ISEJ Indonesian Science Education Journal

ISEJ: Indonesian Science Education Journal
|ISSN: 2716-3350
Vol. 3, No. 1, Januari 2022, Hal 15-23

Fostering Students' Mathematical Communication Skills in Mathematics Learning

Tia Fitri Nuraini[1], Nindy Cahyani Haditia[2], Arif Rahman Hakim[3], Nur Indah Sari[4]

[1,2,3,4] Mathemathic Education Program, Indraprasta PGRI University, Jakarta, Indonesia

e-mail:
[1]tfitrinuraini@gmail.com, [2]nindycahyani958@gmail.com, [3]arsyanriftyrahman@gmail.com, [4]1290nurindahsari@gmail.com

ABSTRACT: This article is the result of a literature review (theory of findings) regarding mathematical communication skills in learning mathematics. This article was written with the aim of providing a thorough understanding of mathematical communication skills as well as describing various alternative ways of building students' mathematical communication skills in learning mathematics. The results obtained from writing this article are in the form of a description of the definition of mathematical communication skills, descriptions of indicators of mathematical communication skills, and descriptions of efforts to develop mathematical communication skills in students. With these results, obtained a way how teachers can build and develop mathematical communication skills in students in each process of learning mathematics activities. Through this article, it can be concluded that teachers in learning mathematics must be able to carry out various learning activities that can clearly develop students in terms of mathematical communication skills.

Keywords: Mathematics Learning, Mathemathical Communication Skills

INTRODUCTION

Mathematics is a basic science that has an important role in the development of science and technology, therefore the need to understand mathematics must be emphasized even more since elementary school. In accordance with the Ministry of National Education (2006) said that mathematics subjects must be given to all students starting from the elementary school level to equip students with the ability to think logically, analytically, systematically, critically, and creatively, as well as the ability to cooperate. It aims that students can adjust to the rapid development of technology. But most of the students think that mathematics is a difficult subject to understand without realizing it, this assumption contributes to changing the negative mindset of students towards mathematics. Mathematics is a basic science that has an important role in the development of science and technology, therefore the need to understand mathematics must be emphasized even more since elementary school. In accordance with the Ministry of National Education (2006) said that mathematics subjects must be given to all students starting from the elementary school level to equip students with the ability to think logically, analytically, systematically, critically, and creatively, as well as the ability to cooperate. It aims that students can adjust to the rapid development of technology. But most of the students think that mathematics is a difficult subject to understand without realizing it, this assumption contributes to changing the negative mindset of students towards mathematics.

Mathematical communication skills are one of the objectives of learning mathematics. This is in accordance with the objectives of learning mathematics according to the Minister of National Education No. 22 of 2006 concerning Content Standards is that the rest must have the ability to: a) understand mathematical concepts; b) using reasoning on patterns and properties; c) problem solving which includes the ability to understand the problem; d) communicate ideas and symbols, tables, diagrams, or other media to clarify circumstances or problems, e) have an attitude of appreciating the usefulness of mathematics in life. Among these mathematical abilities, mathematical communication skills are indispensable for every student in facing developments in the current era of globalization and information.

Functionally, learning mathematics begins with the ability of students to understand mathematical language, the ability to remember mathematical terms, procedures and theories, the ability to master the necessary mathematical tools and the ability to apply them in real life to solve problems (Yuniarti, 2014: 109). In addition, in developing these abilities to students, educators are needed who are competent in communicating matters related to mathematics to students. But most mathematics learning in the classroom of learners does not get enough opportunities to be able to develop mathematical representation skills as an important thing in solving mathematical problems. This is in accordance with the opinion (Hakim, 2019: 556) that mathematics learning activities in the classroom that occur today tend to be based on the acquisition of results in the form of numbers. This fact is one of the factors that causes teachers in mathematics learning classrooms to only focus on delivering material and pursuing target learning outcomes that must be achieved with certain student value standards do not play an important role in the classroom.

