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Analysis of Student's Mathematic Communication Ability in Solving Problems of Pattern Procedures in Pythagoras Theorem

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Abstract

This study aims at knowing and describing students' mathematical communication skills in problem-solving on Pythagorean theorem material based on Polya's procedure. The Polya's problem-solving phase consists of the stage of understanding problems, planning problem solving, implementing problem-solving plans, and re-examining. The subject of this study were 6 students from eighth-grade of Junior High School which was selected based on good, sufficient, and poor mathematical communication criteria. Moreover, this study employed a descriptive qualitative method where the data was collected by using a test and interview. The results of the study revealed that the students with good mathematical communication capabilities criteria were able to solve the problems based on Polya's procedure. Meanwhile, students with sufficient criteria of mathematical communication capability unable to solve the problem based on Polya's procedure at the stage of making plans by altering mathematical information in the form of picture, students did not realize the need for design actions first, students just go ahead and didn 't see the results of completion that have been made. Additionally, students with poor mathematical communication capabilities were unable to solve the problems based on Polya's procedure, students were not meet at the stage of making plans by changing mathematical information in the form of picture, making plans by using and selecting mathematical information or images to solve the problems, and the students did not look back at the completed results.

Keywords: Mathematical Communication; Problem Solving; Polya Procedure

INTRODUCTION

Education basically has two objectives, namely to make humans smart and smart, and to make humans into good and moral humans (Sudrajat, 2011). In an effort to improve the quality of education in Indonesia through learning(Raehang, 2014). Learning is a person's change due to experiences(Khomsiatun & Retnawati, 2015). According to Lanani (2013), learning includes a process in which students are transformed by educational messages about material from learning resources. At the time of transformation activities there is a communication process, both between teachers and students or students and students. Communication in mathematics is very necessary because there are so many symbols and mathematical concepts that are rarely understood by students. In mathematics communication is also called mathematical communication. Mathematical communication is a student's ability to convey mathematical ideas in written or oral

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form(Hodiyanto, 2017). Through communication, there is the delivery of ideas or ideas orally or in writing so that understanding will be created during learning (Asnawati, 2017). Students who have difficulty communicating mathematically will find it difficult to solve problems in mathematics.

Problem solving ability as an indicator of learning objectives is a very important ability to be developed(Mariam, Rohaeti, & Sariningsih, 2018). Mathematics includes subjects that are used to obtain mathematical problem solving(P. Wulandari, Mujib, & Putra, 2016). The steps in solving problems in mathematics according toG. Polya (1973), there are 4 steps that must be considered in problem solving including: (1) understanding the problem; (2) compiling completion planning; (3) carry out planning; (4) review the results of the settlement made. The final stage in the G. Polya procedure is a process of checking all information back with calculations that have been carried out which aims to produce a solution to solving a problem.

One of the activities to solve problems is by presenting the questions in the form of meaningful sentences or so-called story questions (Pritananda & Yusmin, 2016) and (Wahyuddin, 2017). One of the ways to solve problems in mathematics is to use Polya's problem-solving steps to solve a mathematical problem. According toHasan (2019)There are many problems in mathematics, including the Pythagorean theorem, in the form of aspects based on conceptual, procedural, and computational errors. Often students solve problems in the absence of clear stages that begin by writing down what is known and what was asked. When students do not write down what is known, students often experience errors in entering values and conceptual errors can occur. At the assessment stage, students will be judged wrong in solving the problems that have been given.

Junior High School (SMP) is a school level, to be precise in grade VIII there is material for the Pythagorean Theorem. In this material students must be able to solve problems on problems using creativity in calculating and using understanding of the concepts that have been taught. According toKhomsiatun & Retnawati (2015), to get to math proficiency how to reason a student must be trained, creativity and problem solving abilities of a student must be developed, ways of conveying mathematical information in writing and orally must also be developed.

Based on the results of observations made at a junior high school in Malang district, it was found that students' mathematical abilities in solving story problems were relatively low. According toRimilda (2015), Junior high school students' proficiency in mathematical reasoning, communication and connection, as well as problem solving is felt to be lacking.

