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Fakultas Matematika dan Ilmu Pengetahuan Alam
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"Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju"

Universitas Negeri Medan, 09 November 2023

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KATA PENGANTAR
KETUA PANITIA

Segala puji dan syukur kepada Allah SWT atas terbitnya Prosiding Seminar Nasional Jurusan Matematika (SEMNASTIKA) FMIPA Universitas Negeri Medan. Prosiding ini merupakan kumpulan artikel ilmiah yang telah dipresentasikan pada kegiatan SEMNASTIKA 09 November 2023 di Aula Gedung Prof. Syawal Gultom, Universitas Negeri Medan. Adapun cakupan bidang kajian yang disajikan dalam prosiding ini meliputi Matematika, Statistika, Ilmu Komputer, dan Pendidikan Matematika.

Dengan mengangkat tema seminar, “Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju”, kami mengharapkan SEMNASTIKA dapat turut serta berkontribusi bagi perkembangan ilmu pengetahuan jurusan matematika sebagai wadah bagi para peneliti, praktisi, penggiat pendidikan matematika dan pengguna untuk terjalinnya komunikasi dan diseminasi hasil-hasil penelitian.

Kegiatan SEMNASTIKA dan prosiding ini dapat diselesaikan dengan baik tidak terlepas dari bantuan berbagai pihak, oleh sebab itu kami mengucapkan banyak terimakasih kepada:

1. Pimpinan Universitas Negeri Medan
2. Dekan FMIPA dan para Wakil Dekan FMIPA Universitas Negeri Medan
3. Para Narasumber yaitu Bapak Prof. Dr. Janson Naiborhu, M.Si., Bapak Mangara Marianus Simanjorang, M.Pd., Ph.D dan Bapak Ahmad Isnaini, M.Pd.
4. Ketua Jurusan Matematika FMIPA Universitas Negeri Medan
5. Para Ketua Program Studi di Jurusan Matematika Universitas Negeri Medan
6. Panitia SEMNASTIKA
7. Pemakalah dan Peserta SEMNASTIKA
8. Semua pihak yang terlibat dalam pelaksanaan SEMNASTIKA

Kami menyadari bahwa buku prosiding ini masih jauh dari kata sempurna, karena itu kami mengharapkan kritik dan saran yang membangun dari para pembaca untuk perbaikan selanjutnya. Akhirnya, kami menghaturkan maaf jikalau ada hal-hal yang kurang berkenan bagi para pembaca serta ucapan terimakasih kepada semua pihak yang telah berkontribusi bagi terbitnya buku prosiding ini. Semoga buku prosiding ini dapat memberikan manfaat sesuai dengan yang diharapkan.

Medan,   November 2023
Ketua Panitia,

Susiana, S.Si., M.Si.
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KATA PENGANTAR
DEKAN FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS NEGERI MEDAN

Puji dan Syukur kepada Allah SWT atas segala rahmat dan anugerah-Nya sehingga Prosiding Seminar Nasional Jurusan Matematika dengan tema "Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju" yang diselenggarakan oleh Jurusan Matematika FMIPA Universitas Negeri Medan pada hari Kamis, 09 November 2023 di Medan dapat diselesaikan.

Publikasi prosiding ini bertujuan untuk memperluas wawasan pengetahuan yang berasal dari para akademisi baik dari Universitas Negeri Medan maupun yang berasal dari luar Universitas Negeri Medan. Selain itu, prosiding ini juga sebagai sarana untuk mengkomunikasikan hasil penelitian dengan menyajikan topik-topik terbaru yang meliputi bidang Pendidikan Matematika, Statistika, Ilmu Komputer dan Matematika.

Kami mengucapkan terimakasih dan apresiasi yang setinggi-tingginya kepada semua pihak yang telah berkontribusi dalam Seminar Nasional Jurusan Matematika, baik sebagai keynote speakers yaitu Prof. Dr. Janson Naiborhu, M.Si., Mangara Marianus Simanjorang, M.Pd., Ph.D dan Ahmad Isnaini, M.Pd., reviewer makalah, peserta dam panitia yang terlibat. Akhir kata, semoga Prosiding Seminar Nasional Jurusan Matematika ini bermanfaat bagi kita semua sehingga dapat memberikan kontribusi maksimal bagi negara dan bangsa.

