



Analysis of Students' Mathematical Communication Skills in Solving Mathematics Questions for Number Patterns

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Abstract

This study aims to analyze students' mathematical communication abilities in solving math questions with number patterns. The type of research is descriptive qualitative research. The research participants were consisting of 6 students of grade VIII C students of SMP Negeri 3 Sungguminasa in 2019/2020 with high, moderate, and low abilities. The collection technique in this study was in the form of written tests and interviews. The instrument used is a description test which contains indicators of mathematical communication abilities in number pattern material, a totally of 5 questions. The results of this study indicate that students' mathematical communication abilities were in the moderate categories. Students with high abilities are already in the good categories, marked by the achievement of all indicators of mathematical communication abilities. Students with moderate abilities are still in the moderate categories, marked by students only being able to achieve the ability to explain mathematical ideas with pictures and express everyday events in mathematical language. Meanwhile, low-ability students are still in the low categories, marked by students only being able to fulfill their ability to compile arguments and formulate generalizations using their own language.

Keywords: Analysis; Mathematical Communication Ability; Number Patterns.

INTRODUCTION

One of the processes of the developmental nature of a human being through education is increasingly important in ensuring that students are skilled and innovative in learning. Learning means all psychic activities so that changes in behavior occur as different results between before and after for each individual (Djamaluddin & Wardana, 2019; Muflihah, 2021). From this process of change, it is hoped that new experiences, skills, and knowledge in new fields will emerge.

The main field of study that does not escape playing an important role in achieving educational learning goals is mathematics. One of the objectives of learning mathematics in the 2013 curriculum is to communicate ideas with tables, symbols, diagrams, graphs, and other media to expand the situation or question (Kemdikbud, 2014). Communication activities in mathematics in the classroom involve students communicating verbally and in writing (Susanto, 2015). Through this, it allows students' learning potential to communicate mathematical ideas and build their own concepts or knowledge.

In line with that, the National Council of Teachers of Mathematics (NCTM) (2000) sets several abilities that must be possessed by every student, one of which is the ability to communicate mathematically. With mathematical communication, the teacher can see various difficulties, responses, and descriptions of students if they are given a problem with different forms of communication in a visual context; they also can choose the right learning model so that students can know the concept of material correctly and not just memorize it. So apart from being the basis of mathematical solutions as well as a means of communication of science (Vale et al., 2017; Masrukan et al., 2015; Tambunan, 2019)

The ability to convey mathematical opinions/ideas, and problem-solving strategies, both orally and in writing or in the form of tables, graphs, symbols, diagrams, or other media, including the ability to understand, collect, organize, explain, also agree mathematical opinions/ideas other people



critically, analytically, carefully, and evaluatively in sharpening understanding, and finding out what is given and asked about a problem are the definition of mathematical communication skills (Lestari & Yudhanegara, 2015; Noor & Ranti, 2019; Hajj et al., 2021)

However, the current facts in the field prove that students' mathematical communication skills are generally still low. Based on the results of observations and interviews conducted with one of the mathematics teachers at SMPN 3 Sungguminasa, it was stated that students' mathematical communication skills towards mathematics subjects were still low, as seen from the accumulated mathematics scores of all eighth-grade students, about 60% of students had low scores. This can be seen through symptoms such as most students who, when given a math problem, still need a re-explanation from the teacher because they cannot digest the meaning of the question given directly. Students have difficulty in expressing math problems because of the use of the language used, difficulties if given the language of the book (Kasmawati, 2019)

In agreeing with initial research conducted by Morgan, C. et al. (2014) in identifying the characteristics of mathematical language that at all stages of education, students seem to have difficulty knowing and using mathematical language as communication correctly. These include difficulties with algebraic notation, vocabulary, and logical linking (Morgan C. et al., 2014). In line with this, Ariani (2017) explained that when the question sentences are different for the same question or vice versa, different questions for the same question, students will feel confused in determining what steps to take, a factor because students tend to imitate the problem-solving style given. The teacher is often causing unable to solve problems that are different from the previous examples. Hence, they cannot express their ideas or ideas in mathematical form.

