OPEN-ENDED APPROACH TO IMPROVE STUDENTS' MATHEMATICAL COMMUNICATION SKILLS

Feri Haryati[1]

[1]Program Studi Pendidikan Matematika FKIP UMSU

e-mail: feriharyati@umsu.ac.id

ABSTRACT

This study aims to see whether the increase in mathematical communication skills of students who receive learning with an open-ended approach is better than students who receive conventional learning. The population in this study were all UMSU mathematics education students for the 2019/2020 academic year. Sampling using purposive sampling. The research instrument used was a test of students' mathematical communication skills, observation sheets and interview guidelines. Data analysis using T test. The results showed that improving the mathematical communication skills of students who receive learning with an open-ended approach better than students who receive conventional learning. It can be concluded that learning using an open-ended approach can improve students' mathematical communication skills and can increase student activity during learning. Therefore, lecturers and teachers should make learning with an open-ended approach during learning.

Keywords: Mathematical communication skills, Open-ended approach

1) INTRODUCTION

Problem In Government Regulation No. 19 of 2005 concerning National Education Standards, it is stated that educators must have academic qualifications and competencies as learning agents, be physically and mentally healthy, and have the ability to realize national education goals. What is meant by educators as learning agents is the role of educators, among others, as facilitators, motivators, motivators, and educators of learning inspiration for students (President of the Republic of Indonesia, 2005).

As a facilitator, motivator, motivator, and giver of learning inspiration for students, an educator or student teacher candidate needs to master various competencies or abilities. Mathematical communication skills, both oral and written, are essential It is very important to be possessed by an educator or student of prospective mathematics teacher, in addition to various other abilities, such as the ability to reason, prove, represent mathematically, and solve mathematical problems. In addition, the development of science and technology in the era of globalization also demands quality human resources (HR) who have good communication skills so that they are easy to interact orally and in writing in the world of work. Therefore, the teacher's role in improving mathematical communication skills by giving a reasonable description of mathematics is very important and it is hoped that mathematics teachers can communicate mathematical concepts, structures, theorems, or formulas to students.

Mathematics education students are prospective mathematics teachers who play an active role in improving students' mathematical abilities in the future. Therefore, the role of mathematics education lecturers is needed to improve the mathematical communication skills of prospective teacher students. The Committee on Undergraduate Program in Mathematics (CUPM) (Novaliyoshi, 20011) recommends that each course in mathematics should be an activity that will assist students in developing analysis, critical reasoning, problem solving and communication skills. Therefore, mathematics learning given in universities must be able to hone students so that they have basic competencies in mathematics, namely understanding, problem solving, reasoning, mathematical connections, and communication, critical thinking, and creative thinking.

One of the problems in the field of mathematics education is that there are students who are prospective mathematics teachers who are weak in mathematical communication skills, so research on ways to improve the mathematical communication skills of prospective mathematics teacher students is important to do. Lecturers have a very large role and responsibility in achieving the formulated learning objectives. The achievement of learning objectives is influenced by various factors, one of which is the learning method used.

Calculus as a subject taught in the first semester is one of the subjects considered difficult by students. In fact, the Calculus course is one of the basics for students to master other subjects such as Trigonometry, Real Analysis, Algebraic Structures, and Differential Equations. At the university level, Calculus courses are usually divided into three major sections, including Calculus 1, Calculus 2, and Advanced Calculus. In the first semester at the initial level, the Calculus course given to students is Calculus 1. It should be noted that the material presented in Calculus 1 is closely related to the material after it, thus a good mastery of concepts is needed by students. In the Calculus 1 course there are also many symbols, graphs, models, and mathematical applications that students must master.

To accommodate these problems, one of the lessons that allow lecturers to use is an open-ended approach. Through learning with an open-ended approach, students are given space to explore existing problems, communicate their ideas, and can present new problems through initial problems, so that learning will tend to be student-centered. Supported by CUPM which also recommends that classroom learning should be able to present key ideas and concepts from various perspectives, such as presenting various applications to motivate and illustrate material, promote the connection of mathematics to other disciplines, develop the ability of each student to apply mathematics material to other disciplines. the discipline, introduce current topics of mathematics and its applications, and enhance students' perceptions of the vital role and importance of mathematics in today's world. This means that lecturers must always be ready to encourage students to be able to communicate in each lesson.

From the description of the problem and the opinions that have been expressed above, the author proposes a study entitled "Open-Ended Approach as an Effort to Improve Students' Mathematical Communication Ability in Calculus 1 Academic Year 2019/2014" with the hope that it can be useful as an effort to improve the next learning. Substantially: The content of the introduction is supposed to clearly mention the aims of your writing. It states your research problems or the question(s) you intend to address in your paper. Your introduction would typically include some variation such as the statement of your topic, problem or gap in knowledge, your forecast, as well as relevant literature reviews.