Medan, November 2023
Dekan

Prof. Dr. Fauziyah Harahap, M.Si
NIP. 196607281991032002

KATA PENGANTAR
KETUA JURUSAN MATEMATIKA
FMIPA UNIVERSITAS NEGERI MEDAN

Dengan penuh rasa syukur kepada Allah SWT, prosiding Seminar Nasional Jurusan Matematika FMIPA Universitas Negeri Medan ini dapat diselesaikan. Kemajuan ilmu pengetahuan dan teknologi di era ini sangat berdampak bagi kehidupan manusia. Kajian penelitian terkait perkembangan ilmu pengetahuan dan teknologi serta terapannya perlu disosialisasikan kepada khalayak. Seminar Nasional Jurusan Matematika merupakan forum diskusi ilmiah yang sangat penting dalam pengembangan dan penyebaran pengetahuan di bidang matematika yang meliputi pendidikan matematika, statistika, ilmu komputer dan matematika (non pendidikan). Melalui buku prosiding ini, kami berupaya untuk menyajikan rangkuman makalah-makalah yang telah dipresentasikan, serta memberikan wadah bagi pembaca untuk menjelajahi gagasan-gagasan cemerlang yang ditawarkan dan penelitian-penelitian terkini yang dihasilkan oleh para akademisi, peneliti, dan praktisi matematika.

Tema seminar kali ini, “Transformasi Matematika dan Teknologi Menuju Generasi Matematika Unggul untuk Pendidikan Indonesia Maju”, mencerminkan komitmen kami untuk terus menghadirkan diskusi yang relevan dan mendalam mengenai isu-isu terkini dalam dunia matematika. Melalui buku ini, kami berharap pembaca dapat m engeksplorasi berbagai sudut pandang, temuan, dan pemikiran-pemikiran baru yang dapat memperkaya wawasan serta menginspirasi penelitian dan pengembangan dan ilmu matematika.

Secara khusus, kami mengucapkan terimakasih kepada para narasumber, yaitu : Prof. Dr. Janson Naiborhu, M.Si., Mangara Marianus Simanjorang, M.Pd., Ph.D dan Ahmad Isnaini, M.Pd., yang telah membagikan ilmunya dalam kegiatan seminar. Terimakasih yang tulus juga kami sampaikan kepada semua pihak yang telah mendukung kegiatan ini, para pimpinan Universitas Negeri Medan dan para pimpinan FMIPA Universitas Negeri Medan. Apresiasi yang tinggi juga saya ucapkan teruntuk para penulis, reviewer, dan panitia yang telah berperan aktif dalam pembuatan buku prosiding ini. Kontribusi dari setiap individu adalah pondasi kesuksesan acara ini, dan semangat kolaboratif ini sangat berharga bagi perkembangan ilmu matematika.

Akhirnya, kami berharap buku prosiding ini dapat menjadi sumber pengetahuan yang bermanfaat dan memotivasi pembaca untuk terus menggali potensi dalam bidang matematika. Mari kita bersama-sama memperkuat dan memajukan ilmu matematika demi keberlanjutan pembaruan pengetahuan.

Medan,   November 2023
Ketua Jurusan Matematika

Dr. Pardomuan Sitompul, M.Si
NIP.196911261997021001

SUSUNAN ACARA

Waktu	Kegiatan	**PIC**
08.00 - 08.30	Pendaftaran Ulang	Panitia
08.30 - 09.00	Acara Pembukaan 1. Salam Pembuka 2. Menyanyikan Lagu Indonesia Raya 3. Doa 4. Laporan Ketua Pelaksana 5. Sambutan dan Pembukaan acara seminar oleh Dekan Fakultas Matematika dan Ilmu Pengetahuan Alam 6. Foto Bersama	 MC: Putri Maulidina Fadilah, S.Si., M.Si Nurul Ain Farhana, M.Si Khairuddin, M.Pd. Susiana, S,Si., M.Si. Prof. Dr. Fauziyah Harahap,M.Si
09.00 - 10.00	Pembicara I Prof. Dr. Janson Naiborhu, M.Si (Guru Besar Matematika ITB)	Moderator: Yulita Molliq Rangkuti, M.Sc., Ph.D
10.00 - 11.00	Pembicara II Mangaratua Marianus Simanjorang, M.Pd. Ph.D (Dosen Jurusan Matematika UNIMED)	Moderator: Andrea Arifsyah Nasution, S.Pd., M.Sc.
11.00 - 11.45	Pembicara III Ahmad Isnaini, M.Pd (Guru berprestasi Nasional)	Moderator: Dinda Kartika, S.Pd., M.Si.
11.45 - 13.00	ISOMA	
13.00 - 14.30	Sesi I : Seminar Paralel	Moderator Pemakalah Pendamping
14.30 - 16.00	Sesi II: Seminar Paralel	Moderator Pemakalah Pendamping
16.00	Penutupan acara oleh Dekan FMIPA	MC

KEYNOTE SPEAKER

KEYNOTE SPEAKER 1

Prof. Dr. Janson Naiborhu, S.Si., M.Si.

