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Mathematics Communication Ability In Mathematics Education Study Program Post Online Learning

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Abstract: The COVID-19 pandemic has had an impact on various fields in the world, including education in Indonesia. Based on a preliminary study conducted by researchers, several research results were found related to the effectiveness of distance/online learning which were considered less effective. Research on Difficulties in Learning Mathematics Online During the COVID-19 Pandemic, concluded that learning mathematics becomes difficult and has challenges when learning online for several reasons factors, namely; the limited space for interaction with the teacher, the number of concepts used in mathematics, and the objects studied have abstract patterns. This research is a type of qualitative research that uses descriptive qualitative research methodology. The focus of this research is to describe students' mathematical communication during online learning. The research data were obtained from 6 students of the Mathematics Education Study Program, Pawyatan Daha University. Data collection obtained through test questions and questionnaire sheet. The implementation technique, the test questions contain mathematical problems that have been created to obtain data on students' mathematical communication abilities. The second part contains questionnaire sheet to obtain secondary data related to barriers/students in carrying out learning. The results showed that some students still had low or less communicative abilities, this was indicated by the non-fulfillment of all assessment indicators including strategy, organization and communicative language.

Keyword: Mathematical Communication, Student, Post Online Learning

INTRODUCTION

The COVID-19 pandemic has affected various fields throughout the world, especially the education sector in Indonesia (Herliandry, Nurhasanah, Suban, & Kuswanto, 2020). Based on data obtained from UNESCO, 39 countries implemented school closures with a total number of affected students reaching 421,388,462 children. Seeing this condition, the Minister of Education and Culture of the Republic of Indonesia, Nadiem Anwar Makarim issued a circular letter Number 4 of 2020 on March 24, 2020 concerning the Implementation of Education Policies in the Emergency Period for the Spread of COVID-19. In the circular, it is explained that the learning process is carried out at home via online or remotely without meeting students directly. However, technology certainly cannot replace the role of lecturers, lecturers, and learning interactions between students and teachers because education is not only about acquiring knowledge but also about values, cooperation, and communication.

Communication skills are a way for the development of mathematics, where its role can be elaborated to connect existing knowledge, thus giving birth to useful new knowledge. The National Council of Teachers of Mathematics (NCTM, 2010) recommends aspects of communication competence as a fundamental that can be obtained in the mathematics learning process. If so, then communication is one of the basic skills that students must have in the process of learning mathematics. The ability of students to be able to develop in activities of conveying information or communicating ideas through oral

talks, graphs, maps, and diagrams, must be facilitated and guided appropriately during the learning process. Sumarmo (2011) explains that communication skills are the ability to introduce appropriate mathematical notation and language, provide information, explain issues, create models, and provide opportunities to overcome difficulties. Understanding and knowledge can develop through communication with strategies or problem solving methods used by students, such as the use of diagrams and mathematical symbols that students use to communicate their ideas. According to Santos and Semana (2015) mathematical communication involves rational justification, clear rules and statements, as well as procedural descriptions.

Mathematics is one of the sciences that is indispensable in human life, because through this mathematics students are trained to be able to think systematically, logically, critically, and be able to solve the problems they face in real life (Yunitasari, Sahrudin, Kartasasmita, & Prakoso, 2019). Logical and systematic proof skills are the basis for students to find a basis for theory, besides that it needs to be supported by directed fold backs (Purwanto & Solehudin, 2020). Baroody (1993) who said that mathematics is the relationship of several mathematical content, and can connect the content through the process of communication, reasoning, and representation. The process of learning mathematics in higher education institutions has several problems related to the characteristics of mathematics. The objects are abstract, the concepts and principles are tiered, as well as the working procedures that require many connections between concepts so that students often experience difficulties. Problems in mathematics have several types and levels, according to the level of thinking that develops in each student. Vui (2007) ranks math problems based on students' thinking level in four levels, from lowest to highest, namely (1) exploring and remembering facts, principles, and procedures, (2) practicing exercises and skills, (3) solving problems, and (4) investigation.