One of the important problems in the mathematics learning process is that students are less able to communicate ideas with symbols, tables, diagrams, or other media to clarify circumstances or problems. In accordance with Astuti & Leonard (2014: 103) One of the important problems in mathematics learning today is the importance of developing mathematical communication skills of students. Because mathematical communication skills are one of the standardizations for the graduation of students in schools. In reality, teachers tend to cope with the communication of learners in the classroom by explaining the material being taught, explaining examples, and providing questions and answers or discussions. So that in the process of learning mathematics, students are not given the opportunity to express questions or be asked for explanations as they begin to get these answers.

Based on the foregoing, the reality is that there is still weak communication skills in students in solving math problems. Strengthened according to Supriadi & Damayanti (2016: 2) Weak

mathematical communication skills of students result in their ability to solve problems will be weak as well. The most important activity in learning mathematics is to solve problems mathematically, especially problems that will be encountered in everyday life. Therefore, it is necessary for communication skills to be developed in students because mathematics is not only able to solve problems in everyday life but also as a place of communication between teachers and students.

DISCUSSION

Definition of Communication Ability In Mathematics

In real life a person is inseparable from a communication. Communication is something important in mathematics learning. clarified according to Ahmad & Nasution (2018:84) "communication is a process towards a person in conveying a message either directly (verbally) or indirectly (written)".

According to Nugraha & Pujiastuti (2019:2) that "mathematical communication skills have scope, including oral communication and written communication. Oral communication is like discussion and explaining. Written communication is like expressing a mathematical idea through images/graphs, tables, equations, or expressing with one's own language". Through written and oral communication, it can bring students deeper into understanding their mathematical understanding. One of the oral communication tables, diagrams, and graphs is one of the ways used in mathematics that can lead learners to make views, conclusions, and questions.

Mathematical communication skills are abilities that aim to enable students to convey mathematical ideas or messages containing mathematical material. In line with the statement of Budianti & Jubaedah (2018: 20) Mathematical communication ability is an ability where students convey something they know through dialogue events or interconnectedness that occurs in the classroom environment, where there is a diversion of message delivery containing mathematical material Mathematical communication skills are an ability where students convey something they know through discussion events or interconnected that occur in classroom environment, where there is a diversion of message delivery containing mathematical material.

Meanwhile, according to Lestari & Yudhanegara (2015: 83) "mathematical communication skills are the ability to convey mathematical ideas or ideas, both orally and in writing as well as the ability to understand and accept other people's mathematical ideas or ideas carefully, analytically, critically, and evaluatively to deepen mathematical understanding". Based on the understanding according to Lestari & Yudhanegara (2015) that it can be understood that mathematical communication skills are mandatory because through communication also ideas can be improved, discussed, developed, and also carried out in real life.

According to Rahmalia, Hajidin, & Ansari (2020: 138) mathematical communication skills are also skills to interpret and study ideas and the ability to use mathematical symbols, terms, and their structures to describe situations in mathematical problems.

Based on the definition from the experts above, it is interpreted that the importance of mathematical communication skills for students, this is in accordance with the opinion of Yanti, Melati, & Zanty (2019: 211) "Mathematical communication skills are also very important for students to have. The importance of mathematical communication is taught in schools so that students are able to read and understand what is being ordered and talked about on an issue. Mathematical communication is a basic thing that students must understand and as a vehicle for interaction between students and teachers in schools". It can be understood that mathematical communication skills have an important role and must be possessed by high school students.

Mathematical communication skills are a very helpful thing for a teacher in understanding the ability of students in the mathematics learning process. this is supported by Maulyda's (2020:73) opinion that "Teachers can shape students' communication skills during class discussions. The first is to form behaviors that support the learning process in the classroom. In addition, choosing and

using mathematical problems that allow a lot of communication to occur. Third, guide class discussions about what is being learned by monitoring the student's learning process".

Communication skills are basic and important skills that must be possessed by students as a means of ineffection between students and teachers. In line with the opinion according to Yanti, Melati, & Zanty (2019: 211) mathematical communication skills are also very important for students to have. The importance of mathematical communication is taught in schools so that students are able to read and understand what is being ordered and talked about on an issue.

