e-ISSN: 3046 – 5389
p-ISSN: 3046 – 5559
Volume. 1, No. 1, 2024

CONSTRUCTIVISM: Journal of Research in Education

ANALYSIS OF STUDENTS' MATHEMATICAL COMMUNICATION SKILLS IN SOLVING SPACE BUILDING PROBLEMS

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Article History

Received: 29-06-2023

Revision: 23-08-2023

Accepted: 09-12-2023

Published: 13-02-2024

Abstract. Communication skills in mathematics learning are very necessary to achieve good learning outcomes. This study aims to determine students' mathematical communication skills in completing building space material. This type of research is qualitative descriptive with the number of subjects used, namely 1 person. The chosen subject is the student who obtained the highest score. The instruments used are tests and interviews. Tests are used to select subjects and interviews are conducted to determine students' reasoning abilities. The data analysis technique used is using qualitative data analysis, namely using the stages of data collection, data presentation and conclusions. Based on the results of data analysis, it is known that AW subjects meet 7 indicators of mathematical communication skills, namely subjects are able to connect real objects, images, and diagrams into mathematical ideas, subjects can explain ideas, situations, and mathematical relations orally and in writing with real objects, images, graphs, and algebra, subjects can express everyday events in language or mathematical symbols, subjects can listen, discuss, and write about mathematics, subjects can read with comprehension a written mathematical presentation, subjects can make conjectures, construct arguments, formulate definitions, and generalizations, and subjects can explain and make questions about mathematics that have been studied, while subject AB only meets 3 indicators out of 7 indicators used

Keywords: Mathematical Communication, Build Space

How to Cite: Ode, D., Riaddin, D., Kamsurya, R., Lastri., & Sangadji, K. (2024). Analysis of Students' Mathematical Communication Skills in Solving Space Building Problems. *CONSTRUCTIVISM: Journal of Research in Education*, 1 (1), 14-28. http://doi.org/10.54373/cjre.v1i1.92

INTRODUCTION

Communication skills in mathematics learning are very necessary to achieve good learning outcomes (Samsuriadi & Imron, 2019). Without proper communication, the learning process will not run smoothly as planned. Communication using symbols and diagrams in mathematics learning will be very important and will facilitate students' understanding in receiving lessons (Cheeseman et al., 2017; Widodo et al., 2020). Mathematical communication skills are mutually important learning outcomes to build mathematical skills in students. This is in accordance with one of the objectives of learning mathematics, which is to train the way of thinking and reasoning. The ability to solve everyday problems in the form of story problems is a mathematical ability that exists in students (Clooney & Cunningham, 2017). Various kinds of problems that exist in everyday life are often encountered in the form of story problems.

With problems related to daily life in mathematics subjects, it will bring students to understand the benefits of the lessons they learn (Allen, 2017; Linsell et al., 2016).

In general, the steps taken by students in solving story problems are by reading and understanding the questions (Zaenal & Heriyana, 2021). By reading and understanding the problem, new students can determine what is asked from the story problem. In this step, students use numbers and then create a mathematical model (Nikula et al., 2019). If the intended mathematical model has been determined, then the problem in the story problem can only be solved (Pierce & Begg, 2017). Most students find these steps too complicated, so they will have difficulty solving story problems. Especially for students who are used to being taught practical formulas to find the results of a problem. The presentation of these practical formulas can weaken the systematic way of thinking of students, so they will find it difficult if they are required to do story problems with the right sequence of solutions (Balyan et al., 2022; Tambunan, 2018; Zaenal & Heriyana, 2021).

So far, the mathematics learning process at SMP Negeri Satap Namai, West Seram Regency tends to use expository methods so that student activity is still less visible. Teachers are not used to involving students to reason in instilling existing material concepts. Such a situation causes students to reason weaker and when encountering story problems students find it difficult to understand and solve them. This can be seen from the results of daily tests that some students still cannot understand and translate story problems. Therefore, students have not been able to solve the problems presented in the form of story problems. In addition, some students still have difficulty in expressing their mathematical ideas and reasoning in the form of symbols and diagrams. By expressing mathematical ideas in the form of diagrams, drawings, and mathematical models, it will make it easier for students to solve story problems, building space.

As a result of the application of conventional learning methods, it has an impact on students' mathematical communication skills. Student attitudes in learning are not able to reflect indicators of mathematical communication skills, namely (1) connecting concrete objects in the form of mathematical models (pictures and tables), (2) explaining mathematical models (figures and tables) into their own language, (3) asking questions about mathematics that have been learned using their own language, (4) stating problems or daily events in mathematical models, and (5) constructing arguments using their own language (Chasanah et al., 2020).