Based on the results of the preliminary study, it was found that several research results related to the effectiveness of distance/online learning were considered less effective, including the results of a study conducted by Fauzy and Puji (2021) regarding the Difficulties of Online Mathematics Learning During the COVID19 Pandemic. Online learning has its own challenges due to several factors, namely; limited space for interaction, many relationships between concepts used in mathematics, objects studied in mathematics have abstract patterns. Bernard (2015) describes the communication skills that are important to have in order to understand the given mathematical problems and be able to express ideas and ideas in solving mathematical problems and create critical, logical, creative and independent thinking. Students with high creative thinking skills are able to represent their ideas very well, neatly, and clearly in solving problems (Purwanto, 2020). Therefore, researchers want to conduct research on the mathematical communication skills of post-online students, as the basis for forming learning strategies in the new normal.

METHOD

This research is a type of qualitative research that uses descriptive qualitative research methodology. Researchers set the focus of research based on the Covid-19 pandemic, which causes online learning to be carried out which risks affecting students' mathematical communication. The focus of this research is to obtain information on students' mathematical communication skills after carrying out online learning. In this study, data were obtained from 6 students of the Mathematics Education Study Program, Pawyatan Daha University.

The results of answers with material in the scope of basic mathematics and calculus courses that have been done by students are then given a scoring according to the standard-based math rubric of NCTM (2010) to obtain data on students' mathematical communication through the rubric for assessing mathematical communication skills. In

general, the standard-based math rubric of NCTM can analyze the level of students' strategic ability in making mathematical models, analyze students' abilities in expressing ideas in the form of graphs, pictures, and diagrams and analyze students' abilities in providing explanations and reasons mathematically in mathematical language. correct and easy to understand. To obtain accurate data, the data used in this study were obtained through test questions and questionnaire sheet. In practice, the test questions contain mathematical problems that have been made in such a way as to obtain primary data, namely students' mathematical communication skills, while the second part contains an questionnaire sheet that is used to obtain secondary data related to barriers/supports for students in carrying out learning, especially mathematics online. This instrument will be provided directly by taking into account the Health protocol and research ethics.