Apart from this, one of the materials in junior high school mathematics in class VIII that requires students to be able to communicate mathematical communication skills by expressing in writing ideas/opinions correctly is the number pattern material. Because in the number pattern material, various problems or questions must be solved either by using pictures, diagrams, tables, graphs, or mathematical symbols or with words orally and in writing so that they have a role in improving mathematical communication skills. However, there are still students who experience incompleteness; according to Soraya et al. (2021), one of the obstacles to completeness is the expression in drawing and determining the pattern of the arrangement of several numbers. The results of these studies motivate researchers to analyze further students' mathematical communication skills in completing mathematics with number pattern material consisting of high, medium, and low abilities.

METHOD

This descriptive qualitative research aims to analyze and describe the mathematical communication skills of junior high school students on the material of patterns and number sequences. The research subjects were 6 students of class VIII C of SMP 3 Sungguminasa, each with 2 students with high, medium, and low abilities. The sample was taken based on the score of the mathematics test and the results of interviews with the mathematics teacher. The research instrument uses a mathematical communication ability test of number pattern material, containing indicators of mathematical communication ability, designed by researchers and has been validated by several expert lecturers and mathematics'.

The data collection technique in this study is written tests and interview techniques. Written test techniques containing indicators of communication abilities (NCTM, 2020; Lestari, 2015) are as follow: 1) The ability to connect real objects, pictures, graphs, and diagrams into mathematical ideas; 2) The ability to explain mathematical idea **situations, and relations in writing, with real, pictures, graphs, and algebra**; 3) The ability to state everyday events in mathematical language and 4) The ability to formulate arguments, formulate definitions and generalizations.

Scores are given for each test question according to the answers of the grids that have been compiled. Then compared to the criteria of mathematical communication ability, the analysis of student learning results can be seen in the following table:

Table 1. Criteria for Mathematical Communication Ability

Score	Criteria
76-100	Very good
51-75	Good
26-50	Moderate
0-25	Low

(Source: Elvita, 2014: 56)

RESULT AND DISCUSSION

Result

Test results data to measure students' mathematical communication skills are as follows:

Table 2. Analysis of Mathematical Communication Ability Test Results

Student	Question Number, Maximum score, student score					Score	Value	Categories
	1	2	3	4	5			
	10	12	10	10	12			
(KT) R ₁	9	10	6	8	9	42	77	Very Good
(KT) R ₂	8	9	6	9	8	40	74	Good
(KS) R ₃	6	6	3	6	4	25	46	Moderate
(KS) R ₄	6	4	4	5	5	24	44	Moderate
(KR) R ₅	3	3	2	1	1	10	18	Low
(KR) R ₆	3	4	0	3	2	12	22	Low
	Average						46	Moderate

2. Untuk membuat meja makan, pak Ali menebang pohon jati di kebun miliknya. Kayu dari pohon jati tersebut cukup panjang, jika pak Ali memotong kayu menjadi dua potong bagian, kemudian masing-masing bagian dari potongan kayu tersebut dipotong kembali menjadi dua bagian, dan terus berlanjut pada potongan-potongan berikutnya.

- Gambarkanlah pola bilangan yang terbentuk jika proses pemotongan dilakukan sebanyak 3 kali!
- Tentukan banyaknya potongan kayu yang dihasilkan pak Ali apabila dilakukan 10 kali proses pemotongan dengan menggunakan pola bilangan!

Figure 1. Question Number 2

Question number 2 contains indicators of communication skills in explaining ideas, mathematical situations in writing in the form of pictures, the ability to state everyday events in the language of mathematics, and the ability to formulate arguments and formulate definitions based on the questions that have been provided. Here are the results of student completion.

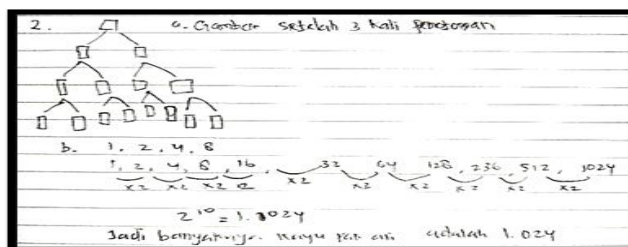


Figure 2. Answers No. 2 High Ability Students (R₃)

Figure 2 shows that the answer to R₂ draws the shape of the pattern of pieces of wood that is cut after 3 times per what was asked in the question. Students can convert the problem of Mr. Ali's number of pieces of wood into mathematical language. At the end of the answer, they have compiled an argument based on the conclusions of the answers obtained. It was concluded that high-ability students could achieve all the indicators of communication skills in explaining ideas, mathematical situations in writing in the form of pictures, the ability to state everyday events in the language of mathematics, and the ability to formulate arguments and formulate definitions.