Research by Rohid et al., (2019) found that students' mathematical communication skills in Indonesia still need to be developed. This needs to be the attention of Mathematics teachers so that they not only teach mathematics but also stimulate students' mathematical communication skills through creative and innovative learning activities. Research by Ikhsan et al., (2020) shows that the factors causing students' low mathematical communication skills are found in the use of mathematical vocabulary and language, students' learning styles and the ability to express their ideas. Research by Kamid et al., (2020) concluded that there is a mathematical communication ability between male and female students. Male students can explain problem-solving strategies and steps quite clearly, but less structured. Female students can explain strategies and steps for solving problems in a clear and structured manner. Thus, students' mathematical communication skills must be well developed by teachers in classroom learning. This study aims to determine students' mathematical communication skills in solving space building problems.

METHOD

The type of research used in this study is descriptive qualitative, which is research that aims to obtain data and describe students' mathematical communication skills in solving problems on building space material. The subjects in this study were grade VIII students of SMP Negeri Satap Namai. The process of determining the subject using purposive sampling, which is the process of determining the subject using certain objectives or criteria, namely student test results (Sugiono, 2018). The subject retrieval is based on the test results achieved by the student at the execution of the final test. From the test results, 2 students who have high and low mathematical cognitive abilities were taken which were shown based on student test scores.

Indicators of mathematical communication skills used in research are (1) connecting real objects, pictures, and diagrams into mathematical ideas, (2) explaining ideas, situations, and mathematical relations orally and in writing with real objects, images, graphs, and algebra, (3) stating everyday events in mathematical language or symbols, (4) listening, discussing, and writing about mathematics, (5) reading with understanding a written mathematical presentation, (6) make conjectures, construct arguments, formulate definitions, and generalizations, and (7) explain and make questions about mathematics that has been learned (Ikhsan et al., 2020).

The instruments used in this study are researchers, test questions, and interview guidelines. Researchers are included in research instruments, because in the implementation of research researchers are directly involved in the research process, namely researchers go directly into the field in making observations and interviews. The test aims to determine the ability of students based on the results of student tests that will later be selected as subjects in research. The test used is in the form of a description test which aims to determine students' mathematical communication skills in solving problems on the material of building space (Sudijono, 2007). The interview used is an unstructured interview. The interviews used in this study were unstructured interviews. The people to be interviewed are the subjects in this study, namely 3 students. The questions used in the interview process are developed based on the answers submitted by the subject. The data analysis technique used in this study is qualitative data analysis, following the concept developed by Miles and Huberman which consists of data reduction, data presentation, and conclusion drawing (Sugiyono, 2014).

RESULTS

Selection of Research Subjects

Subject selection is carried out using purposive sampling techniques with the criteria used are the final test results. Based on the test scores obtained by students in the implementation of the final test, 2 students were taken with the provision that students who had qualified test scores in the very high category. This is so that later the chosen subject can represent all grade VIII students of SMP Negeri Satap Namai.

Based on the results of the analysis of the final student test results carried out on all grade VIII students of SMP Negeri Satap Namati, 2 students were obtained who met the subject selection qualifications, namely with the initials WA as the student who had the highest score and the subject with the initials AB who obtained the lowest score. On the basis of these test scores, the 2 students were selected as subjects in this study who would later be interviewed to find out the mathematical communication skills of each student.

Results of Interviews with WA Subjects

Interviews with WA subjects focus on the results of the subject's work in solving test questions conducted on the test in relation to students' mathematical communication skills, especially in solving questions on building space material. Based on the results of the interview, WA subjects solved the questions on the building room material very well and

explained them directly. In general, based on the results of interviews with WA subjects, all indicators of mathematical communication skills in this study were met.

Connect real objects, drawings, and diagrams into mathematical ideas

The ability to connect real objects is one of the most important abilities in the process of learning mathematics. When students are able to connect real objects as well as pictures and diagrams, it will greatly help students in solving problems in mathematics. Mathematics as an abstract field of science really requires students' ability to connect real objects and images into mathematical ideas and forms. Therefore, this ability is very important for students to have.

Based on the results of interviews conducted with WA subjects, it is known that subjects can connect real objects into mathematical forms or ideas. This can be seen from the subject's ability to solve questions during the interview. WA subjects can write well the length, width, and height possessed by block-shaped cabinets. The subject writes it according to what is known in the problem.