Prof. Janson Naiborhu memiliki dua gelar doktor yang ia peroleh dari Keio University (Jepang) dan Institut Teknologi Bandung. Kariernya sebagai dosen dimulai sejak tahun 1991, sejak ia bergabung sebagai Dosen FMIPA ITB, dengan Kelompok Keahlian Matematika Industri dan Keuangan. Ia menjadi Guru Besar sejak 1 Desember 2014 dan Pembina Utama Muda/Gol IV C sejak 1 April 2011.

Prof. Janson aktif dalam melakukan riset dan telah banyak menghasilkan jurnal ilmiah baik nasional maupun internasional. Namanyapun telah dikenal luas di dunia pendidikan dan industri, khususnya dalam bidang Matematika.

KEYNOTE SPEAKER 2

Mangaratua M Simanjorang, M.Pd., Ph.D

Mangaratua M Simanjorang, M.Pd., Ph.D adalah dosen Pendidikan Matematika di Universitas Negeri Medan. Beliau meraih gelar sarjana di Universitas HKBP Nomensen tahun 2003, dan di tahun 2007 beliau mendapat gelar magister dari Universitas Negeri Surabaya. Beliau melanjutkan program doktor di Murdoch University, Australia dan memperoleh gelar Ph.D tahun 2016. Fokus pada pendidikan matematika, beliau melaksanakan tridarma universitas, beliau mendapatkan penghargaan sebagai dosen muda terbaik tahun 2009.

Dengan menjadi reviewer dan narasumber dibanyak kegiatan seminar, beliau berbagi ilmu dalam bidang pendidikan matematika, pendidikan karakter dan media pembelajaran seperti *augmented reality*.

KEYNOTE SPEAKER 3

Ahmad Isnaini M.Pd.

Ahmad Isnaini, M.Pd adalah seorang pendidik yang memiliki dedikasi tinggi terhadap dunia pendidikan. Ia meraih gelar Sarjana Pendidikan Matematika dari Universitas Negeri Medan pada tahun 2010, kemudian melanjutkan studi pascasarjana dan meraih gelar Magister Pendidikan Matematika pada tahun 2019 dari universitas yang sama. Saat ini, Ahmad sedang mengejar gelar Doktor dalam bidang yang sama di Universitas Negeri Medan.

Ahmad Isnaini juga telah mengukir prestasi gemilang dalam berbagai kompetisi dan olimpiade. Sebagai Finalis Apresiasi GTK 2023 BBGP Sumatera Utara Tingkat Provinsi dan penerima berbagai medali emas, perak, dan perunggu dalam Olimpiade Guru tingkat Nasional dan Provinsi, Ahmad Isnaini memperlihatkan dedikasinya dalam pengembangan kemampuan diri dan juga siswanya.

Tidak hanya aktif di dunia akademis, Ahmad Isnaini juga telah berkontribusi dalam literatur pendidikan. Karya-karyanya yang terpublikasi dalam jurnal nasional dan internasional, serta buku-buku seperti "Guru Merdeka" (2020) dan "Inovasi Pembelajaran" (2018), mencerminkan pemikiran dan wawasan yang mendalam dalam bidang Pendidikan.

DAFTAR ISI

THE EFFECT OF PROBLEM-BASED LEARNING MODEL ASSISTED BY GEOGEBRA SOFTWARE ON STUDENTS' MATHEMATICAL COMMUNICATION ABILITYIN SMP N 1 SELESAI

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Abstract

The level of students' mathematical communication ability is still poor. The model of learning as element that affect it. This research aimed, firstly to analyze how the difference of students' mathematical communication ability taught by PBL assisted by Geogebra and Conventional learning model. Secondly, to analyze how the PBL assisted by Geogebra can affect students' mathematical communication ability. This research was Quasi Experiment with Nonequivalent Control Group design. Sample of this research was 31 students of class VIII-7 as experiment class and VIII-8 with 30 students as control class, which were selected through random sampling technique at SMP N 1 Selesai. The experiment class was taught by PBL aided by Geogebra while Conventional learning in the control class. Data collection instrument used mathematics communication ability test. Hypothesis testing with t-test showed that $t_{calculate} > t_{table}$ (3,846 > 1,671) with $\alpha = 0{,}05$ and $df = 59$. Thus H_o is rejected and H_a is accepted. Therefore, students' mathematical communication ability taught by PBL assisted by Geogebra was higher than students taught by Conventional learning. The difference implies ability of students' mathematics communication are affected by the learning models used. Through the implementation of PBL syntaxes and Geogebra, ability of students' mathematical communication increased.

