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The use of set magnetic teaching aids to improve mathematical communication ability

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Abstract

Mathematical teaching aids are a set of concrete objects designed, created, collected, or arranged on purpose that is used to help instill or develop concepts or principles in mathematics. The purpose of this study to improve students' mathematical communication skills by using teaching aids. The method in this research is a quantitative approach. This type of research is experimental research, where the purpose of this study to examine the effect of teaching aids on students' mathematical communication skills. The study was conducted on 26 students randomly. Students are selected based on scores from the highest to the lowest on their mathematical abilities. The instruments used were the pretest and posttest of the set material in the form of students' mathematical communication skills. Based on the analysis results, set magnetic teaching aids in learning selected material shows a good category. This was obtained from the posttest average score of 86.73. From these results, in general, mathematics learning using set magnetic teaching aids received a positive response; this was seen through the posttest results of students' good communication skills with a percentage of 84.62%.

1. Introduction

Mathematics is a branch of all kinds of knowledge (Hartinah, 2019; Wardani, 2019). Human life cannot be separated from mathematics (Septiana, 2018). Either formally or not, humans will always find things related to mathematics. For example, in everyday life, mathematics education is necessary to cultivate and develop something about mathematics (Pujiastuti et al., 2019).

Mathematics in school is a subject that has an essential role in life. Many problems in everyday life can be solved with mathematics. Students as part of society must be equipped to apply mathematics in life. Students must be able to understand the material being studied well. Thus, students can communicate mathematics into ideas with symbols, tables, diagrams, or other media to clarify mathematical situations or problems.

Mathematical communication can express mathematical ideas coherently to friends, teachers, and others through written, spoken language (Chasanah, 2020; Syaiful, 2019). Students need to get used to learning to provide arguments for each answer and provide responses to others' solutions so that what is being known becomes more meaningful to them (Hernawati, 2020).

When learning mathematics, communication plays an influential role in developing student knowledge (Suwarno, 2020). Through good communication, students can represent their knowledge so that if there is a concept, it can be immediately anticipated, and the transfer of knowledge to other students can be carried out (Kamid, 2020).

When learning mathematics, communication plays an influential role in developing student knowledge. Through good communication, students can represent their knowledge so that if there is a concept, it can be immediately anticipated, and the transfer of knowledge to other students can be carried out.

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Seeing the importance of mathematical communication in mathematics learning, (Saleh, 2020) states that one of the best mathematics learning programs in schools is to suppress students' mathematical language to express mathematical ideas correctly.

In the learning process, instructional media is essential to support the learning process (Pujiastuti & Haryadi, 2020a). Learning media can be understood as anything that can convey or transmit messages from a source in a planned manner, resulting in a conducive learning environment where the recipient can efficiently and effectively carry out the learning process.

The facts have shown that students still need the help of concrete objects or visual representations in receiving and understanding the material as knowledge, namely in the form of tangible things called teaching aids (Bujak et al., 2013). Concrete objects are intended so that students' learning is closer to the real world. Through teaching aids, it is intended that students in education will gradually learn by using image representations that represent the actual situation in an abstract direction (Haryadi, 2019). This is in line with the theory that describes the stages of learning that the learning process begins with an active mode using concrete objects or real situations. When this learning stage is deemed sufficient, students move to the second learning stage by using iconic representations (Pujiastuti & Haryadi, 2020). In pictures or diagrams as a visual representation of natural objects and the end, the learning process leads to a symbolic mode (Joseph Dube & İnce, 2019).

Mathematical teaching aids are a set of concrete objects that are designed, created, collected, or arranged on purpose that is used to help instill or develop concepts or principles in mathematics (Anggo, 2018). The use of teaching aids in the learning process: 1) Increase students' interest in learning. 2) encourage student curiosity so that students feel like learning it. 3) can reduce barriers to education (Sugiman, 2018).

There are two essential elements in a teaching and learning process: teaching methods and learning media (Rajendran, 2019b). These two aspects are interrelated. The choice of a particular teaching method will affect the media or learning aids used. Learning tools teach aids that influence the climate, conditions, and learning environment that the teacher arranges and creates (Macrae, 1971).

However, in reality, the problem of using learning aids is still often ignored for various reasons. Reasons that often arise include limited time to prepare for teaching, difficulty to find the right teaching aids, no cost. This does not need to happen if every teacher has equipped themselves with knowledge and instructional media skills (Pujiastuti et al., 2020).