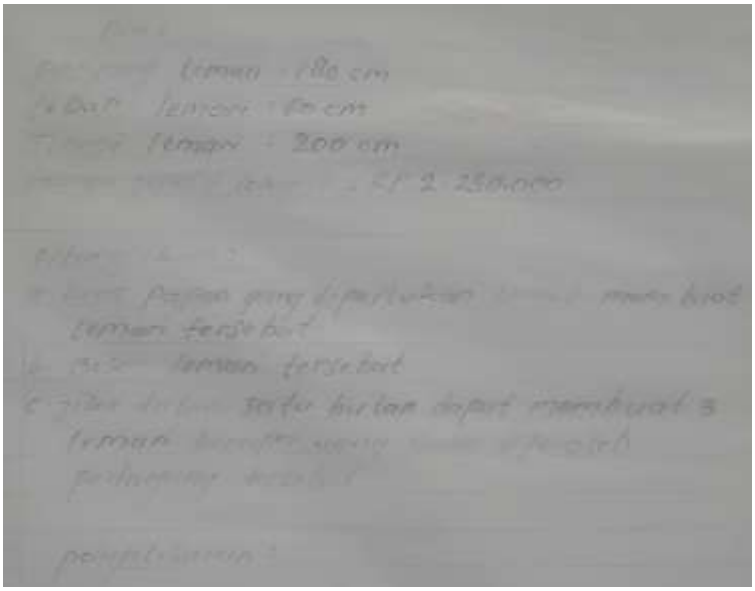

Figure 1. The work of WA subjects in solving problems

Explain ideas, situations, and mathematical relationships orally and in writing with real objects, pictures, graphs, and algebra

Based on the results of interviews, WA subjects were able to explain ideas and relationships orally and in writing. This is done that in solving the problem, the WA subject is able to explain it very well and in accordance with the answers written in his work. These results can be seen, from the results of the following interview:

R : How do you think determine the area of cabinets that a carpenter will make?
WA : To determine the area of the cabinet we can use the length, width, and height of the cabinet that have been known in the problem. In the matter it is known that the length of the cabinet = 180 cm, the width of the cabinet = 60 cm, and the height of the cabinet is 200 cm. So by using the formula $L = 2(pl + pt + lt)$, we can get the area of the cabinet. In the result of the solution when using the formula obtained the cabinet area is 117.600 cm^2.

Express everyday events in mathematical language or symbols

In addition to being able to solve problems on building space material, WA subjects can express problems that occur daily in the form of mathematics. This can be seen from the results of the following interview:

R : What do you think the solution to the problem looks like?
WA : The question is about building space, that is, about blocks. If the problem is known, the length of the cabinet = 180 cm, the width of the cabinet = 60 cm, and the height of the cabinet is 200 cm. While the selling price of the cabinet is IDR 2,250,000 per cabinet. What is asked in the question is the area of boards needed to make cabinets, the volume of cabinets, and if one month can make 3 cabinets how much money the merchant will get. In solving the problem in part a, we can use the formula to find the area of the beam, which is $L = 2(pl + pt + lt)$. Meanwhile, to find the volume of the beam, you can use the formula $V = p \times l \times t$. To calculate the amount of money earned by a merchant we can calculate the price of cabinets multiplied by the number of cabinets that can be made in one month.

Listen, discuss, and write about mathematics

Listening, discussing, and writing about mathematics must be owned by students in learning mathematics. In the learning process, the material delivered by the teacher must be able to be listened to well by students, so as to be able to write back what is heard into a mathematical statement. That way the material received by students is not immediately lost, but can be remembered for a long time by students.

This indicator is well owned by WA subjects, because subjects are able to listen and remember the material delivered by students and then write it back. With this ability, the subject is able to solve the questions given by the researcher during the interview process. Indicators of listening, discussing and writing about mathematics owned by students can be seen from the following interview results:

R : Do you think the answer you got in determining the volume of the cabinet is correct?
WA : Yes, mother.
R : Where do you know that the answer you got was correct?
WA : In yesterday's lesson, the teacher said that in studying blocks, the thing that must be remembered is how to determine the area and volume of cubes and blocks. In determining the beam, the formula used is $V = p \times l \times t$. In the problem, it is known the length, width, and height of the block-shaped cabinet. So we can directly enter the value and multiply it using the formula. So the volume of the beam or cabinet is $2.160.000\ cm^3$.