Keywords: *Geogebra, Problem-Based Learning (PBL), Students' Mathematical Communication Ability.*

1. INTRODUCTION

Mathematics is one of the compulsory subjects in the primary and secondary education Curriculum. Mastering mathematics can be a powerful tool for learning other subjects (Heryan, 2018). A good knowledge of mathematics corresponds with the goal of mathematics learning. This is because the success of mathematics learning can be seen by achieving the goals of learning. According to NCTM (2000), the goals of learning mathematics are that pupils must have five standards of mathematical ability: The ability to solve problems, connection, reasoning, communication, and representation.

Communication is the most crucial component in mathematics learning, as are speech and writing. Students can think and reason to optimize their understanding of a mathematical concept and then communicate their ideas. According to Yulianti et al. (2021), the ability for mathematical communication includes being able to express, comprehend, read situations into mathematical language, express ideas using diagrams, symbols, tables, or other visual representations to explain the issues, and express mathematical ideas appropriately using mathematical language.

The ability to communicate mathematically is able to encourage other mathematical skills including problem-solving (Elmujahidah, Mulyono, & Banjarnahor, 2018). In other words, if students cannot grasp mathematical concepts and problems clearly through communication, they will not be able to answer the problem correctly. Students who are skilled communicators may solve mathematical problems easily. In the opinion of Safitri and Effendi (2022), effective mathematical communication skills enable pupils to comprehend and resolve mathematical problems relating to the concepts they learn with ease.

Through indicators of communication in mathematics ability, the abilities of learners to communicate mathematically can be assessed. As determined by Heryan (2018), Three markers of mathematical communication abilities should be grown in mathematics learning, which are, students can: (1) write explanations of answers of problems mathematically, reasonably, and systematically (writing); (2) express problems in the form of images, diagrams, and table with completely (drawing); (3) create models of existing mathematical problems, do calculations so that the correct and complete solution is obtained (mathematics expression).

Despite the fact that mathematics communication is an essential ability that all students should acquire, the current state of affairs demonstrates that this ability is still lacking among students. In PISA 2018, Indonesia only placed 73 out of 79, with an mean score that is still far below the global mean, which is 489 (OECD, 2019). It will undoubtedly have an impact on pupils' weak mathematical skills, including their ability to communicate mathematically.

The research of Risdianti et al. (2019) and Deswita et al. (2018) also demonstrates the poor ability for mathematical communication. Due to research of Deswita et al. (2018) stated that the inability of pupils to express a situation or issue using mathematical expressions and when the teacher asks students, they have not been able to communicate their ideas. Then, Risdianti et al. (2019) stated that most students still struggle to solve mathematics issues presented with images and expressions of mathematics. Because in the math learning process occurs in one direction, so most students are only silent and unwilling to ask about materials that are not understood.

The truth obtained on the ground also show that students at SMP N 1 Selesai have difficulty both verbally and written expressing their mathematical thoughts, which has an impact on students' poor mathematical communication skills. This is evidenced based on interviews with several mathematics teachers at SMP N 1 Selesai and initial test results of students, which revealed that the ability of students to communicate mathematically was poor.

Based on a conversation with a math teacher at SMP N 1 Selesai, it is known that students often memorize and remember mathematical formulas in learning mathematics. Thus, most students have difficulty when solving a mathematics problem that is different compared to the example given by the teacher. This is caused by the inability of students to comprehend, explain, and clarify issues in mathematics by communicating ideas using their own language, symbols, pictures, diagrams and tables.

The results of the initial tests, which measure mathematical communication ability, further demonstrate the low level of mathematical communication ability. Tests that have been given to class VIII students consisting of 32 people are still far from expectations. From 32 students who had the test, there were no students who possess high and medium levels of mathematical communication ability categories (0%), 5 students (15,62%) who had low mathematical communication ability, and 27 students (84,37%) who had very low mathematical communication ability.

According to Andini et al. (2018), the cause of students' underdeveloped mathematical communication abilities is caused by the teacher-centered learning process and tends to be a memorization process without understanding the theory. This is in accordance with the researcher's observation found when the teacher teaches in class.

The teacher generally uses conventional methods in learning mathematics, where learning processes that are carried out emphasize more teacher activities. As a result, lots of pupils continue to engage in less active learning. One element influencing ability for communication in mathematics is the learning model. Therefore, it is essential to alter the problem-based learning (PBL) paradigm in order to enhance mathematical communication ability of students.

The problem-based learning model was student-centered. Because it is a form of transformation from the teaching paradigm to the learning paradigm. According to Hafidloh et al. (2020), with the help of their teachers, students must solve the problems either individually or in groups using the problem-based learning. Due to, there is an exchange of information or ideas. The problem-based learning model's syntaxes and indicators of mathematical communication ability have a number of connections in common.