After analyzing from several expert opinions described above, it can be concluded that the mathematical communication skills of students can be interpreted as an ability where the process of students must be able to convey ideas or ideas about mathematical material both in writing and orally.

Aspects and Indicators of Mathematical Communication Ability

To measure communication skills in students, measuring instruments or indicators are needed, therefore they are very important and can be used as appropriate measurement guidelines. Exact and appropriate indicators are indicators of a variety of clear sources. In this case, students show certain aspects and indicators that affect mathematical communication skills. According to Baroody (in Ansari, 2016:17) mathematical communication skills include the following aspects: 1) New representations or forms as a result of translation of a problem or idea; 2) Listening, an important aspect in a discussion. Students will not be able to comment well if they are unable to take the essence of a discussion topic; 3) Reading, the activity of actively reading the text in search of answers to the questions that have been compiled; 4) Discussion, a means of expressing and reflecting on students' thoughts; 5) Writing, an activity carried out consciously to express and reflect thoughts

According to Hendriana & Soemarmo (2017:30) Indicators of mathematical communication ability are as follows: (1) Linking real objects, drawings, and diagrams into mathematical ideas; (2) Describe mathematical ideas, situations, and relationships orally or in writing, with real objects, images, graphs, and algebra; (3) Stating everyday events in the language of mathematics; (4) Listening, discussing, and writing about mathematics; (5) Reading with comprehension a written mathematical presentation; (6) Compile mathematical questions relevant to the problem situation; (7) Make conjectures, formulate arguments, formulate definitions and generalizations

While the indicators of mathematical communication skills used according to NCTM (Rofiq, 2018: 30) can be seen from: 1) The ability to express mathematical ideas through oral, written and demonstrate them and describe them visually, 2) The ability to understand, interpret and evaluate mathematical ideas both orally and in other visual forms, 3) The ability to use terms, mathematical notations and their structures to present ideas, describes relationships and models of situations.

Other indicators of mathematical communication skills are put forward by the Ontario Ministry of Education (in Hendriana, Rohaeti, & Sumarmo, 2017:62): (1) Written text, which is to provide answers using their own language, model situations or problems using oral, written, concrete, graph and algebra, explain and make questions about mathematics that have been studied, listen, discuss, and write about mathematics, make conjectures, compile arguments and generalizations; (2) Drawing, that is, reflecting real objects, drawings, and diagrams into mathematical ideas; (3) Mathematical expressions, that is, expressing mathematical concepts by stating everyday events in mathematical language or symbols.

Meanwhile, based on the Principles and Standards for School Mathematics from NCTM in 2000 (in Maulyda, 2020: 65) students' mathematical communication skills can be seen from the following aspects: 1) The ability to express mathematical ideas through oral, written, and visually described. 2) Ability to interpret and evaluate mathematical ideas both orally and in writing. 3)

Ability to use terms, mathematical symbols, and their structures to model mathematical situations or problems.

The indicators of mathematical communication according to LACOE (in Hendriana, Rohaeti, & Sumarmo, 2017:63) are as follows: 1) Reflecting and clarifying thoughts about mathematical ideas; b) Connecting colloquial language with mathematical language using symbols; c) Using his skills of reading, listening, evaluating, interpreting mathematical ideas; and d) Using mathematical ideas to make conjectures and make convincing arguments.

Guidelines for scoring mathematical problem solving abilities according to Hendriana & Soemarmmo (2014:77-78); Sumarmo (Wijayanto, Fajriah, & Anita, 2018:99).