RESULT AND DISCUSSION
Results Of Mathematic Communication Assessment

As described in the research method, Indicators for measuring mathematical communication skills, firstly by analyzing the level of students' strategic abilities in making mathematical modeling, secondly by analyzing students' abilities in expressing ideas in the form of graphs, pictures, and diagrams, and thirdly analyzing students' ability to provide mathematical explanations and reasons with mathematical language that is correct and easy to understand. The data obtained will be discussed below. As shown in Figures 1 and 2, the results of student tests are in good categories in expressing graphical ideas. Whereas in Figure 3 shows the category is not enough.
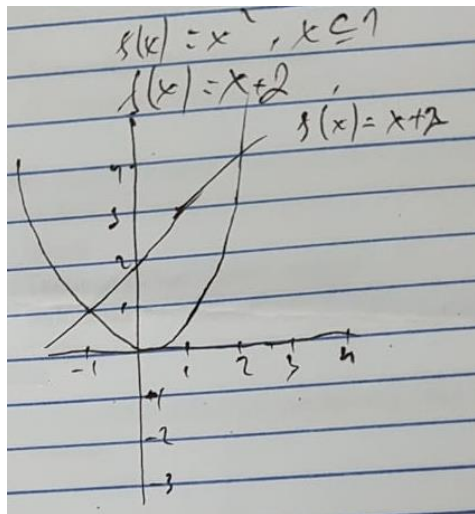
Figure 1. An example of a student's ability to express ideas in graphic form (student test results, 2022)
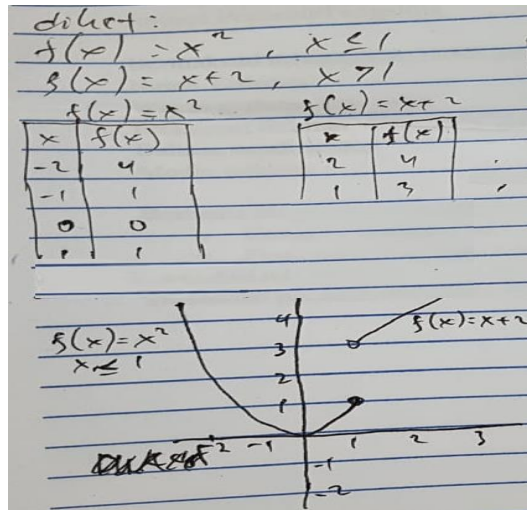
Figure 2. An example of a student's ability to express ideas in graphic form (student test results, 2022)
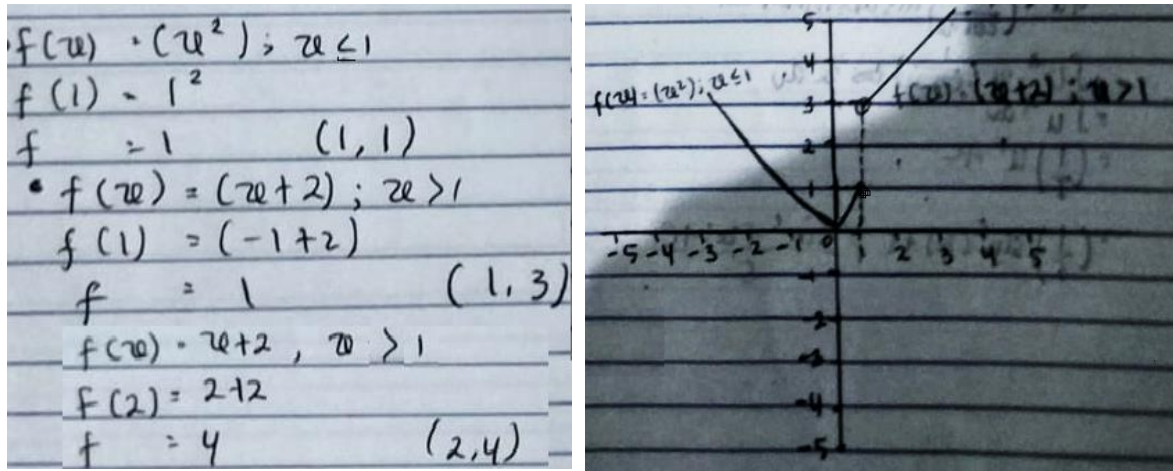
Figure 3. results of student tests are in not enough categories in expressing graphical ideas **(student test results, 2022)**

Overall, it was found that of the 6 respondents, 4 of them had a level of mathematical communication that was less or less than 50%. The percentage of the results of the Mathematical Communication Assessment Rubric, then tabulated in the following table, to then be categorized according to the results obtained:

Table 1. Percentage of Results of the Mathematical Communication Assessment Rubric (student test results, 2022)

No	Respondent	Percentage	Information
1.	A.N.	64,17 %	Good
2.	D.A.	45,13 %	Not Enough
3.	O.M.	43,83 %	Not Enough
4.	P.P.	45,83 %	Not Enough
5.	R.N.	42,30 %	Not Enough
6.	S.M.	87,50 %	Good

Based on the results in the table above, it can be concluded that during the learning that was carried out from the time of the Covid-19 Pandemic, there were students who had poor mathematical communication, which was below 50%, on the other hand there were also

students whose mathematical communication was good, reaching 87,50%. So that learning in this new normal era must be able to improve students' mathematical communication achievements, so that further learning can run well. As explained by Bernard (2015) that communication skills are important for students to have in order to understand mathematical problems and be able to convey ideas and ideas in solving mathematical problems by thinking critically, logically, creatively and independently.

**Results Of The Student Strategy/Procedure Rubric**

The Strategy/Procedure Rubric is an assessment of students' abilities in making mathematical modeling strategies based on appropriate concepts and reasonable reasons. The results of the strategy/procedure rubric of the 6 students are as follows

Table 2. Percentage of Student Strategy/Procedure Ribrik (student test results, 2022)

| No	Respondent	Percentage	Information
1.	A.N.	84,12 %	Good
2.	D.A.	55,15 %	Good
3.	O.M.	49,63 %	Not Enough
4.	P.P.	65,73 %	Good
5.	R.N.	52,39 %	Good
6.	S.M.	97,20 %	Good

Based on the results in the table above, it can be concluded that during online learning during the Covid-19 Pandemic, students who had less mathematical modeling strategies achieved 49.63%, while the highest achievement was 97.20%, although the the percentage of student modeling strategies/procedures is categorized as good, but does not fully support student mathematical communication. One example, students are able to determine the value of $f(x)$, but are unable to represent it in graphical form. This can be seen in the following figure.