Research conducted by Hafidloh et al. (2020) also stated that pupils who use the PBL model have better mathematical communication skills than pupils who using conventional learning model, because in the process of learning in groups, students are seen asking each other to students who have more understanding of the problems given, it means that there is good communication between students and students can be more independent in solving a problem.

Besides using the suitable learning model, The students' ability for mathematical communication affected by the presentation of the material and the media used. One of the efforts to visualize mathematical ideas so that mathematics can be truly understood by students, especially in geometry material is needed a media. According to the findings of Fadilah et al. (2019),, students' ability to communicate mathematically can be improved by using geogebra in mathematics instruction. Her research demonstrated that junior high school students who use geogebra software in their learning have better mathematical communication skills than those who do not.

It is expected that using pbl in conjunction with geogebra software to learn mathematics will improve students' ability to communicate mathematically. Due to, this research was conducted with the aim (1) to analyze how the difference of students' mathematical communication ability taught by PBL assisted by Geogebra and students' mathematical communication ability taught by Conventional learning model, and (2) to analyze how the PBL assisted by Geogebra can affect students' mathematical communication ability. If the students' ability to communicate mathematically changes after receiving the treatment, this proves that it had a significant effect.

2. METHOD

A non-equivalent control group design was used in this quasi-experimental research. Determination of the design is adjusted to actions that will be conducted during the research, such as giving pretest, treatment for a certain period of time then ending with giving the posttest. The design shown in Table 1.

Table 1. Design of research

Class	Pretest	Treatment	Posttest
Eksperiment	Y_1	X_1	Y_2
Control	Y_1	X_2	Y_2

Explanation :

Y_1 : Giving the pretest
Y_2 : Giving the posttest
X_1 : PBL assisted by geogebra
X_2 : Conventional learning model

Random sampling technique was used to obtain the sample for this research. Class VIII-7 consisting of 31 students (experiment class) and 30 students of Class VIII-8 (control class) at SMP N 1 Selesai were selected as samples in this research. This research uses data collection techniques in form of tests. Tests used in this research were mathematical communication ability tests consisting of pretest and posttest. The pretest was given to measure the initial ability of students in both classes homogeneous or not while the posttest was given to assess the ability of mathematical communication of students after being given treatment.

Posttest data were analysed in this research. The posttest was retrieved to compare students who had been taught using a problem-based learning model and geogebra software (the experiment class) with those who had received conventional learning (the control class). The results of posttest will be compared, and the variation will demonstrate the effect of the indicated behavior. With the presumption that the data were evenly distributed and homogeneous, the t-test was used to analyze the data. Following is the hypothesis that was examined in this study:

$H_o: \mu_1 \leq \mu_2$ = The students' mathematical communication ability taught by problem-based learning model assisted by geogebra is lower or equal than students' mathematical communication ability taught by conventional learning model.

$H_a: \mu_1 > \mu_2$ = The students' mathematical communication ability taught by problem-based learning model assisted by geogebra is higher than students' mathematical communication ability taught by conventional learning model.

The hypothesis test used following the formula below.

$$t_{calculate} = \frac{\overline{X_1} - \overline{X_2}}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad (1)$$

Where:
$\overline{X_1}$: Posttest average in experimental class
$\overline{X_2}$: Posttest average in control class
n_1 : Amount of pupils in experiment class
n_2 : Amount of pupils in control class
S^2 : Combined variance of both classes

The hypothesis testing criteria is : H_o is accepted if $t < t_{1-\alpha}$, otherwise, if $t > t_{1-\alpha}$ then H_a is accepted with $(df = n_1 + n_2 - 2;\ a = 0{,}05)$ and $a = 0{,}05$ (Sudjana, 2018).

3. RESULTS AND DISCUSSION

3.1. Result

This research focused on the ability of mathematical communication of class VIII at SMP N 1

Selesai. The lesson taught in this research is flat-sided space, namely cubes and rectangular prism. The execution of this research was undertaken for five meetings. At the 1st meeting, pretest questions were given to students in both classes. The 2nd to the 4th was the stage of giving treatment to both classes. At the 5th, both classes were given posttest questions. Therefore, pretest and posttest are the data used in this research. Data processing in the research was assisted by SPSS Version 26.

d. Data of pre test

An initial test (pretest) was first conducted before the two classes received different treatments, respectively, problem-based learning activities supported by geogebra software in the experimental class and conventional learning activities in the control class. The objective is to ascertain whether or not students have a fundamental comprehension of the material that will be presented in a homogeneous setting. The outcomes of the pretest for both classes were displayed in Table 2.