Table 1. Guidelines for Scoring Students' Mathematical Communication Skills

Communication Skills Indicators	Answer	Score
Expressing mathematical situations or everyday events into mathematical models and solving them	No Answer	0
	Identify known and questionable elements/data and state in mathematical symbol elements	0-2
	Identify known and questionable elements/data	0-2
	Compile mathematical models of problems in the form of mathematical drawings and or expressions and explain the mathematical concepts involved	0-2
	Solving mathematical problems/models with reasons	0-2
	Establish relevant solutions with reasons	0-2
	Sub total	0-10
Declaring mametaic models (images, algebraic expressions) into ordinary language (composing story questions)	No Answer	0
	Equipping mathematical models (figures) and or mathematical expressions with relevant elements	0-2
	Identifying mathematical concepts/principles contained in a given mathematical model (images and or expressions)	0-2
	Identify the problem to be posed and determine the mathematical concepts contained in the problem in question	0-3
	Compile questions that are relevant to the mathematical model in question	0-3
	Sub total	0-10
Explaining the mathematical model of dana tau pattern	No Answer	0
	Identify mathematical concepts and processes contained in a given mathematical model	0-2
	Identifying the relationships between mathematical concepts and processes contained in a given mathematical model / pattern	0-2
	Provide an explanation of the relationship between mathematical concepts and processes contained in the given mathematical model / pattern	0-2
	Sub total	0-6
	No answer	0

Prepare questions about the situation given along with reasons	Identifying mathematical concepts and processes contained in a given situation	0-2
	Identifying mathematical concepts and processes to be asked	0-3
	Compile questions related to mathematical concepts and processes that will be asked along with reasons	0-3
	Sub total	0-8

Table 2. Guidelines for Scoring Students' Mathematical Communication Skills

No	Criterion	Score
1	Complete and clear response, no hesitation, complete diagram, efficient communication, logical presentation, accompanied by examples.	4
2	The response is correct, complete and clear, the diagram is complete, communication is efficient, and the presentation is complete but not accompanied by examples.	3
3	The response is correct, complete and clear, the diagram is complete, the communication and presentation are incomplete and not accompanied by examples.	2
4	The response is correct but incomplete/ clear, diagrams, communication and presentations are incomplete, not accompanied by examples of none.	1
5	Response, inefficient communication, misinterpretation (no answer whatsoever/blank student answer sheet)	0

Fostering Mathematical Communication Skills in Students in Mathematics Learning.

In an effort to face and adjust to the rapid development of science and technology, mathematics learning needs to be updated or innovated in the learning process in the classroom. In the process of learning, educators not only provide information but as a driver so that students are able to develop their own knowledge through communication (Ariani, 2017: 97). Through communication, the process of conveying questions and ideas of students can be improved, discussed, developed, and also carried out in real life. Thus, a model or mathematics learning strategy is needed that educators use in the classroom to achieve an expected learning goal.

According to Goet (in Ariani, 2017: 103), strategies in developing students' mathematical communication skills are not much different from how to develop communication in general, namely by: 1) Using brainstorming techniques or expressing opinions every time they start the mathematics learning process; 2) Provide opportunities for students first to verbally express ideas before writing them down; 3) Give students the opportunity to describe their key ideas; 4) Encourage and give students the opportunity to revise and correct their writing; and 5) doing reflection.

Learning strategies that promote mathematical communication skills and are effective in improving students' mathematical attitudes in mathematics learning that are needed by students are learning that involve students to be able to play an active role such as asking, answering questions, solving problems and others (Sumirat, 2014: 24). An activity that is expected and can be applied in the classroom to develop students' mathematical communication skills, one of which is by applying a Think Talk Write (TTW) type cooperative learning strategy or model, and giving open ended assignments (open problems).

The Think Talk Writer (TTW) Cooperative learning model consists of three stages, namely Think (thinking or reflective dialogue, Talk (talking or discussing), and Writer

(writing). Theoretically, the stages in the TTW cooperative learning model can develop mathematical communication skills. This can be seen from the Think or thinking stage referred to here according to Huinker and Laughlin (Sumirat, 2014: 25) namely thinking and speaking / discussing are important steps in the process of bringing understanding into the student's writing, then Talk or speak at the talk stage students join their group to reflect, compile, and express ideas in discussion activities, and according to Masingila, Davidenko, and Prus-Wisniowska (Sumirat, 2014:25) Writer or writing can help students express their knowledge and ideas and reflect on their knowledge and ideas.

The purpose of the Think Talk Writer (TTW) strategy is to attach importance to students in communicating the results of thinking on mathematics to open ended or open problems given by the teacher, while the purpose of giving open ended assignments is to prioritize the process of getting results in doing the task. The TTW strategy is a cooperative learning model which is basically a learning strategy through the stages of thinking, speaking (talk) and writing (write).