Figure 4. Examples of good category modeling strategies, but unable to represent them in graphical form (student test results, 2022)
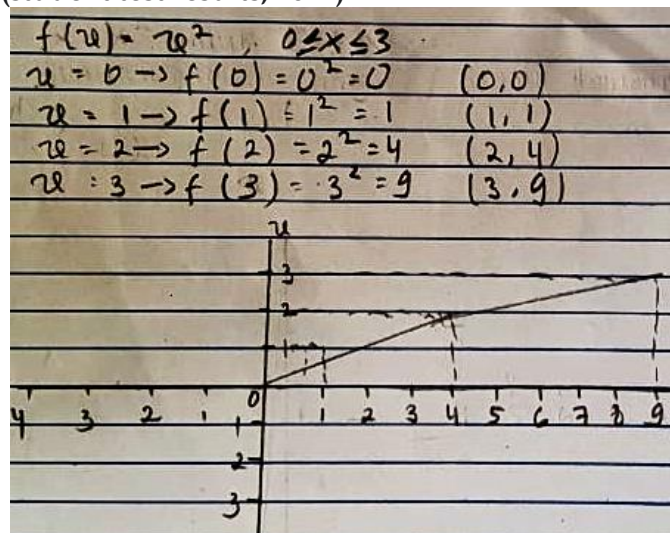
In Figure 5, an example of the test results of students who carry out modeling is in a good category, and is able to represent well on graphs as well. This supports students' mathematical communication skills.

Figure 5. An example of a good category modeling strategy, and being able to represent it in graphical form (student test results, 2022)
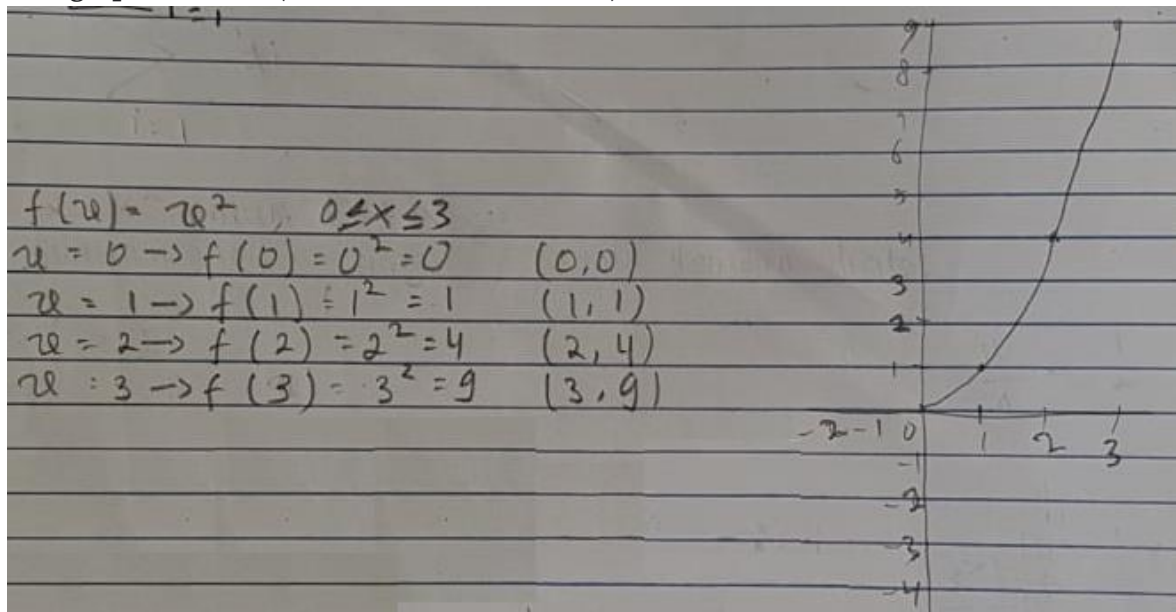
Results Of The Sequence And Student Organization Rubric

The Sequence and Organization Rubric is an assessment of a student's ability to use pictures, tables, symbols, and graphs correctly and accurately and to use mathematical calculations correctly. In Figure 6, an example of student answers is given not enough category. Whereas in Figure 7 an example of student answers is given in the good category.