Table 2. Data of pre test

Statistics	Experiment	Control
N	31	30
Min	22,92	25,00
Max	45,83	45,83
Sum	1033,35	1052,07
Mean	33,33	35,07
Ideal Score	100	100
Standard Deviation	6,803	5,843
Variance	46,287	34,144

From Table 2. above, knowing that the maximum score obtained by both classes is the same, 45,83. The average score of both classes is not too far away, 33,33 for the experimental classs and 35,07 for the control class. In the pretest, the control class's pupils' mathematical communication capacity were better compared to the pupils of the experimental class. Moreover, Figure 1. below shows the average pretest results for each indicator of students' mathematical communication ability.

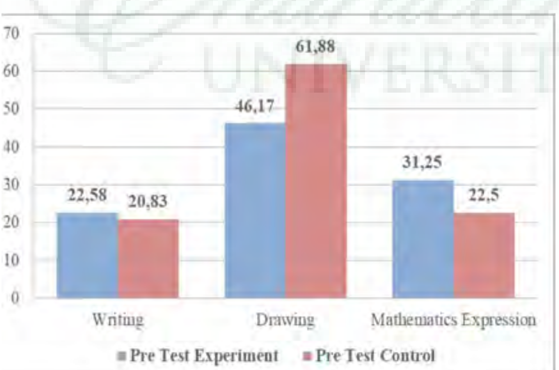

Figure 1. The average pretest on each indicator

.

Based on the Figure 1. above, it is known that students' ability to communicate mathematically is still considered to be low. Finding from the average of students' mathematical communication ability on each indicator. The indicator which has the highest average score compared another indicators is the drawing indicator. However, the average value of the drawing indicator is still categorized as low. In the control class, the drawing indicator has a higher average score than the experimental class, which is control class of 61,88 and the experimental class of 46,17. Whereas in the indicators of mathematical writing and mathematical expression, the experimental class has better average score (22,58 and 31,25) than the control class (20,83 and 22,50).

e. Data of post test

After the pretest in both classes taken, the experimental class received the problem-based learning assisted with geogebra software, whereas the control class received conventional learning. Both classes took a posttest following the various interventions. Table 3 contains information on the outcomes of the posttest for both classes.

Table 3. Data of post test

Statistics	Experiment	Control
N	31	30
Min	72,92	68,75
Max	97,92	89,58
Sum	2647,91	2377,10
Mean	85,42	79,24
Ideal Score	100	100
Standard Deviation	6,697	5,803
Variance	44,855	33,673

The purpose of the post test is to compare students who learn using a problem-based learning model assisted by geogebra with conventional learning to see how their mathematical communication skills differ. The results of posttest as a benchmark for whether the hypothesis in this research is rejected or accepted. Based on Table 3. above, the average posttest score for the experimental class's students in mathematical communication is known (85,42) is higher than the average posttest score for the control class's students in mathematical communication (79,24). Additionally, Figure 2. below shows the average posttest results for students' mathematical communication ability for each indicator.

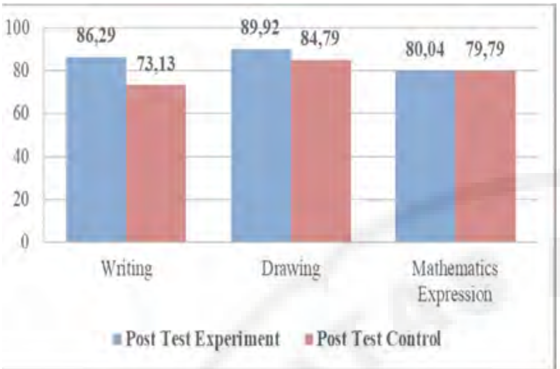

Figure 2. The average posttest on each indicator

From the Figure 2. above, it is known that in the experimental class, students' mathematical communication ability in each indicator has higher average value than the control class. The indicator that has the highest average score compared to other indicators in experimental and control classes is the drawing indicator. The experimental class' average value for the drawing indicator was 89,92, while the control class' average value was 84,79. The control class had an average value of 73,13 and the experimental class had an average value of 86,29 on the mathematical writing indicator. The experimental class' average value on the indicator for mathematical expression was 80,04, while the control class' average value was 79,79.

f. Hypothesis Testing

In this research, data from pretest and posttest are normally distributed as shown in Table 4 and homogeneous as shown in Table 5. Therefore, hypothesis testing can then be carried out using independent sample t test statistics.