This Think Talk Writer (TTW) strategy involves students to participate in building thoughts, developing ideas, communicating their thoughts and then students discussing and writing the results of these thoughts. Reinforced by the opinion of Ansari (2016:7) TTW's cooperative learning strategy begins with how students think about solving an open-ended task (problem), then followed by communicating the results of their thoughts, and finally through discussion students can write the results of these thoughts. The same opinion from Sumirat (2014:24) that TTW's strategy builds thoughts, reflects, and organizes ideas, then tests those ideas before learners are expected to write. Thinking activities can be seen from the process of reading a mathematical text or containing a mathematical story and then making notes about what has been read. Sumirat (2014:25) This TTW learning strategy has advantages, namely after the reading process students are required to think or dialogue with themselves and then convey the ideas they get from reading with their friends before writing their ideas. Therefore, it is necessary for teachers to know how to cultivate mathematical communication skills among learners.

In fact, there are still many teachers who do not pay attention to the learning process and only prioritize the final results of students. In line with the opinion of the Judge (2019: 556) This fact is one of the factors that causes teachers in mathematics learning classrooms to only focus on delivering material and pursuing the target number of learning outcomes that must be achieved with certain grade standards. It is this variety of good teacher attitudes that students will consciously or unconsciously imitate. Then the teacher also still tends to be active, with a lecture approach to delivering material to students which causes that students are less able to communicate their mathematical ideas clearly and correctly, both orally and in writing. Therefore, in order for learners to communicate their mathematical ideas and convey their ideas about mathematics, learners need a habit of taking the courage to actively participate in trying to present their ideas. The learning process of students by discussing to strive for results is also a way to develop students' mathematical communication skills. In providing a way with class discussions, students are not just listening to explanations from the teacher and taking notes, but by discussing students can communicate the results of their discussions, and rewrite the results of their thoughts to solve problems regarding mathematical material. Therefore, the teacher must provide opportunities for students to be able to convey mathematical ideas or messages containing mathematical material both oral and written.

CONCLUSION

Overall, to be able to achieve a goal and maximum result standards for each guide to the process of mathematics learning activities, with this article, it can be concluded that teachers in mathematics learning must be able to carry out various learning process activities that can

clearly develop students in terms of mathematical communication skills. Among them is, teachers must be able to apply various learning methods to the mathematics learning process, not by applying the old method. With new methods that are appropriate and seriously prepared by teachers, of course, they will be able to develop mathematical communication skills. In addition, teachers must also regularly make a class discussion by presenting various practice questions that are in accordance with mathematical communication skills.SITASI DAN REFERENSI

REFERENCE

Ariana, D. N. (2017). Strategi Peningkatan Kemampuan Komunikasi Matematis Siswa SD/MI. *MUALLIMUNA: Jurnal Madrasah Ibtidaiyah*, 3 (1): 96-107. https://ojs.uniska-bjm.ac.id/index.php/jurnalmuallimuna/article/view/958.

Ansari, B. I. (2016).Komunikasi Matematik, Strategi Berfikir dan Manajemen Belajar; Konsep dan Aplikasi.Yayasan PeNA. Banda Aceh.

Yuniarti, Y. (2014). Pengembangan Kemampuan Komunikasi Matematis Dalam Pembelajaran Matematika Sekolah Dasar. *EduHumaniora*, 6 (2): 109-114. https://ejournal.upi.edu/index.php/eduhumaniora/article/view/4575.

Hakim, A. R. (2019). Menumbuhkembangkan Kemampuan Disposisi Matematis Siswa dalam Pembelajaran Matematika. *Prosiding DPNPM Unindra*, 555-564. http://proceeding.unindra.ac.id/index.php/DPNPMunindra/article/view/3933.

Astuti, A. dkk. (2015). Peran Kemampuan Komunikasi Matematika Terhadap Prestasi Belajar Matematika Siswa. *Jurnal Formatif,* 2 (2): 102-110. https://journal.lppmunindra.ac.id/index.php/Formatif/article/view/91.