Reading with comprehension of a written mathematical presentation

The ability of students' understanding of the material to build space is very good, this can be seen from the ability of AW subjects in solving questions given by researchers during the interview process. The subject can solve the questions well and is able to explain them well to the researcher. Subject after solving the problem directly in front of the researcher, the subject can explain well the steps of solving the problem carried out. Thus the idea can be known with certainty to come directly from the subject, and is not the result of copying or the result of the thoughts of his friend. This can be seen from the following interviews:

R : Please explain where you got $117.600\ cm^2$?
WA : $117.600\ cm^2$ obtained from the calculation results in determining the area of the cabinet. In the matter it is known that the length of the cabinet is 180 cm, width, 60 cm, and height 200 cm. Thus we enter into the formula to find the area of the beam, which is $L = 2(pl + pt + lt)$. Then we will get $2[(180 \times 60) + (180 \times 200) + (60 \times 200)]$, and the result is $117.600\ cm^2$.
R : where does $Rp6.750.000$ come from?
WA : IDR 6,750,000 is obtained from the result of multiplication between IDR 2,250,000 multiplied by 3. In the matter, it is known that the price of the cabinet is IDR 2,250,000 so that if in one month you can make 3 pieces, the money obtained is IDR 6,750,000

Create conjectures, construct arguments, formulate definitions, and generalizations

In this indicator, the AW subject is seen to make a conjecture in advance and arrange his arguments in solving the problem during the interview process. In solving the problem, the subject arranges his argument based on what is known in the problem before solving the problem. This can be seen from the results of interviews conducted directly with researchers, namely as follows:

R : What do you think the solution to the problem will be?
WA : The question is a question about blocks. If the problem is known, the length of the cabinet = $180\ cm$, the width of the cabinet = $60\ cm$, and the height of the cabinet is $200\ cm$. While the selling price of the cabinet is $IDR\ 2.250.000$ per

cabinet. What is asked in the question is the area of boards needed to make cabinets, the volume of cabinets, and if one month can make 3 cabinets how much money the merchant will get. In solving the problem in part a, we can use the formula to find the area of the beam, which is $L = 2(pl + pt + lt)$. Meanwhile, to find the volume of the beam, you can use the formula $V = p \times l \times t$.

Explain and make questions about the math you have learned

The ability to explain is well possessed by students. Because in the interview process the subject is able to explain well every question submitted by the teacher and the results of solving the questions done. The subject's explanation of how to solve the problem is very accurate and in accordance with the steps for solving the problem that the subject of AW has made. This can also be seen from the results of interviews with AW subjects as follows:

P : Please explain where you got $117.600\ cm^2$?

WA : $117.600\ cm^2$ obtained from the calculation results in determining the area of the cabinet. In the matter it is known that the length of the cabinet is $180\ cm$, width, $60\ cm$, and height $200\ cm$. Thus we input it into the formula to find the area of the beam, which is $L = 2(pl + pt + lt)$. Then we will get $2[(180 \times 60) + (180 \times 200) + (60 \times 200)]$, and the final result is $117.600\ cm^2$.

Results of Interviews with AB Subjects

Interviews with subject AB were conducted as the interview process was conducted on subject AW. Interviews on subject AB were conducted on the results of the subject's work in solving problems by focusing on indicators of mathematical communication skills. Subject AB was chosen as a subject on consideration of having a lower score compared to his peers. The results of interviews on subject AB on each indicator are as follows:

Connect real objects, drawings, and diagrams into mathematical ideas

Based on the results of interviews with subject AB, it can be seen that in the process of solving problems, subject AB can connect real objects into mathematical ideas. The subject is able to understand well the questions given and write them in the form of key words in the process of solving the questions. When viewed from this step, the subject is able to connect what is known in the problem and connect it into mathematical form. In more detail, the ability of the subject to connect real objects into mathematical form can be seen from the work of the following subjects:

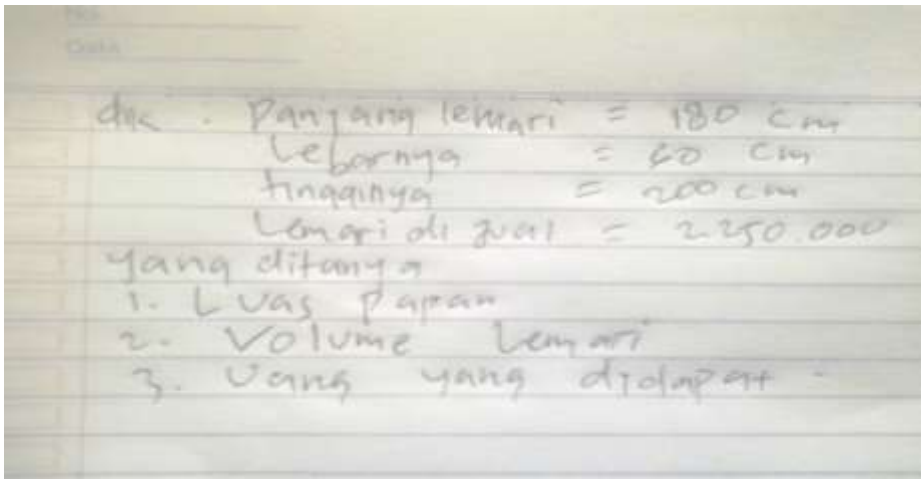

Figure 2. The work of subject AB in solving space building problems

Explain ideas, situations, and mathematical relationships orally and in writing with real objects, pictures, graphs, and algebra

The ability to explain mathematical ideas or situations orally and in writing is an indicator of mathematical communication where students can explain a mathematical situation in oral or written form. In this research process, this ability is an ability where students can explain ideas or situations contained in the problem into the form of real objects and algebra. Based on the results of the interview with subject AB, it is known that the subject can explain well the idea or a situation contained in the problem solved by the subject at the interview. This means that the subject can explain the purpose of the given question and then formulate it in a process of solving the problem. The results of the interview with subject AB showed that the subject could explain about the problem given and write it into mathematical form. This can be seen from the following interview excerpts:

P : What do you think that is the case?

WA : In question number 3, what is known is that the length of the cabinet is $180\ cm$ means $p = 180\ cm$, the width of the cabinet is $60\ cm$ means $l = 60\ cm$, the height of the cabinet is $200\ cm$ means $t = 200\ cm$, dan and the selling price / cabinet is IDR 2.250.000. Meanwhile, what is asked is how much the board area, how much is the volume of the cabinet, and the money the trader gets if he can sell 3 cabinets in one month

Express everyday events in mathematical language or symbols

The ability to state everyday events is the ability to interpret things that happen in everyday life into mathematical form. In learning mathematics, this ability is needed by students in solving problems faced by students in everyday life. Mathematics is closely related to everyday

life, therefore in learning mathematics it is very necessary the ability to express everyday events into mathematical form.

Based on the results of interviews with subject AB it is known that subjects can express everyday events into language and mathematical symbols. This can be seen from the results of interviews conducted on subjects directly, namely on questions used for interviews, namely questions related to daily events. The question mentions making a closet which is an event that often occurs in students' lives. This is stated in the following interview excerpts:

P : What do you think that is the case?

WA : In question number 3, the length of the cabinet is known to be $180\ cm$ means $p = 180\ cm$, he width of the cabinet is $60\ cm$ means $l = 60\ cm$, the height of the cabinet is $200\ cm$ means $t = 200\ cm$, and the selling price / cabinet is $IDR\ 2.250.000$. Meanwhile, what is asked is how much the board area, how much is the volume of the cabinet, and the money the trader gets if he can sell 3 cabinets in one month.

While indicators 4 to 7 about mathematical communication skills possessed by subject AB are not fulfilled by the subject. This is because during the interview process the subject could not solve the question perfectly. The subject can only write down what is known and asked in the question without any further solving process. In addition, during the interview process the subject could not make an argument about the question, when the subject was asked about the process of solving the advanced question the subject simply answered that he could not solve it. So that indicators 4 to 7 are not owned by subject AB in solving social arithmetic material problems.

DISCUSSION

Mathematical communication skills are a very important thinking ability possessed by a student, especially in learning mathematics (Aufa et al., 2016; Tambunan & Naibaho, 2019). Mathematics is a subject that is very demanding for students in the problem-solving process (Trisnawati et al., 2018). Solving these problems will not be achieved properly if students are only passive in the learning process because problem solving requires student involvement in thinking to solve the problem (Kurniawan et al., 2021; Palinussa et al., 2021).