Figure 6. An example of a student's ability to use images in a not enough category (student test results, 2022)
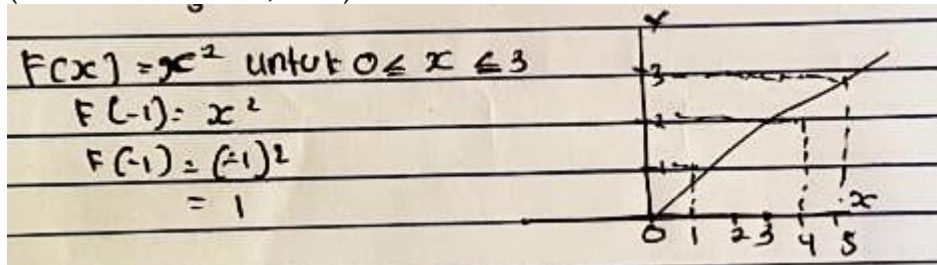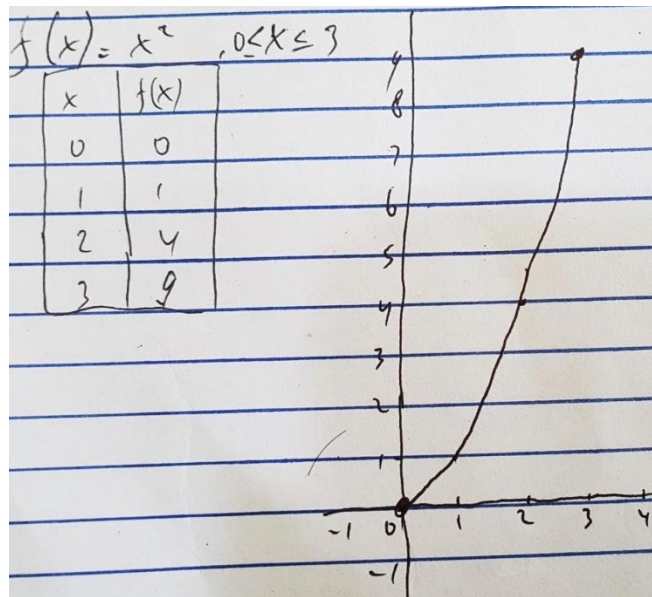

Figure 7. An example of a student's ability to use images in a good category (student test results, 2022)

The results of the strategy/procedure rubric of the 6 students are as follows.

Table 3. Percentage of Rubric Sequence and Student Organization (student test results, 2022)

No	Respondent	Percentage	Information
1.	A.N.	74,32 %	Good
2.	D.A.	52,25 %	Good
3.	O.M.	46,42 %	Not Enough
4.	P.P.	61,37 %	Good
5.	R.N.	49,39 %	Not Enough
6.	S.M.	92,25 %	Good

Based on the results in the table above, it can be concluded that during the learning that was carried out from the time of the Covid-19 Pandemic, students had the ability of students to use pictures, tables, symbols, and graphs as well as the ability to calculate the highest achievement of 92.25% in the good category, while 46,42 % for the achievement is less in students' ability to use pictures, tables, symbols, and graphs as well as the ability to count. This can also be seen in the following diagram:

Results Of The Student Mathematical Language Rubric
Mathematical Language Rubric is an assessment of students' ability to use language and mathematical symbol notation appropriately to communicate mathematical ideas in their minds. In Figure 8, an example of a student's answer is given which gives good language and symbol notation. Whereas in Figure 9 an example of student answers is given which gives language and symbol notation that is not good.

Figure 8. Student's answer is given which gives good language and symbol notation

Figure 9. Student answers is given which gives language and symbol notation that is not good

The results of the mathematical language rubric of the 6 students are as follows.