2) METHODS

Place and time of research

This research was conducted at the Muhammadiyah University of North Sumatra, especially the Mathematics Education Study Program for first semester students for the 2019/2020 academic year, starting from October 2019 to January 2020

Population and Sample

The population in this study were all first semester students of the Mathematics Education Study Program, University of Muhammadiyah North Sumatra in the 2019/2020 academic year who took the Calculus 1 course. The sample consisted of 2 randomly selected classes, then the first class was determined as the experimental class (learning using an open-ended approach) and the second as the control class (conventional learning).

Research variable

The variables in this study were learning with an open-ended approach as the independent variable, and mathematical communication skills as the dependent variable.

Research design

This research is a quasi-experimental or quasi-experimental study consisting of two groups. The research design used was a non-equivalent control group design (Ruseffendi, 2005). In this design, the subjects were not grouped randomly, but the researcher accepted the condition of the subjects as they were. In this research, there are pretest, different treatment (treatment), and posttest. Briefly, the research design is as follows:

Experiment Class: O X O

Control Class: O O

Description:

O: Pretest or posttest.

X : Learning with an open-ended approach

--- : Subjects are not grouped randomly

Research Procedure

1. Preparation phase

   a. Develop a research schedule.

   b. Make tests for pretest and posttest.

   c. Develop syllabus, SAP, contracts and hand out supporting materials for an open-ended approach.

2. Implementation Stage

   a. Determine the experimental and control classes from the existing population.

   b. Give an initial test (pretest).

   c. Carry out learning (treatment).

   d. Give a final test (posttest).

6. Research Instruments

To obtain data in this study used several instruments consisting of tests of mathematical communication skills in the form of descriptions, attitude scales, and observation sheets and interviews.

3) RESULTS

This study aims to describe and examine the mathematical communication skills of students who receive learning with an open-ended approach. The data analyzed were the data from the pretest results of the experimental class and control class students to see an overview of the initial abilities of the two groups and the posttest results after receiving the learning treatment with an open-ended approach. To find out the increase in students' mathematical communication skills, it can be seen from the N-Gain score formulated by Meltzer (2002). Data processing was carried out using the SPSS 16 program and Microsoft Office Excel 2007.

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
pretes_kontrol	37	35.00	50.00	40.9459	3.87976
pretes_eksperimen	37	30.00	50.00	40.8108	5.20597
postes_kontrol	37	50.00	75.00	65.6486	5.87469
postes_eksperimen	37	65.00	85.00	76.2162	5.57841
N_Gain_kontrol	37	.09	.62	.4138	.11998
N_Gain_eksperimen	37	.36	.75	.5955	.10092
Valid N (listwise)	37				

Table.1 shows that the average score of communication skills of experimental class students before learning is smaller than that of control class students, namely the average score of the experimental class is 40.94 while the mean score of the control class is 40.81. The difference is only about 0.13. This shows a very small difference.

After the learning was carried out, the average score of experimental students' communication skills was 76.21 with a standard deviation of 5.87. Meanwhile, the average posttest score for the control class was 65.64 with a standard deviation of 5.57. Based on the standard deviation of the posttest scores of the experimental class and the control class, it can be seen that the distribution of students' communication skills after learning for the experimental class is less spread out than the control class. This is because the standard deviation of the experimental class looks bigger than the standard deviation of the control class.

Furthermore, an analysis of the pretest data was carried out to determine the initial ability of the experimental class students and the control class students to have the same average. Then proceed with analyzing the normalized N-Gain of the experimental class and the control class to determine whether the increase in students' mathematical communication skills in the two classes is significantly different or not. To see the average test, first the normality test and homogeneity test were carried out, with a significance level of 0.05 for each test or a 95% confidence level.

Research Results of Students' Mathematical Communication Ability

Initial Ability Analysis (Pretest) of Student Mathematical Communication Based on the processing of the pretest score, the minimum score (xmin), maximum score (xmax), mean score (x), and standard deviation (s) are as shown in the table. 4.3 following:

Table 2. Pretest Results of Experiment Class and Control Class

	N	Minimum	Maximum	Mean	Std. Deviation
pretes_kontrol	37	35.00	50.00	40.9459	3.87976
pretes_eksperimen	37	30.00	50.00	40.8108	5.20597
Valid N (listwise)	37				

Table 2 shows that the mean results of the pretest in the experimental class and the control class have differences. The mean score of the control group was 0.13 higher than the experimental class. However, it is necessary to test the mean difference to show that the mean pretest scores of the two classes are different or not significantly. Prior to the mean difference test, the normality test and homogeneity test were first performed, as a requirement in determining which statistical test should be used.