Based on the results of research conducted on grade VII students of SMP Negeri Satap Namami, it is known that the two subjects interviewed, namely subject AW and subject AB, have different mathematical communication skills in the process of solving spatial problems. AW subjects who are students have the highest scores based on test results meet 7 indicators of mathematical communication skills, namely the subject is able to connect real objects,

pictures, and diagrams into mathematical ideas, subjects can explain ideas, situations, and mathematical relations orally and in writing with real objects, pictures, graphs, and algebra, subjects can express everyday events in mathematical language or symbols, The subject can listen, discuss, and write about mathematics, the subject is able to read with comprehension a written mathematical presentation, the subject can make conjectures, construct arguments, formulate definitions, and generalizations, and the subject can explain and make questions about the mathematics that has been studied.

This can be seen from the process of solving questions and interviews directly with AW subjects. In the process of interviewing the subject can connect real objects into mathematical ideas. In this indicator, the subject is able to see problems in problems related to everyday life, then connect and write them into ideas and mathematical forms (1st and 3rd indicators). This is very clear from the way the problem is solved by the AW subject. After that, the subject explains the problem in algebraic form so as to help the subject in solving the problem during the interview process (2nd indicator). The understanding possessed by the subject of social arithmetic material is very good, this is what makes the subject AW able to solve all the problems given in accordance with the steps to solve it. This ability comes from the knowledge gained during the mathematics learning process in the classroom (Ikhsan et al., 2020; Nuraina & Mursalin, 2018). The subject listens well, explains the material delivered by the teacher in class, and remembers it through practice questions given by the teacher so as to help the AW subject in the process of solving the problem (4th indicator).

The problem solving process carried out by the subject first pays attention to the key words contained in the problem and writes them into a simpler mathematical form (Dina et al., 2019). After this is done, the AW subject begins to compile arguments and carefully analyze how to solve them based on the understanding of the material he has so that the problem can be resolved properly (5th and 6th indicators). In addition to being able to solve questions well, AW subjects in the interview process can explain carefully the solving process and the answers obtained in solving the questions. The explanation presented by the AW subject is in accordance with the results of the problem work, so it can be concluded that the thought is the result of the thoughts of the AW subject (7th indicator).

Something different happened to subject AB. Based on the results of interviews with subject AB, it is known that subject AB only meets 3 indicators out of 7 indicators used in this study, namely subjects are able to connect real objects, images, and diagrams into mathematical ideas (1st indicator), subjects can explain ideas, situations, and mathematical relations orally and in writing with real objects, images, graphs, and algebra (2nd indicator), The subject can

state everyday events in language or mathematical symbols (3rd indicator). This is because the subject cannot solve all the questions given during the interview process and the subject is unable to make arguments or explain the answers obtained in the process of solving questions during the interview process. The inability of the subject to solve problems is a result of his lack of in-depth understanding of the concept in the material studied (Abidin, 2019). In addition, different learning styles in each student also affect students' understanding and mathematical communication skills. The level of understanding deepens when various learning methods are presented and discussed where students can understand the ideas that best suit the student's learning style (Rohid et al., 2019)

Based on the above, mathematical communication skills should need to be considered by teachers in every learning process in general and more specifically in mathematics learning (Chasanah et al., 2020; Lestari et al., 2019). Mathematics needs to be given to all students starting from elementary school to equip students with logical, communicating, analytical, systematic, critical, and creative thinking skills, as well as the ability to work together (Triana et al., 2019; Wardono et al., 2020).

CONCLUSION

Based on the results of research conducted on grade VIII students of SMP Negeri Satap Namami, it can be concluded that AW subjects meet 7 indicators of mathematical communication skills, namely subjects are able to connect real objects, pictures, and diagrams into mathematical ideas, subjects can explain ideas, situations, and mathematical relations orally and in writing with real objects, pictures, graphs, and algebra, The subject can state everyday events in mathematical language or symbols, the subject can listen, discuss, and write about mathematics, the subject is able to read with comprehension a written mathematical presentation, the subject can make conjectures, construct arguments, formulate definitions, and generalizations, and the subject can explain and make questions about the mathematics that has been learned. Subject AB only meets 3 indicators out of 7 indicators used, namely the 1st, 2nd, and 3rd indicators. This study did not conduct a review based on the initial abilities and learning styles of students, so more in-depth research is needed on these aspects, to find out the mathematical communication skills possessed by students.

RECOMMENDATIONS

Based on the conclusions above, there are recommendations conveyed, namely (1) in teaching mathematics, teachers should emphasize mathematical communication skills so as

to stimulate students in the problem-solving process, and (2) teachers should be able to pay attention to the learning styles possessed by each student, so that learning can be in accordance with their needs and learning styles.

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