Learning mathematics with a higher level of difficulty and abstractness of concepts certainly requires different communication methods with other subjects (Mishra et al., 2019). Based on abstract mathematics learning objects, special media and teaching aids must convey it (Fitriasari, 2020). Media that can convey mathematical concepts can come from existing things or media explicitly for this (Kumar, 2015). Creative use of media and teaching aids will enable students to learn better and can improve their performance according to the goals they want to achieve (Widiatsih, 2020). The teaching media used can be in the form of adequate equipment, namely teaching aids (Samba, 2018).

In this study, the mathematical material used is the set material because the selected material is one of the materials in mathematics that can be made in the form of teaching aids to help teachers in learning mathematics on set material.

The novelty of this research is the use of set material props, namely Set Magnets. A magnet set is a teaching material in the form of teaching aids that are used to assist students in learning mathematics set material. Magnet Set is a development of existing teaching materials, namely Venn Diagrams. Set Magnetic advantage compared to Venn Diagrams because storage is much easier and more accessible for students and teachers to carry. Also, the Association Magnets are more durable and not easily damaged because they are made of cardboard which has been coated with iron inside so that it is not easily damaged, compared to Venn Diagrams made of Styrofoam. Set Magnetic is also equipped with command cards and question cards to be glued to the learning book.

2. Methods

This research is quantitative experimental type research, where the purpose of this study is to examine the effect of using teaching aids to improve students' mathematical communication skills. The research steps taken can be seen in Figure 1 below.

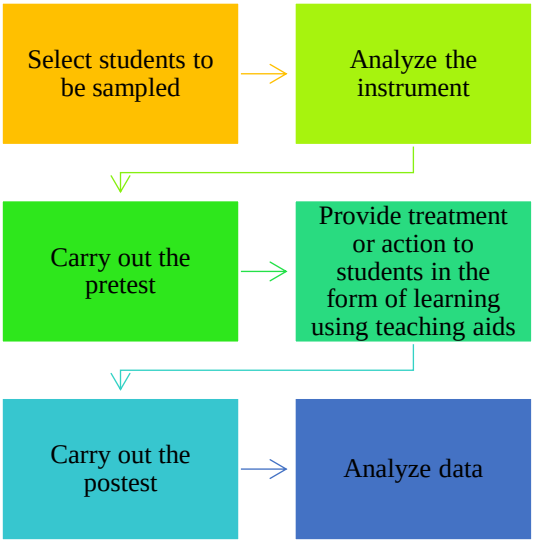


Figure 1. Research steps

This study used a pretest and posttest group design. This study used 26 students as the subject. Learning is treated by using set magnetic teaching aids. Before being treated, students are given a test first, namely a pretest, to determine the students' prior knowledge of the material to be taught. After being given the treatment, the students were given the final test, namely the posttest, to determine the increase in students' mathematical communication skills.

The variable of expectations used in this study is mathematical communication skills. The action variable used in this study is the set magnet. The set magnet is a teaching aid that is used to assist students in learning mathematics on the set material.

The disadvantage of using this method is that it does not use a control group, so it cannot be assumed that the experimental treatment causes changes between the pretest and posttest results. There is always the possibility that some external variable caused all or part of the change.

Based on accurate data, in this study, data can be obtained using instruments; in this study, the tool used was a type of test instrument. In this study, this test aims to determine students' mathematical communication skills in the learning process using set magnetic teaching aids. The students' test is a description of 5 questions with the selected material with the same pretest questions as posttest questions on mathematical communication skills tests. Indicators of mathematical communication skills can be seen in Table 1 below.

Table 1. Indicators of Mathematical Communication Ability

No	Indicator
1	The ability to express a situation or material ideas in the form of pictures, diagrams, or graphs
2	Ability to analyze and evaluate a given information
3	The ability to express a mathematical idea or idea into a mathematical model
4	the ability to explain concepts, ideas, or problems in their language

3. Results & Discussions

The set magnets used in the study can be seen in Figure 2. The results of this study were obtained from tests of mathematical communication skills. This test was given to 26 students who were met randomly. This research was conducted beginning with providing a pretest to students. Furthermore, students will be introduced to teaching aids that will be used to assist in the learning process of mathematics related to the set material. After taking action in the form of learning using teaching aids then the students were given posttest questions.