Table 4. Shapiro-wilk normality test

Class	Statistics	df	Sig
Pretest Experiment	0,167	31	0,133
Pretest Control	0,150	30	0,168
Posttest Experiment	0,120	31	0,410
Posttest Control	0,126	30	0,237

Table 5. Homogeneity test

Class	Levene Statistics	df_1	df_2	Sig
Based on Mean	0,167	3	118	0,558

From Table 4 and Table 5, discovering the homogeneity and normal distribution of the experimental and control classes. From Table 4, it can be found that the normality test results have a significant value > 0,05. Therefore, it can be said that the samples used in this study come from a population that is normally distributed. According to Table 5, it is also known that the homogeneity test results have a significant value of 0,558 > 0,05, leading one to the conclusion that the research sample is representative of a homogeneous population.

Hypothesis testing can then be done after knowing that the experimental and control classes are homogeneous and distributed normally. Table 6. displays the findings of the hypothesis test.

Table 6. Summary of hypothesis test calculations

Posttest Average Score		df	$t_{calculate}$	t_{table}
Experiment Class	**Control Class**	59	3,846	1,671
85,42	79,24			

Based on Table 6 above, it was found that $t_{calculate} > t_{table}$,namely 3,846 > 1,671 then H_o rejected and H_a accepted. Thus it can be obtained that the students' mathematical communication ability taught by problem-based learning model assisted by geogebra is higher than students' mathematical communication ability taught by conventional learning model. According to Sugiyono (2018), a treatment is considered to have had an important effect if there is a difference between the experimental group and the control group following treatment. Thus, it can be said that the treatment has an effect on students' ability to communicate mathematically. In this instance, the problem-based learning combined with the geogebra software has a positive effect on the mathematical communication ability in grade of VIII students at SMP N 1 Selesai.

a. Discussion

A. The difference of students' mathematics communication ability in experimental and control

Students' abilities to communicate mathematically varied depending on the treatment they received, specifically between the experimental class using a problem-based learning model assisted by geogebra software and the conventional learning model. Data from the posttest results administered to both classes after treatment indicate that the average scores for students' mathematical communication skills in the experimental and control classes are different. It is well known that the experimental class's posttest average is higher than the control group's.

Based on results of the hypothesis test analysis, $t_{calculate} > t_{table}$, namely 3, 846 > 1,671. According to the t value, it can be inferred that students who are taught using a problem-based learning model with the aid of geogebra software have better mathematical communication ability than those who are taught using a conventional learning model. This is consistent with one of the benefits of problem-based learning models over other learning models, which can develop students' communication ability, which can be seen in discussion activities and presentations of student work (Sujana and Sopandi, 2019).

In the problem-based learning assisted by geogebra in the experimental class, students were formed into groups and then given worksheet to present the problems to be solved. At the 1st meeting, students still looked stiff and unfamiliar with the learning process using groups and worksheet. However, students are very enthusiastic about geogebra's attractive visualization display, able to draw geometry displays easily, can be moved, changed shape and size. This resulted in students spontaneously asking questions, predicting, and arguing among themselves or the teacher to develop students' mathematical communication abilities. As stated by Supriadi (2015) that visualization on geogebra provides opportunities for students to explore and observe easily, where these activities can develop students' mathematical communication ability.

In the control class, studying was taken using a conventional learning. The learning process began with giving theory to students, giving example problems and checking student understanding, and giving practice problems or homework to students at the end of learning. Andini et al. (2018) stated that in the learning process using conventional learning, knowledge tends to be transferred from teachers to students without students building their own knowledge. Students' communication activities are low as a result of learning activities like these, which give them few chances to independently express mathematical ideas. Students only use existing algorithms to solve problems.

From the explanation of the learning process in the experimental and control classes above, it can be seen that the mathematical communication ability of students taught by problem-based learning assisted by geogebra are higher than the conventional model. Because the syntaxes in the problem-based learning model was able to train students' mathematical communication ability, research by Layliyyah et al. (2022) also revealed the same results as this research, showing that the mathematical communication ability of students who used the PBL model was higher than students who studied with conventional learning models. The indicators of students' mathematical communication skills used in this study are also used in Layliyyah et al. (2022) research, namely writing, drawing, and mathematics expression.

Compared to the relevant research above, it can be found that the experimental class using problem-based learning had students with an average mathematical communication ability of (91.11), which was higher than the findings of this study (85.42). This is due to the advantage that the relevant research above has: the average initial ability of students' mathematical communication (pretest) in the experimental class and control class is higher than the findings of this research (33.33 and 35.07), with pretest scores of 37.9 and 39.72 respectively.

However, when viewed from the indicators of mathematical communication ability, the average value of the drawing indicator in the experimental class taught with problem-based learning in the results of this research is higher than the drawing indicator in the relevant research. This is because this research has the advantage that in addition to using the problem-based learning model, it also uses learning media, namely geogebra. With geogebra, students' mathematical communication skills on drawing indicators are also more improved.