Problem-solving abilities have attracted a lot of mathematics researchers and educators because of the weak abilities of each student. According toArtana (2014), the causes of the low ability of problem solving for each student include: students tend to take the examples given by the teacher without any attempt to ask if anything is not understood or understood so that the effort in solving the problem itself is lacking and students do not work on problem solving in a structured manner. Things like that ultimately lead to less student learning outcomes and doubtful students' mathematical communication because it is not optimal.

In this research, the communication that will be analyzed is written and oral communication. Written and oral communication was chosen because the delivery

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of information between students and teachers is not through one of them only, sometimes there are some students who understand problem solving but cannot write in mathematical symbols or in clear sequences. According toAminah, Wijaya, & Yuspriyati (2018), in his research, mathematical communication in junior high school students, comparative material is still low in terms of expressing everyday events into the language of mathematics or mathematical symbols. On researchYuwono, Sup Sophisticated, & Ferdiani (2018), shows the problem-solving analysis in solving story problems based on the poly theory theory states that many students are still not in accordance with the pattern theory.

Based on the description above, the formulation of the problem is how the students 'mathematical communication skills in problem solving based on Polya's procedures for class VIII students of SMP Aisyiyah Muhammadiyah 3 Malang .. So that this study has the aim of knowing and describing the results of the analysis of students' mathematical communication skills both written and oral. by solving problems based on the polya procedure on the material problem of the Pythagorean theorem class VIII. The benefit of the results of this study is expected to be a comparison of teachers to further improve or maintain mathematical communication to students both orally and in writing using the polya procedure.

RESEARCH METHOD

Research seen from the approach has two types, namely a qualitative approach and a quantitative approach. In the research that has been done, which is used includes a qualitative approach with descriptive research type. Qualitative research aims to explain the events that occur thoroughly through the collection of data obtained(Lutfianannisak & Sholihah, 2018). This study is to determine and describe the results of the analysis of students' mathematical communication skills at SMP Aisyiyah Muhammadiyah 3 Malang in solving problems based on Polya's procedures on the Pythagorean theorem.

This research is about the analysis of written and oral mathematical communication in problem solving based on Polya's procedure on the Pythagorean theorem which was carried out at SMP Aisyiyah Muhammadiyah 3 Malang. The research was carried out on January 29, 2020 in accordance with the Pythagorean theorem material presented. Pythagorean theorem material entered in the even semester of class VIII using the 2013 curriculum.

On The 2013 curriculum for mathematics subjects is designed for class VIII with the Pythagorean theorem material in the even semester. So that the subjects in this study were class VIII students at SMP Aisyiyah Muhammadiyah 3 Malang. Data collection techniques in this study used tests and interviews. The test is used to obtain primary data with the mathematical communication skills of VIII grade junior high school students. The instruments used in this study were a test sheet of mathematical communication skills in the form of an essay, amounting to 3 questions, and an interview guideline sheet. Before being used for research, the questions and interview guide sheets had been tested for validity by one lecturer and one mathematics subject teacher. Based on the assessment of the validator, It was found that the research instrument was valid with a total average for the test instrument of 3.21. As for the interview instrument, it was 3.23. So that the research

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instrument is valid and suitable for use. Interviews are used to observe and determine students' mathematical communication skills verbally by explaining the questions that have been completed and looking for more complete information. Interviews were conducted after the written test using the subject of 6 students from the criterion level of ability which included 2 students from good criteria, 2 students from sufficient criteria, and 2 students with poor criteria. With the above calculations, the students' written mathematical communication skills test scores were obtained. Then determined the category of student ability level for further interviews conducted. To critique students' written mathematical communication skills with value intervals from 0 to 100 with referenceLaksananti, Putri, Setiawan, Toto, & Setiawani (2017), so it looks like the following table.

Table 1. Criteria for Level of Communication Capability

No.	Score	Students' Mathematical Communication Ability Criteria
1	75 <Value ≤ 100	Good
2	50 <Value ≤ 75	Enough
3	Value ≤ 50	Less

After being matched with the level of categories that have been provided, then the next interview is to take 6 students from class VIII using the interview question guide.

RESULTS AND DISCUSSION

Research on mathematical communication skills was conducted at SMP Aisyiyah Muhammadiyah 3 Malang on January 29, 2020 aimed at grade VIII students. VIII grade students who have studied the Pythagorean theorem material that has been taken at the beginning of the even semester. The results can be obtained by carrying out a written test with a total of 3 questions that contain questions about the Pythagorean theorem that must be solved by students.

