The selected research subjects were three out of 30 students who had different criteria from the results of the mathematical communication ability test and student response questionnaire with details in Table 6. Based on the results of the student response questionnaire, there were 13 subjects with less positive responses and 1 was selected for the research subject. Furthermore, 16 subjects were obtained with positive response criteria and 1 was selected for the research subject. while for the subject with a very positive response there is 1 which is then used as a research subject.

Table 6. Research Subject

Code	Student Response Category	Criteria Test
E-04	Less positive	Low
E-26	Positive	Currently
E-15	Very Positive	High

Quantitative Discussion

The discovery learning model assisted by individual manipulative teaching aids was carried out to research quantitatively, so that in this study the results obtained were in the form of scores on the mathematical communication ability test. The experimental class uses a discovery learning model with the help of individual manipulative teaching aids, while the control class uses a conventional model with the help of activity sheets.

The implementation of learning is carried out with home based learning using the WhatsApp group application, due to the pandemic period. In the experimental class, the implementation of learning is carried out using individual manipulative props that have previously been given to students by applying health protocols.

After learning discovery learning online was completed, the researcher gave a test of mathematical communication skills and student response questionnaires in the experimental class while the control class was only given a test of mathematical communication skills. Mathematical communication skills tests are carried out by students and sent via the WhatsApp group application. After the questions have been sent by the students, the researcher then conducted interviews in the experimental class through the WhatsApp group application with the selected students. In the interview, the researcher looked at the students' mathematical communication skills verbally and the researcher also saw the student's response to the discovery learning model assisted by individual manipulative teaching aids. After everything is done, then the normality and homogeneity tests are carried out for the final data (posttest). The normality test obtained a significance value = $0.156 > 0.05$. As for the homogeneity test, the significance value = $0.231 > 0.05$ so that the data is normally distributed and has the same or homogeneous variance.

Based on the results of students' mathematical communication skills, it is known that learning using discovery learning models assisted by individual manipulative teaching aids is more effective than conventional models assisted by activity sheets. This can be seen from (1) the completeness of students who have achieved a score of 65 is more than 75%; (2) the average test results of students' mathematical communication skills in the experimental class were greater than the control class, namely 77.86 for the

experimental class and 69.86 for the control class.

Qualitative Discussion

(1) Students' mathematical communication skills on less positive responses

Based on the analysis obtained from 13 subjects with less positive responses, 1 research subject was selected with the results of a student response questionnaire of 65 and getting a mathematical communication ability test score of 64. Subjects with a score of 64 were only able to achieve one indicator of mathematical communication skills, namely being able to change mathematical ideas. into the mathematical model while the other three indicators of mathematical communication skills have not been achieved. In the results of the interview, the subject stated that the results had not been achieved.

(2) Mathematical communication skills on positive responses

The results obtained indicate that from the 16 subjects in the positive response category, 1 research subject was selected with a student response questionnaire of 80, while the mathematical communication ability test got a score of 80. Subjects tend to write mathematical problem solving procedures in their own language but there are still lack. The student was able, but did not achieve all indicators of mathematical communication skills. This is what ultimately makes the answer is not correct. In the results of the interview, the subject stated that the results were unsatisfactory.

(3) Mathematical communication skills in very positive response

The results obtained indicate that 1 subject in the very positive response category gets a student response questionnaire of 90 while the mathematical communication ability test score scores 90. This subject tends to be able to achieve all indicators of mathematical communication well. The results of the interview also

mentioned the results that the subject was able to answer all the questions.

CONCLUSION

Based on the results of the discussion, it is concluded that learning using discovery learning models assisted by manipulative teaching aids is effective on students' mathematical communication skills and the average mathematical communication skills of students who use discovery learning models assisted by individual manipulative teaching aids have increased, where the posttest value is higher than the pretest value. The posttest results of the experimental class students' mathematical communication skills were higher than the control class posttest results. Mathematical communication skills with less positive response categories indicate the subject is able to achieve one of the indicators. Mathematical communication skills with positive responses indicate the subject is able to achieve three indicators. Meanwhile, mathematical communication skills with a very positive response category indicate that the subject is able to achieve all indicators.

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