Additionally, Hafidloh et al. (2020) found the same outcomes as this research, namely that students who were taught using the problem-based learning model had significantly better mathematical communication ability than those who were taught using conventional learning.

Compared to the relevant research above, it can be found the average mathematical communication ability in the results of this research as a whole and each indicator shows higher results than the research of Hafidloh et al. (2020). This is because in research Hafidloh et al. (2020) It was explained that in the learning process there were several obstacles experienced, namely, at the 1st meeting, the teacher introduced and explained the stages in the problem-based learning model, but pupils still looked confused in participating in learning activities even though the stages of learning had been explained. Meanwhile, in this research, students were very enthusiastic about Geogebra's attractive visualization display.

According to the explanation given above, it is known that there is a difference between the average value of pupils mathematical communication ability when they are taught using a problem-based learning model assisted by geogebra software and when they are taught using a conventional model, namely that the mathematical communication ability of pupils taught using a problem-based learning model assisted by geogebra software is higher than the mathematical communication ability of pupils taught using a conventional learning model as reinforced with relevant research.

The difference suggests that a student's ability to communicate mathematically can be significantly affected by the learning model being used. According to Sugiyono (2018), if there is a significant difference between the experimental group and the control group following treatment, then the treatment had a significant effect. In this case, the problem-based learning model assisted by geogebra software has a positive effect on students' mathematical communication ability.

B. The way problem-based learning model assisted by geogebra software can affect students' mathematical communication ability

Using the PBL with geogebra as a support, pupils' mathematical communication ability can be enhanced. Stages of PBL offer opportunities for students to develop their mathematical communication ability, as discovered in the research of Andini et al. (2018). According to this research, pupils' mathematical communication ability can be afffected by the use of problem-based learning with geogebra during the stages of orienting students to the problem, guiding individual and group investigation, then evaluating problem-solving results.

At the orienting pupils to problem, researchers propose phenomena or story demonstrations to raise problems. In proposing these problems, researchers utilize geogebra media to visualize problems to provide opportunities for students to make observations easily. The same thing is also revealed in Rudhihastuti (2022) that one of the utilizations of geogebra in junior high school mathematics learning that it can be used to explore cubes, by utilizing the slider facility or tool in geogebra, students can find the surface area of flat-sided spaces. At this stage, after observing the problem, students will begin to think, write, convert problems into mathematical form, and explain the answers to these problems. This can certainly encourage indicators of students' mathematical communication abilities, namely mathematical writing and mathematical expression.

At the guiding individual and group investigation, researcher guide students in their groups to gather the information needed to solve the problems. In this stage, with teacher guidance, students' writing, drawing, and mathematical expression abilities are trained to solve the issues presented in the worksheet. This is also reinforced by the research of Hafidloh et al. (2020), which stated that at the stage of guiding individual and group investigations, students' writing, drawing and mathematical expression indicators can increase.

The teacher assists students in reflecting on or evaluating their investigations at the stages of developing and evaluating problem-solving. In evaluating the problem-solving process, the teacher direct students to verify that the drawing of the space they made is correct according to the geogebra display or in terms of solving problems related to finding the volume of cubes and rectangular prism, students compare the results of the volume of cubes and rectangular prism they find with the many cubes of units contained in the geogebra display. As revealed by Rudhihastuti (2022)that using geogebra software in mathematics learning is as feedback / evaluation to ensure drawings or answers that have been made are correct so it encourages drawing, which is one of the indicators of mathematical communiaction ability.

4. CONCLUSION

The following conclusions for this research as follows:

1. The students' mathematical communication ability taught by problem-based learning model assisted by geogebra software is higher than the students' mathematical communication ability taught by conventional learning model. This is based on hypothesis testing using t-test that has been done. From the hypothesis testing of communication ability, $t_{calculate} > t_{table}$ is obtained, which is 3,846 > 1,671 then H_o is rejected dan H_a is accepted. The difference indicates that a student's ability to communicate mathematically can be significantly affected by the learning model being used. In this case, the problem-based learning model assisted by geogebra software has a positive effect on students' mathematical communication ability. This is due to the fact that problem-based learning syntaxes give students the chance to develop their mathematical communication ability.
2. The way the problem-based learning model assisted by geogebra software can affect students' mathematical communication ability is through the problem-based learning Stage. The problem-based learning model offers students the chance to develop their mathematical communication skills at various stages. Writing and mathematical expression are the indicators of mathematical communication ability that are encouraged at the orienting problem stage. At the stage of guiding individual or group investigations, students' writing, drawing, mathematics expression abilities are trained to gather information so that they can solve the problems contained in the LKPD. At the stage of analyzing and evaluating, students' drawing also encourage.

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