Written Mathematical Communication Skills

The written test in this study was attended by 21 students of class VIII with the provisions previously described in the research method. This written mathematical communication has 4 indicators to achieve these 4 indicators, given 3 problems about the Pythagorean theorem material in the form of test questions. Students must solve 3 problems so that it can be seen that students' written mathematical communication skills are in accordance with each indicator

Table 2. Written Mathematical Communication Ability Test Results

No.	Score	Frequency	Criteria
1.	75 ≤ Value ≤ 100	2	Good
2.	50 ≤ Value <75	9	Enough
3.	0 ≤ Value <50	10	Less
Total Student Score		1093	
Average		52.07	Enough

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So that the results can be averaged, namely students of SMP Aisyiyah Muhammadiyah 3 Malang class VIII of students' written mathematical communication skills on the Pythagorean theorem material occupy the sufficient category. The following is a table of students who meet each indicator of the problems that have been given.

Table 3. Number of Students Fulfilling Each Indicator

Indicator	Problem 1	Problem 2	Problem 3
1	20 Students	19 Students	15 Students
2	21 Students	15 Students	15 Students
3	19 Students	20 Students	19 Students
4	10 Students	10 Students	12 Students

The table shows that many of the 21 students have written on each indicator.

a. Written Mathematical Communication Skills Good

Students' mathematical communication is considered good if the written mathematical communication result scores are from more than 66 to 100.After the Pythagorean theorem problem solving analysis is carried out, there are 2 students who get good criteria, 1 of them gets the highest score 91.30, MF and RJ get 80 , 43. MF gets the highest score in written mathematical communication skills, MF is able to write down known and asked problems correctly from all questions, RJ does not have the same thing. The ability to change mathematical information in the form of an image can be solved by RJ, because RJ is able to solve the indicator well even though there is an error solving one of the problems. Furthermore, written mathematical communication skills with indicators of choosing mathematical information to solve problems are owned by both students with good ability criteria, but there is one problem that cannot be resolved properly by them. This is similar to indicators making conclusions in their own language, because when they are wrong in solving problems, the conclusions written are not correct. In written mathematical communication problems students with good criteria average problems when changing mathematical information in the form of pictures that are not understood by students This is similar to the indicators making conclusions in their own language, because when they are wrong in solving problems, the conclusions written are not correct. In written mathematical communication problems students with good criteria average problems when changing mathematical information in the form of pictures that are not understood by students This is similar to the indicators making conclusions in their own language, because when they are wrong in solving problems, the conclusions written are not correct. In written mathematical communication problems students with good criteria average problems when changing mathematical information in the form of pictures that are not understood by students

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b. Written Mathematical Communication Ability Sufficient

Students 'written mathematical communication is categorized as sufficient if the students' written mathematical communication result score is more than 50 to equal to 75. After the Pythagorean theorem problem solving analysis was carried out, there were 9 students who occupied sufficient criteria. Of the 9 students with sufficient criteria, the highest score was KG with a value of 69.57 and there was the lowest score in the sufficient criteria, namely AM with a value of 54.35. Students with sufficient criteria in the first indicator state the situation or information in the form of symbols or language, there are 7 students who state correctly on problem 1, 5 students with problem 2, and 6 students on problem 3.In the second indicator, which is changing a mathematical information in the form of an image no one has been able to pinpoint, there were 9 students who wrote it down but it wasn't quite right. In the third indicator, which is using and selecting mathematical information or images to solve the problem, there are 2 students who state correctly on problem 1, and 6 students on problem 3.In the fourth indicator, which is making conclusions in their own language that is in accordance with the correct solution, there are 2 students stated correctly in problem 1, no one stated correctly on problem 2, and there were 6 students who stated correctly on problem 3. Students with sufficient criteria were unable to write correctly when changing mathematical information in the form of pictures.