Figure 2. Set Magnets

The sample in this study was junior high school students. The research results were obtained from the effects of data analysis during the study. Based on results obtained from the pretest and posttest results by learning using props and not using props.

Table 2 below displays the scores obtained by students based on the answers they gave to the students' mathematical communication skills test.

Table 2. Recapitulation of mathematical communication skills test scores

No.	Pretest	Postest	No.	Pretest	Postest
1	60	90	14	40	90
2	40	60	15	40	90
3	40	80	16	50	90
4	40	60	17	50	95
5	40	100	18	60	100
6	50	90	19	50	90
7	50	90	20	40	95
8	40	90	21	60	95
9	60	80	22	60	90
10	50	60	23	60	90
11	50	60	24	60	100
12	50	80	25	60	100
13	60	80	26	60	100

From data processing the value of students' mathematical communication skills which are presented in table 2 above, the analysis is obtained in Table 3 as follows.

Table 3. Descriptive analysis of value

	n	max	min	mean	SD
Pretest	26	60	40	50.77	8.45
postest	26	100	60	86.73	13.19

Tables 2 and 3 show that this study was conducted on 26 junior high school students. With a maximum pretest score of 60 and postest of 100 and a minimum value of pretest 40 and postest 60. So that the

average pretest score is 50.77, and the postest is 86.73. This is based on the pretest data that students must achieve from 5 test questions, namely a maximum score of 100 and a minimum of 0. So that the range 100-0 = 100, the number of classes = 3 (interpretation: low, sufficient, good). While the length of the interval class = 100/3 = 33.33 so that interpretations can be made, as shown in Table 4 below.

Table 4. Interpretation of Pretest Data

Range	Interpretation	Frequency	(%)
0-32	Low Mathematical Communication Skills	0	0%
33-65	Sufficient Mathematical Communication Skills	26	100%
66-98	Good Mathematical Communication Skills	0	0%
	Total	26	100%

Based on Table 4, the data above shows that students' communication skills before using set magnetic teaching aids are categorized as sufficient, with 100% of the total 26 students. Furthermore, the interpretation of the posttest data can be seen in Table 5 below.

Table 5. Interpretation of Postest Data

Range	Interpretation	Frequency	(%)
0-32	Low Mathematical Communication Skills	0	0%
33-65	Sufficient Mathematical Communication Skills	4	15,38%
66-98	Good Mathematical Communication Skills	22	84,62%
	Total	26	100%

From table 5, the data obtained above shows that the students' mathematical communication skills after using set magnetic teaching aids are in a suitable category with a percentage of 84.62% and a good variety with a rate of 15.38%.

In general, it can be seen that after learning using teaching aids, namely set magnets, students' scores increase. This is in line with other studies which state that learning using teaching aids can improve mathematics learning outcomes (Rajendran, 2019a, 2019b). Based on the increase in students' mathematical communication, several examples of questions and the results of the pretest and posttest answers that students have done will be presented (Anggo, 2018; Dewi, 2018).

Indicator 1. The ability to express a situation or material ideas in pictures, diagrams, or graphs.
Question 1.
Y = {primary number less than 10,} and Z = {natural number less than 10}. Draw a Venn Diagram showing the relationship between the two sets, Y and Z!
Student answers:

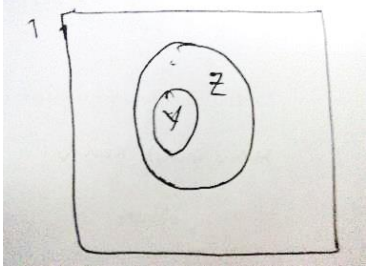


Figure 3. Pretest answer type

In Figure 3, it can be seen that the answers given by students are so short and it is unclear the meaning of the answers given. This student only provides the answer intended by the question without rewriting what

information can be obtained through the question. This indicates that students' communication skills are still low or not good enough so that it needs to be improved.

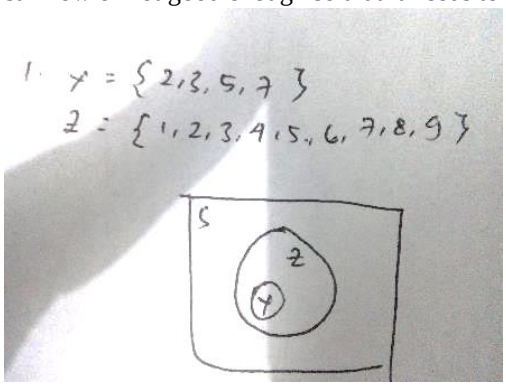


Figure 4. Posttest answer type

In Figure 4, the students' answers are more visible about the answers' meaning because they have been equipped with information that needs to be conveyed. First, students write down the tie members of the Y and Z groups so that the information on the questions becomes complete and easier to understand. From these answers, it can be seen that the students' mathematical communication skills are good because students can communicate the questions given more clearly to be understood by others.