To see if the data comes from a normally distributed population, a normality test is performed. The hypothesis of the normality test of the mathematical communication pretest scores of the experimental and control group students are:

H_0 : The sample comes from a normally distributed population

H_1: The sample comes from a population that is not normally distributed

The statistical test used was Shapiro-Wilk in both groups of data. With the test criteria, at the significance level reject H_0 if the p-value is less than α .

Table 3. Normality Test Results of Students' Communication Ability Pretest Scores Experimental and Control class

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
pretes_kontrol	.299	37	.000	.845	37	.000
pretes_eksperimen	.195	37	.001	.913	37	.007
a. Lilliefors Significance Correction						

From Table 3 obtained a significance value (sig.) of 0.000 each for the pretest score of students' mathematical communication skills in the control group and 0.007 in the experimental group. At the significance level α = 0.05, the significance value is smaller than the value = 0.05 so the null hypothesis is rejected. That is, the two groups of data pretest scores of mathematical communication skills are not normally distributed.

Because the data on the average mathematical communication ability of the students of the two classes were not normally distributed, it was not necessary to do a homogeneity test. Furthermore, to test the mean similarity of the mathematical communication ability pretest score using the U Mann-Whitney non-parametric test. To find out the significance of the difference in the mean of the two groups, the formulation of the hypothesis of the mean difference test was used pretest students' mathematical communication skills with the following hypothesis:

H_0 : There is no difference between the average mathematical communication pretest of experimental class students and control class students.

H_1 : There is a difference between the average mathematical communication pretest of experimental class students and control class students.

The statistical test used is the Nonparametric Statistics Test. The complete calculation results can be seen in the following table.

Table 4. The Result of the Difference between Two Means of the Pretest Score of Mathematical Communication Ability Students of Experiment Class and Control Class

	Data
Mann-Whitney U	679.000
Wilcoxon W	1.382E3
Z	-.063
Asymp. Sig. (2-tailed)	.950
a. Grouping Variable: group	

From Table 4 above, it is known that the significance value (sig.) of 0.950 is greater than the value of $\alpha = 0.05$, so it can be concluded that the null hypothesis which states that there is no significant difference between the means of the two groups is accepted. This means that the two groups of students' mathematical communication ability pretest score data have an average student's mathematical communication ability that is not significantly different.

Analysis of Students' Mathematical Communication Ability Improvement

To see the increase in mathematical communication skills achieved by students, normalized N-Gain data is used. So that the data analyzed in this study is the normalized N-Gain score. The average normalized N-Gain score is an illustration of the increase in students' mathematical communication skills both with open-ended learning approaches and with conventional learning can be seen in the following table.

Table 5. Average N-Gain Score of Students' Communication Skills

	N	Minimum	Maximum	Mean	Std. Deviation
N_Gain_kontrol	37	.091	.615	.41380	.119979
N_Gain_Eksperimen	37	.400	.786	.59598	.106072
Valid N (listwise)	37				

Based on Table 5 above, there are several conclusions related to students' mathematical communication skills that can be revealed, namely: the average N-Gain score of experimental and control class students' mathematical communication skills is in the medium category, while the difference in the average N-Gain score of mathematical communication skills experimental class students 0.18 greater than the control class. To find out the truth of the above average, it is necessary to calculate the statistical test using the test of the difference in the mean of the two populations against the following hypothesis.

Hypothesis 1:

"The increase in mathematical communication skills of students who receive learning with an open-ended approach is better than students who receive conventional learning".

Before performing the mean difference test, first the normality test and homogeneity test were carried out on the N-Gain score. The score was obtained from the N-Gain of the experimental class students' mathematical communication skills and the N-Gain data on the control class students' communication skills. The tested hypotheses are:

H_0: The N-Gain sample comes from a normally distributed population

H_1: The N-Gain sample comes from a population that is not normally distributed

The normality test was calculated using the SPSS 16 program on the Shapiro-Wilk statistical test.

Table 6. Normality Test Data Distribution Score N-Gain Ability Student Mathematical Communication

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
N_Gain_kontrol	.131	37	.109	.928	37	.020
N_Gain_Eksperimen	.116	37	.200*	.962	37	.227

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

From Table 6 obtained a significance value of 0.020 for the N-Gain score of students' mathematical communication skills in the control class and 0.227 for the N-Gain score of control class students' communication skills. The significance value for the control class is smaller than the value of α = 0.05, so it can be concluded that the null hypothesis which states that the sample comes from a normally distributed population is rejected. This means that the control class data on the N-Gain score of students' mathematical communication skills are not normally distributed. Meanwhile, the experimental class is normally distributed, because the significance value is greater than α = 0.05.