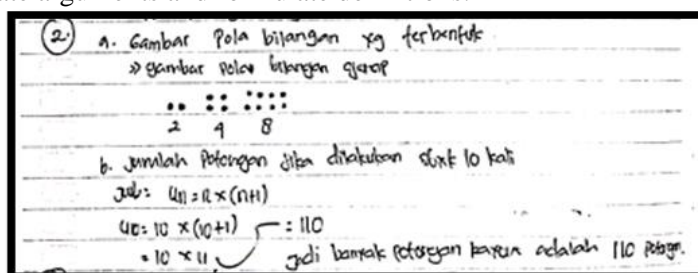


Figure 3. Answers No. 2 Medium Ability Students (R₃)

Based on the answers, students R₃ have mastered the sentences in the problem, which can communicate ideas logically by using pictures in the form of number patterns. There is still an error in converting contextual problems into mathematical language, judging by the inaccuracy of drawing formulas to answer word problems. For the ability to construct arguments and generalizations, they can make conclusions even though the results are not right. It was concluded that students with the moderate ability for answer number 2 had not all been fulfilled.

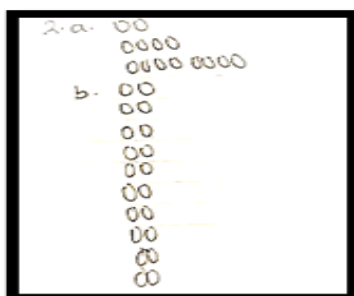


Figure 4. Answers No. 2 Low Ability Students (R₆)

Students' answers R₆, it can be seen that students describe the shape of the problem based on the concept of a number pattern. Still, the students did not do it again for the second problem regarding determining the number of values using the concept of a number pattern. Instead, the students again described a pattern. This shows that indicators regarding explaining ideas in writing, with pictures, have been achieved. Indicators in the ability to state daily events in mathematical language and make arguments into problems still need to be met.

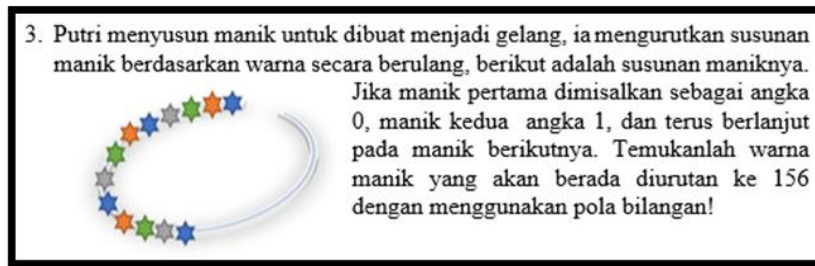


Figure 5. Question Number 3

Question number 3 is provided with a picture that is asked to find the color of beads in a certain order based on the number pattern contained in the picture of the problem; it includes indicators of the ability to connect real objects to mathematical ideas and the ability to compose arguments, and make definitions. The following are the results of student completion.

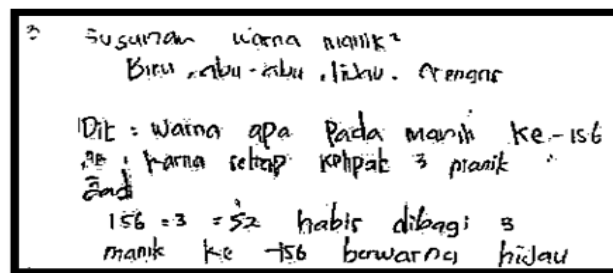


Figure 6. Answers No. 3 High Ability Students (R_1)

Based on Figure 6, students have changed the images contained in the problem into mathematical ideas and ideas to the final completion stage. However, it does not include steps to complete the problem in its entirety and consists of a clear reason for the final answer obtained. So indicators of the ability to connect real objects to mathematical ideas can already be seen but not with generalizations.