Indicator 2. Ability to analyze and evaluate a given information
Question 2.
If A = {1,2}, B = {2,3,4} and S = {1,2,3,4,5}
The true or false statement below?

a. $(A \cap B)^C = A^C \cup B^C$
b. $(A \cup B)^C = A^C \cap B^C$
c. $(A \cap B)^C = (A \cup B)^C$

Student answers:

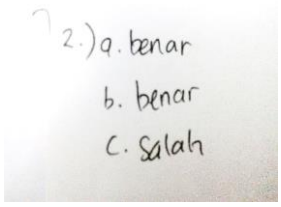


Figure 5. Pretest answer type

Figure 5 is the answer to question number 2 given to students during the pretest. In the picture, the student's answers are correct, but the answers are not enough to communicate to others the meaning of the answers and how to get those answers. Students also do not inform what students get in reading the questions into the answer sheet. In this case, students' communication skills can be categorized as not good enough and need to be improved.

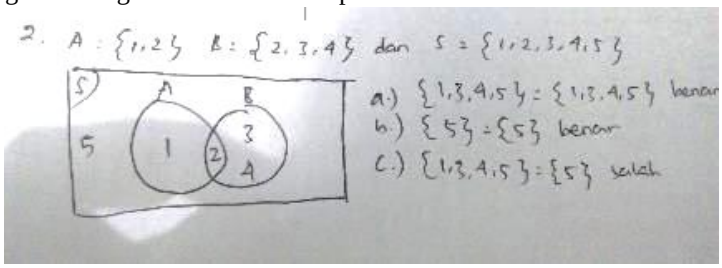
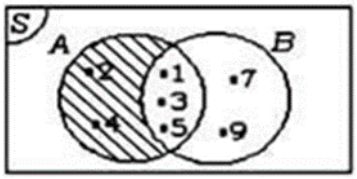


Figure 6. Posttest answer type

In the answer above, it can be seen that the students first wrote down what information they got from question number 2, namely, what the students got when reading the questions. Furthermore, the student does not just give the correct answer directly but provides how the student can get the answer correctly. By providing this information, people who do not see the questions can understand what students' answers mean. This means that the student can communicate the problem well; in other words, the student's mathematical communication ability is good.

Indicator 3. Ability to explain concepts, ideas, or problems in their language
Question 3.



Express the shaded areas in the image above in set A and set B!
Student answers:

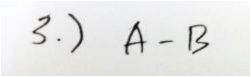


Figure 7. Pretest answer type

The student's answer above is concise but correct; in assessing students' mathematical communication skills who only give answers like this will only get half the score that should be obtained. This is because students cannot correctly communicate their responses and what information students can get from reading the questions given. This can raise the teacher's suspicion of students because too short an answer will make the teacher think that the solution was obtained from cheating on friends. This answer shows that these students' mathematical communication skills are classified as low, so they need to be improved again.

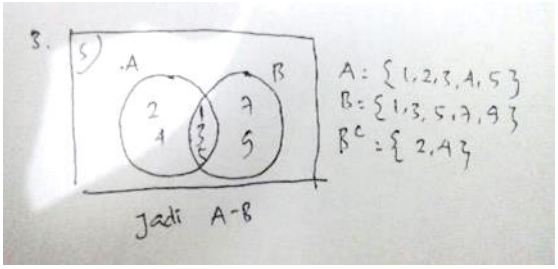


Figure 8. Posttest answer type

Figure 8 shows that students have done the questions quite well. The student first draws the diagram that is in the problem. Then the student writes down the results of the information he got from the questions given. Then the student passes the desired answer by concluding it. Judging from the responses provided by these students, it can be supposed that the students' mathematical communication skills are good.