Table 4. Percentage of Student Mathematical Language Rubric (student test results, 2022)

No	Respondent	Percentage	Information
1.	A.N.	64,32 %	Good
2.	D.A.	42,25 %	Not Enough
3.	O.M.	46,42 %	Not Enough
4.	P.P.	51,37 %	Good
5.	R.N.	49,39 %	Not Enough
6.	S.M.	72,25 %	Good

Based on the results in the table above, it can be concluded that during the learning that was carried out during the Covid-19 Pandemic, students had the ability to communicate mathematical ideas, the highest achievement was 72.25% in the good category, while 42.25% for the achievement was less in ability. students in communicating mathematical ideas in their minds.

Evaluation Results

The questionnaire sheet, which is one with the questions that have been given, is filled in by students to explore several factors that influence students' mathematical communication abilities during online learning amid the Covid-19 Pandemic. Based on the observations from the questionnaires, it can be concluded that most of the students experienced difficulties in working on basic math and calculus questions, most students also experienced difficulties in explaining the results of their answers to calculus questions in writing but were more optimistic about being able to explain verbally. During online learning, many students feel bored, do not understand and are burdened by excessive assignments, students also have difficulty understanding the material and digesting the examples of questions given which result in students not understanding and having difficulty in carrying out the assignments given .

Discussion

From the student answer sheets equipped with the results of evaluation, it is known that some students (50%) are still unable to answer questions about the area of the building, the volume of the building, functions and limits correctly. The questions used in this study are questions in the form of descriptions. According to Ansari (2012), to measure students' mathematical communication skills in learning mathematics, it can be done by giving description questions that can reveal mathematical communication skills. Some of the questions that can be used include exploratory, transfer, elaborative, and applicative questions.

In solving all the questions, only 39.27% of the students were able to demonstrate an accurate understanding of the concept, use the right strategy and reasonable reasons and use mathematical symbols correctly and show mathematical calculations correctly. This means that only a few students meet the first and second indicators of mathematical communication skills, namely strategies/procedures and sequences/organizations. Meanwhile, it was found that only 50% of students were able to use the language and mathematical symbol notation appropriately to communicate mathematical ideas in their minds which indicated that only some students met the third indicator of mathematical communication ability, namely mathematical language.

Pugalee (Qohar, 2013) suggests that to improve students' communication skills in learning mathematics, students should be encouraged to answer questions accompanied by relevant reasons, and comment on mathematical statements expressed by students, so that students understand mathematical concepts and their arguments are meaningful. This is obtained from the answers in the description questions. Explanation questions are questions that in the process require students to use responses or describe steps to get the right answer. This problem provides an opportunity for students to express their ideas or ideas according to their own words and arrange the ideas they already have. Students can answer questions freely, with freedom the test scores will be more subjective. Scoring and scoring depends on the person scoring the test.

In the curriculum it is stated that mathematics is a means of communication. Communication in mathematics is the ability or skill of students in stating and interpreting mathematical ideas orally, in writing, or demonstrating what is in learning mathematics. According to NCTM (2010) communication in mathematics is a way to share ideas and clarify understanding. Through communication, ideas can be described, improved, discussed, and developed. Mathematical communication can be interpreted as an event of dialogue or mutual relationships that occur in the classroom environment, where there is a transfer of messages and messages that are transferred contain the mathematical material studied by students, for example in the form of concepts, formulas, or problem solving strategies.

The teaching and learning process can make an important contribution in developing students' communication skills. Communication is needed to find out how far students understand the material being taught. This can be seen from the way students convey their ideas. However, the current COVID-19 pandemic is a major challenge in the field of education. The COVID-19 pandemic has changed the learning process in higher education institutions into distance learning or independent learning at home to reduce the spread of COVID-19. As a result, students must study independently at home so that students have independent learning that is different from one another. The results of Ansari's research (2012), reveal that various research results show that the decline in students' mathematical understanding in class is partly because: (1) in teaching lecturers give examples to students how to solve problems; (2) students learn by listening and watching the lecturer do the math, then the lecturer solves it himself; and (3) when teaching mathematics, the lecturer immediately explains the topic to be studied, followed by giving examples and questions for practice.