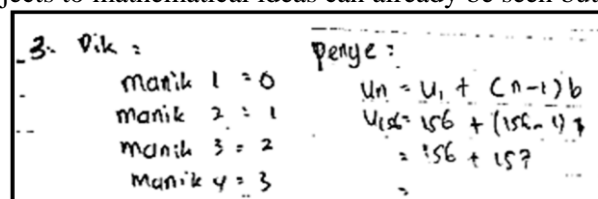


Figure 7. Answers No. 3 Medium Ability Students (R_4)

The answers of students R_4 are known that students directly use the formula for number sequences by substituting their values even though the question only wants to know the color of beads instead of determining the number of certain tribes; in this case, students experience errors in connecting real objects into mathematical ideas, so that it can be seen that the ability student communication has not been achieved for these indicators.

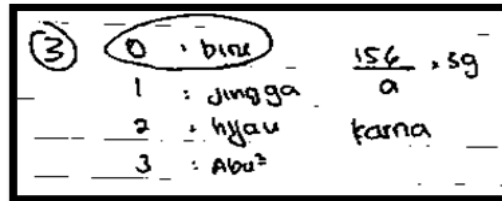


Figure 8. Answers No. 3 Low Ability Students (R₅)

Student answers R₅, it was seen that there was a mistake in translating the meaning of the question in the form of images into mathematical language. Students make their own formulas and do not produce the right solution. It was concluded that student with low ability on the indicators of turning pictures into mathematical language and making arguments was still lacking.

Discussion

Based on the research done in analyzing and describing the results of students' work based on indicator items, it shows that the mathematical communication skills of SMP 3 Sungguminasa students are in the moderate categories. It is known that high-ability students can correctly answer questions that contain indicators of mathematical communication skills. This is reinforced by the opinion of Marni et al. (2020) that high-ability students tend to include all indicators of mathematical communication skills. Connecting opinion, Rohid et al. (2019) argue that students with good communication skills also have good math skills; this means that students' ability to convert into symbols and notations affects students' ability to solve mathematical questions.

Even so, there are still students who have not been able to fully communicate the results of their work correctly on the test, errors in answering, some also directly write down the answers in the preparation of the test questions and are unable to change what is known in the test question. For example, moderately capable students can only achieve half of all indicators of mathematical communication skills, marked by students who can only fulfill the ability to explain mathematical ideas with pictures and compose arguments or formulate generalizations. Agree with Fauzi et al. (2021) that moderate-ability students can write conclusions from the problem but are not complete. So that subjects with moderate abilities can re-express a description in their own language. In general, the medium ability of mathematical communication skills can be said to be quite good, as well as the opinion of Marni et al. (2021), moderately capable students can fulfill two KKM indicators in the moderate categories.

For low-ability students who are unable to write answers according to the questions asked, do not answer completely by reasons or explanations, and are not able to meet all the answer indicators contained in the questions, only able to fulfill the ability to compose arguments and formulate generalizations using their own language so that they are still in the process of writing low categories. Agree with the idea of Fauzi et al. (2021) that students with low ability grouping can be categorized as low. As explained by the research of Hajj et al. (2021) is not good because it has not been able to translate the problem into mathematical language, and the difficulty of expressing and explaining the meaning of the question results in the non-fulfillment of indicators.

Then this shows that students' mathematical communication skills on number pattern material are in the moderate categories; this is relevant to Oktaviani & Aini (2021), who states that students' mathematical communication skills are included in the category that is quite visible in the results of the research score reaching a percentage 50%.

CONCLUSION AND SUGGESTION

Based on the results and discussion of the research described, it was concluded that the mathematical communication skills of class VIII C students of SMP Negeri 3 Sungguminasa from 6 subjects, there

were 2 students in good categories, 2 students in moderate categories and 2 students in low categories of mathematical communication skills. So that if averaged, the six research subjects are in moderate categories for mathematical communication skills. When solving number pattern problems, high-ability students can direct their answers based on indicators of mathematical communication skills that contain items. In addition, some students solve problems with the right steps. However, there are still students who are not careful and wrong, causing students to experience errors when solving questions.

Students need to be accustomed to solving problems related to mathematical communication abilities, and the teacher is expected to enrich the variety of problems that require the mathematical communication abilities of students.