Because one of the data on the N-Gain score of students' mathematical communication skills is not normally distributed, it is not necessary to do a homogeneity test. Furthermore, to test the mean similarity of the N-Gain scores of students' communication skills using the Mann-Whitney U non-parametric test. To determine the significance of the difference in the mean of the two classes, the formulation of the hypothesis test for the difference in the mean N-Gain scores of students' mathematical communication skills was used as follows:

H_0 : The increase in mathematical communication skills of students who receive learning with an open-ended approach is the same as the improvement of communication skills of students who receive conventional learning.

H_1: The improvement of mathematical communication skills of students who receive learning with an open-ended approach is better than students who receive learning

The statistical test used is the Nonparametric Statistics Test. The summary results are presented in Table 7 below:

Table 7. The Result of the Difference between Two Mean Scores of N-Gain Ability Student Mathematical Communication

	Data
Mann-Whitney U	155.500
Wilcoxon W	821.500
Z	-5.649
Asymp. Sig. (2-tailed)	.000

From Table 4.7 above, it can be seen that the significance value (sig.) of 0.000 is smaller than $\frac{\alpha}{2} = 0.025$, so it can be concluded that the null hypothesis which states that there is no difference in the mean of the two groups is rejected. It means that the increase in mathematical communication skills of experimental class students is statistically better than the improvement of control class students' communication skills.

4) DICUSSION

Based on the results of research and discussion regarding the differences in increasing mathematical communication skills of students who receive learning with an open-ended approach and students who receive conventional learning, the following conclusions are obtained:

1. Improved mathematical communication skills of students who receive learning with an open-ended approach are better than students who receive conventional learning.
2. Students' attitudes towards learning with an open-ended approach show a positive attitude, and students are interested in the learning.

Based on the conclusions above, the authors put forward some suggestions as follows:

1. The results of this study indicate that learning with an open-ended approach can improve students' mathematical communication skills, therefore lecturers and teachers should make learning with an open-ended approach an alternative learning approach used in the classroom.
2. Further research is needed to determine the improvement of mathematical communication skills based on students' abilities (in terms of the ability of high, middle and lower groups) using an open-ended approach.

REFERENCES

Arifin, Zainal (2018). *Pengguanan software Lindo Dalam Mata Kuliah Program Linier*. Jurnal Theorems (The Original Research of Mathematics. Juni 2018 .

Borg. W.R. and Gall, M.D. (1987*). educational Reaserch: An Introduction*.London: longman, Inc.

Daries, I. (1981), *Instructional Tenchnology and Media*, MC Graw Hill Company, Newyork

Fauzi. A. (2011). *Peningkatan Kemampuan Koneksi Matematis dan Kemandirian Belajar Siswa dengan Pendekatan Pembelajaran Metakognitif di Sekolah Menengah Pertama*. Disertasi pada PPS UPI: Tidak diterbitkan

Goos, M. (1995).*Metacognitive Knowledge, Belief, and Classroom Mathematics. Eighteen Annual Conference of The Mathematics Education Research Group of Australasia*, Darwin, July 7-10 1995.

Haryati, Feri. (2012). *Peningkatan Kemampuan Pemecahan Masalah Dan Kemandirian Belajar Melalui Pembelajaran Dengan Pendekatan Metakognitif Berbasis Soft Skill*. Tesis pada PPs UPI: Tidak diterbitkan

Menteri Pendidikan dan Kebudayaan Presiden RI. (2013). *Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Tahun 2013 Tentang Standar Nasional Pendidikan Tinggi*

Munir, Renaldi. (2013). *Metode Numerik*. Bandung: Informatika Bandung.

Noornia, Anton. (2011). *Cooperative Learning with Metacognitive Approach Ton Enhance Mathematical Critical Thinking And Probelem Solving Ability And the Relation To Self Regulated Learning.* Jurnal International Seminar and the 4th National Conference on Mathematics Education. Juni 2011

Novaliyosi. (2011). *Meningkatkan Kemampuan Berpikir Kritis Matematis Dan Kemandirian Belajar Mahasiswa Melalui Pembelajaran Dengan Pendekatan Investigasi*. Tesis pada SPs UPI: Tidak diterbitkan.

Presiden RI .(2013). *Peraturan Pemerintah Republik Indonesia Nomor 32 Tahun 2013 Tentang Standar Nasional Pendidikan*.

Schneider, W. & Artelt, C. (2010). Metacognition and mathematics education. *ZDM -The International Journal on Mathematics Education* 42(2): 149– 161.

Sianifar, R.H. (2013). *Pemrograman Matlab*. Bandung: Informatika Bandung

Sutikno, Sobry. (2013). *Belajar dan Pembelajaran*. Lombok: Holistica

Yaumi, Muhammad. (2013). *Prinsip-Prinsip Desain Pembelajaran*. Jakarta:Kencana.