Indicator 4. The ability to express a mathematical idea or idea into a mathematical model
Question 4.
Of all the students in class VII A, it was found that 22 students liked basketball, 21 students liked volleyball, and seven students liked both.
a. Express the problem in a Venn diagram!
b. Determine the number of students in class VII A!
Student answers:

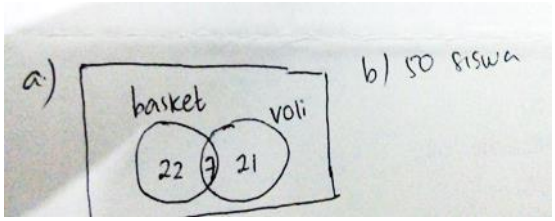


Figure 9. Pretest answer type

The answer given in Figure 9 is quite good and correct for the diagram part. However, determining the number of students in the class is still lacking because the answer does not include how he got 50 students' responses and other information students can write on the answer sheet. Suppose it is only seen from the answers given by students. In that case, it is found that the students' mathematical communication skills are sufficient but to get answers according to their mathematical communication capabilities still need to be improved again.

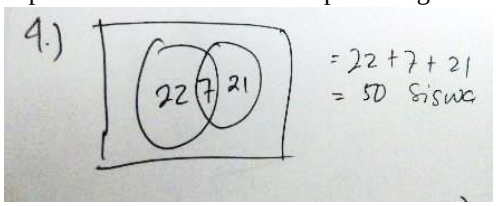


Figure 10. Posttest answer type

The answer in Figure 10 is not much different from Figure 9. What is missing is the name of each set that represents the name of the collection. But it is clear that in Figure 10, the student's answer is accompanied by how he or she got the explanation that the student wrote. This shows that the students 'mathematical communication skills are good or have increased, but it would be even better if the students' mathematical communication skills were continuously improved.

Based on this study's results, previous research conducted by (Dwi Anggraeni, 2011) concluded that using the Everyone is a teacher here strategy and slide rule props can improve students' mathematics learning outcomes.

Based on research on improving mathematical communication skills on the subject of trigonometry, it is concluded that the use of Tunoltu Graph media can improve students' mathematical communication skills and increase the level of student competence attainment in learning trigonometric equations (Sugiarti, Kompetensi, & Tunoltu, 2017)

In other studies that use teaching aids to improve learning outcomes, it shows that using triangular model teaching aids affects student learning outcomes with a contribution of 19% for the use of teaching aids, and the other 81% is determined by different variables that affect learning outcomes (Baskoro & Habibah, 2013)

Based on the previous research, there are differences between the research and the research carried out, namely the learning strategy, subject matter, and variable expectations. At the same time, the similarity is the use of teaching aids.

Learning that uses teaching aids enables students to be more active and think creatively, effectively, and fun. Making students more dynamic, creative, and effective will make it easier for them to understand the concept. The changes that occur have an impact on the mathematics learning outcomes obtained by students.

Teaching using teaching aids will increase students' attention to the learning carried out because they are actively involved in the education being carried out.

Thus, in this study, teaching aids are more effective because students better understand the problems associated with real-life and can bring them into a mathematical form.

Teaching using teaching aids can stimulate thoughts, feelings and concerns, and the willingness of students to learn so that it can encourage the learning process. Furthermore, teaching aids can give a more meaningful impression to students and foster positive values on student learning outcomes and processes. Besides, teaching aids are also tools used by teachers for the teaching and learning process by seeing,

feeling, and manipulating teaching aids to have authentic experiences in the meaning of the concept of mathematical material. The results of this study, the use of teaching aids (Magnet Set) can improve good mathematical communication skills and make students active in the learning process to make it easier for them to communicate about existing problem problems.

By using teaching aids, the learning process will motivate teachers and students, especially students, to be more stimulated by their interest and liking in learning mathematics.

Based on the observations during the language learning process. Students who have high mathematical communication tend to participate more in learning activities such as solving problems, working on questions, daring to express their ideas or opinions, and daring to ask questions if they encounter difficulties. Meanwhile, students who have sufficient mathematical communication skills participate in solving problems and working on issues. However, sometimes they still do not dare express their ideas or opinions or do not dare to ask their questions. Furthermore, suppose students have low mathematical communication. In that case, they tend not to solve problems, work on issues, and do not dare to express their ideas or opinions, and not dare to ask their questions.

4. Conclusion

Based on the analysis results, set magnetic teaching aids in learning set material shows a good category. This was obtained from the posttest average score of 86.73. From these results, in general, mathematics learning using selected magnetic teaching aids received a positive response; this was seen through the posttest results of students' good communication skills with a percentage of 84.62%.

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