Supriadi, N. & Damayanti, R. (2016). Analisis Kemampuan Komunikasi Matematis Siswa Lamban Belajar dalam Menyelesaikan Soal Bangun Datar. *Al-Jabar: Jurnal Pendidikan Matematika*, 7 (1):1-9. http://ejournal.radenintan.ac.id/index.php/al-jabar/article/view/21.

Khadijah, I. N. A. dkk. (2018). Analisis kemampuan Komunikasi Matematis Siswa SMP Pada Materi Statistika. *Jurnal Pembelajaran Matematika Inovatif,* 1 (6):1095-1104. https://journal.ikipsiliwangi.ac.id/index.php/jpmi/article/view/1742.

Maulyda M. A. (2020). Paradigma Pembelajaran Matematika Berbasis NCTM. Purwokerto CV IRDH.

Rahmalia, R. dkk. (2020). Peningkatan Kemampuan Komunikasi Matematis dan Disposisi Matematis Siswa SMP Melalui Model Problem Based Learning. *Jurnal Numeracy*, 7 (1): 137-149. https://ejournal.bbg.ac.id/numeracy/article/view/1038.

Sumirat, L. A. (2014). Efektifitas Strategi Pembelajaran Kooperatif Tipe Think-Talk-Write (TTW) Terhadap Kemampuan Komunikasi Dan Disposisi Matematis Siswa. *Jurnal Pendidikan dan Keguruan*, 1 (2): 21-29. https://www.neliti.com/id/publications/209667/efektifitas-strategi-pembelajaran-kooperatif-tipe-think-talk-write-ttw-terhadap.

Nugraha, T. H. dkk. (2019). Analisis Kemampuan Komunikasi Matematis Siswa Berdasarkan Perbedaan Gender. *Edumatica*, 9 (1): 1-7. https://online-journal.unja.ac.id/edumatica/article/view/5880.

Ahmad, M. dkk. (2018). Analisis Kualitatif Kemampuan Komunikasi Matematis Siswa Yang Diberi Pembelajaran Matematika Realistik. *Jurnal Gantang,* 3 (2): 83-95. https://ojs.umrah.ac.id/index.php/gantang/article/view/471.

Nurjanah, M. T. (2018). Kemampuan Komunikasi Matematis Siswa Dalam Menyelesaikan Masalah Perbandingan Ditinjau Dari Gaya Kognitif Field Dependent dan Field Independent. (Skripsi). Universitas Jember.

Hendriana, H. & Sormarmo, U. (2014). Penilaian Pembelajaran Matematika. PT Refika Aditama. Bandung.

Hendriana, H. Rohaeti, E. E. & Soemarmo, U. (2018). Hard Skills dan Soft Skills Matematik Siswa. PT Refika Aditama. Bandung.

Lestari, K.A & Yudhanegara, M. R. (2017). Penelitian Pendidikan Matematika. PT Refika Aditama. Bandung.

Budianti, A. & Jubaeda, D. S. (2018). Analisis Kemampuan Komunikasi Matematik Siswa di SMPN 10 Cimahi Pada Materi Lingkaran. *Jurnal Cendekia: Jurnal Pendidikan Matematika,* 2 (2):20-28. https://media.neliti.com/media/publications/269836-analisis-kemanpuan-komunikasi-matematik-7279a6f2.pdf.

Yanti, R. N. dkk. (2019). Analisis Kemampuan Pemahaman dan Kemampuan Komunikasi Matematis Siswa SMP Pada Materi Relasi dan Fungsi. *Jurnal cendekia; Jurnal Pendidikan Matematika,* 3 (1): 2019-219. https://j-cup.org/index.php/cendekia/article/view/95.

Rofiq, M. Z. (2018). Kemampuan Komunikasi Matematis Siswa Dalam Menyelesaikan Soal Cerita Materi Sistem Persamaan Linier Dua Variabel (SPLDV) Kelas VIII-B Di MTs Negeri 1 Tulungagung Tahun Ajaran 2017/2018. (Skripsi). Institut Agama Islam Negeri Tulungagung. http://repo.iain-tulungagung.ac.id/10657/.