REFERENCES

- Chotimah, S., Bernard, M., & Wulandari, S. M. (2018) Contextual Approach using VBA learning media to improve students' mathematical displacement and disposition ability. *The Journal of Physics: Conference Series*, 948(1), 1-10 <https://doi.org/10.1088/1742-6596/948/1/012025>
- Djamaluddin, Ahdar & Wardana. (2019). *Belajar dan Pembelajaran*. Jakarta: CV. Kaaffah Learning Center.
- Evita, Ayu, L.C.. (2015) "Pengembangan Soal Matematika Mode PISA untuk Mengukur Kemampuan Komunikasi Matematis Siswa Sekolah Menengah Pertama"
- Fauzi, A., Rahmi., & Melisa. (2021). Analisis Kemampuan Komunikasi Matematis Siswa Pada Pembelajaran Daring. *Jurnal Pendidikan Matematika Undiksha*, 12(1), 32-41. <https://doi.org/10.23887/jjpm.v12i1>
- Hajj, I., I., et al. (2021). Analisis Kemampuan Komunikasi Matematis Siswa MTS dalam Menyelesaikan Soal Bentuk Aljabar. *MAJU*, 8(1), 474-479,
- Kemendikbud. (2014). Salinan Lampiran Permendikbud Nomor 59 Tahun 2014 tentang Kurikulum 2013 Sekolah Menengah Atas/Madrasah Aliyah Kemendikbud.
- Lestari, K., E. & Yudhanegara, M. R. (2015). *Penelitian Pendidikan Matematika*. Bandung: Refika Aditama
- Marni, et al. (2020). Analisis Kemampuan Komunikasi Matematis Siswa Kelas VIII SMP Pada Materi Pola dan Barisan Bilangan. *Math Didactic: Jurnal Pendidikan Matematika*, 6(2), 169-182. <https://doi.org/10.33654/math>
- Masrukan, Susilo, E., & Pertiwi, A.D. (2015) Analysis of Mathematical Communication Ability Through 4K Model Based on 7th Graders' Personality Types. *The International Journal of Education and Research*, 3(7), 343-352.
- Muhlifah, Ali. (2021) Meningkatkan Motivasi dan Hasil Belajar Siswa Melalui Model Pembelajaran Index Card Match ada Mata Pelajaran Matematika *Jurnal Pendidikan Indonesia*, 2(1), 152-160. <https://doi.org/10.36418/japendi.v2i1.86>
- Morgan, C. et al. (2014). Language and Communication In Mathematics Education: An Overview of research in the field. *ZDM: International Journal of Mathematics Education*, 46(6), 843-853. <https://doi.org/10.1007/s11858-014-0624-9>
- Noor, F., & Ranti, M G (2019). Hubungan Antara Kemampuan Berpikir Kritis dengan Kemampuan Komunikasi Matematis Siswa SMP Pada Pembelajaran Matematika. *Math Didactic: Jurnal Pendidikan Matematika*, 5(1), 75-82. <https://doi.org/10.33654/math.v5i1.470>
- Octaviani E., & Aini, I., N. (2021). Analisis Kemampuan Komunikasi Matematis Siswa SMA. *MAJU*. Vol. 8(2)
- Rohid, N., et al (2019) Students' Mathematical Communication Skills (MCS) in Solving Mathematics Problems: A Case in Indonesian Context. *Anatolian Journal of Education*, 4(2), 19-30. <http://dx.doi.org/10.29333/aje.2019.423a>
- Soraya, et al. (2021) Pengaruh Model Pembelajaran SQ3R Terhadap Kemampuan Komunikasi Matematis Siswa SMP Pada Materi Pola Bilangan. *Jurnal Pendidikan Matematika Indonesia*. 6(1), 28-34. <http://dx.doi.org/10.26737/jpmi.v6i1.880>



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- Susanto, H. A. & M., & U (2015) Improving students' Activity in Mathematics Communication. The International Journal Of Education and Reseach, 3(2). 169-180.
- Tambunan, Hardi (2019). The Effectiveness of the Problem Solving Strategy and The Scientific Approach to Students' Mathematical Capabilities in High Order Thinking Skills. The International Electronic Journal of Mathematics Education, 14(2), 293-302. <https://doi.org/10.29333/iejme/5715>
- The National Council of Teacher of Mathematics (NCTM). (2000). Principles and Standards for School Mathematics, Reston, VA: NCTM
- Vale, I & Barbosa, A. (2017). The Improtance of Seeing in Mathematics Communication. The Journal of the European Teacher Education Network 12