The distance learning system mostly gives the effect as mentioned above which leads to the undeveloped mathematical communication skills of students. As the results of evaluation by researchers who get the results that students complain of difficulties in understanding the learning given, because the delivery by the lecturer is felt to be unclear and too short. Lecturers tend to give examples of questions without discussing them together coupled with demands to do tasks that tend to be a lot. Students also feel bored when they have to do distance learning because there is no active interaction with both lecturers and other students.

CONCLUSION

Based on the results of the study, it was found that some students still have poor or low communicative abilities, this is indicated by the non-fulfillment of all assessment indicators which include strategy, organization and communicative language. Most students feel that distance learning in the midst of a pandemic is less effective, because they have difficulty understanding learning and lecturers only provide brief explanations accompanied by questions that students cannot understand. Therefore, it is necessary to have a learning method in the New Normal Era to support the improvement of students' mathematical communication skills, so that there are no obstacles in the next learning.

Suggestion

For Lecturers, it is expected that they can provide better two-way learning and familiarize students to continue working on practice questions and be taught to be able to provide explanations in order to improve mathematical communication skills or other abilities.

For students, students are expected to be able to explore their mathematical communication skills to solve math problems. In addition, it is hoped that students can be more communicative if they find difficulties in learning.

For other researchers, it is hoped that they can conduct more in-depth discussions about students' mathematical communication skills in solving math problems.

REFERENCES

Ansari, B.I. (2012). *Komunikasi Matematik dan Politik.* Banda Aceh: Yayasan Pena.

Baroody, Arthur. (1993). *Problem Solving, Reasoning, and Communicating*. New York: Macmillan Publishing Company.

Bernard, M.. (2015). Meningkatkan Kemampuan Komunikasi dan Penalaran serta Disposisi Matematik Siswa SMK dengan pendekatan kontekstual melalui game adobe flash cs 4.0. *Infinity Journal*, 4(2), 197-222.

Purwanto, Edi and Solehudin, M.. (2021). "Pseudo Folding Back When Students Solve Real Analysis Problems". *Nusantara Journal of Social Sciences and Humanities*, 1(1), pp. 80-90.

Fauzy , Alwan & Nurfauziah, Puji. (2021). Kesulitan Pembelajaran Daring Matematika Pada Masa Pandemi COVID19 di SMP Muslimin Cililin. *Jurnal Cendekia: Jurnal Pendidikan Matematika* , 5(1), pp. 551-561

Herliandry, L. D., Nurhasanah, Suban, M. E., & Kuswanto, H.. (2020). Pembelajaran Pada Masa Pandemi Covid-19. *Jurnal Teknologi Pendidikan*, 22(1), 65–70. doi: 10. 21009/jtp.v22i1.15286

NCTM. 2010. Principles and Standards for School Mathematics. Reston, Virginia: NCTM.

Purwanto, Edi. (2020). Representasi Siswa Sma Dalam Menyelesaikan Masalah Matematika. ***THETA: Jurnal Pendidikan Matematika***, 2(1), 1-11.

Qohar, A.. (2013). Mathematical Communication: What And How To Develop It inMathematics Learning?. Proceeding International Seminar and the Fourth National Conference on Mathematics Education 2011. Yogyakarta: Universitas Negeri Yogyakarta.

Santos dan Semana, (2015). "Developing Mathematics Written Communication Through Expository Writing Supported by Assessment Strategies." *Educational Studies in Mathematics*, 88(1), 65-87.

Sumarmo, Utari. (2011). Pembelajaran Matematika Berbasis Pendidikan Karakter. Vol.1, Tahun 2011. ISBN 978-602-19541-0-2.

Vui, T. (2007). A Lesson that may Enhance Classroom Communication to Develop Student's Mathematical Thinking in Vietnam. Paper presented at APEC-TSUKUBA International Conference III, TokyoKanazawa, December 9-14.

Yunitasari, I., Sahrudin, A., Kartasasmita, B. G., & Prakoso, T. B.. (2019). Pengembangan Bahan Ajar Matematika Dengan Memanfaatkan Program GeoGebra Untuk Meningkatkan Pemahaman Konsep dan Kemandirian Belajar Mahasiswa Pada Pokok Bahasan Bangun Ruang Sisi Datar. *Journal Of Matematics Learning*, 2(2), 1–11