c. Poor Written Mathematical Communication Skills

Students' written mathematical communication is criticized for being deficient if the student's written mathematical communication result score is less than 50. After the Pythagorean theorem problem-solving analysis was carried out, out of 21 students there were 10 students who were in poor criteria. The value of 10 students has the lowest score of 19.57. Students with insufficient criteria in the indicators state the situation or mathematical information in the form of symbols or language, 1 student wrote correctly, 6 students wrote it incorrectly and 3 students did not write it on problem 1.In problem 2 there were 3 students wrote correctly, 5 students wrote incorrectly, and 2 students did not write them down. In problem 3 there were 4 students writing correctly, 4 students writing incorrectly and 2 students writing not. On the indicator of changing a mathematical information in the form of an image with problems 1, 2 and 3 no one wrote it correctly, on problem 1 all students wrote it incorrectly, problems 2 and 3 there were 4 students wrote it incorrectly and 6 students did not write it on indicators use and select mathematical information or pictures to solve problems on problems 1 and 2, no one is able to write correctly, problem 3 there are 3 students who write correctly. On the indicators of making conclusions in their own language according to the solution, no one was able to write correctly, there were 2 students who wrote incorrectly on problems 1,2 and 3.

Oral Mathematical Communication Skills

Retrieval of data from oral mathematical communication through interviews that were conducted on February 3, 2020 to six students, namely RJ, MF, HD. AM, PR, and RB. In oral mathematical communication analysis refers to the answers of six students in answering questions when asked and refers to four indicators of oral

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mathematical communication. In oral mathematical communication, there is some information that is not known when solving problems by writing, namely in changing mathematical information in the form of images, there are students who are reluctant to use pictures when working on it. In the indicator, looking back at the results of the completion that has been made, only a few students are capable of this indicator because students are not familiar with the stages of working on such questions.

The following is a table of oral mathematical communication skills when students conduct interviews.

Table 4. Results of Oral Mathematical Communication Ability

No.	Write Criteria	Initial Name	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Average	Oral Criteria
1	Good	MF	100.00	33.33	75.00	50.00	64.58	Enough
2	Good	RJ	91.67	58.33	75.00	33.33	64.58	Enough
3	Enough	HD	91.67	33.33	75.00	0.00	50.00	Enough
4	Enough	AM	75.00	50.00	66.67	0.00	47.92	Less
5	Less	Homework	75.00	25.00	33.33	66.67	50.00	Enough
6	Kuramg	RB	58.33	8.33	8.33	0.00	18.75	Less

Based on the results of interviews with 6 students with the assessment as shown in the table, it shows that students with good writing criteria do not necessarily get good oral criteria either. Students with good writing criteria excel at indicators stating mathematical situations or information and use and select mathematical information or images to solve problems. Likewise for students with sufficient writing criteria. While the written criteria are not good in terms of stating mathematical situations or information and seeing the results of the solutions that have been made.

Based on the research results, a discussion of the research results from descriptive data analysis will be presented. Written mathematical communication skills have 4 indicators, as well as oral mathematical communication has 4 indicators. This indicator fulfills the ability to solve mathematical problems based on steps according toG. Polya (1973), which consists of four stages, namely: 1) understanding the problem by writing down what information is known and asked, 2) planning and formulating strategies to be used in this study using pictures, 3) completing the mathematical planning stage, 4) checking the results of completion . The following is a discussion of the results of tests and interviews about mathematical communication skills in problem solving with polya procedures based on each criterion.

1. Students' Mathematical Communication Ability Good Criteria

Based on the data obtained through the test results, students on good criteria in written mathematical communication are able to state mathematical situations or information in the form of symbols and language. In the indicator of changing a mathematical information in the form of a picture, there is one student with the right good criteria in changing the information, while in the picture for students other good criteria are less able to fulfill the second indicator. In the third indicator

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using and selecting mathematical information or images to solve problems students with high criteria are able to solve correctly. In the fourth indicator, making conclusions in their own language, students with good criteria are able to complete them correctly.

At the time of the interview, students with good criteria were able to meet all four indicators even though they did not perform them correctly. Good criteria students are able to write the three stages in the Polya procedure even though there are some inaccuracies in the completion. In the fourth stage, about reviewing the results of the completion that can be seen during interviews with students, one student has obtained one student who checks again at all stages and checks the calculations he has made, while another student only checks the final calculation. Polya-based problem solving has been met by students with good criteria with correct solutions, although not all problems can be resolved correctly.

2. Students' Mathematical Communication Ability with Sufficient Criteria

Based on the data obtained through the test results, students on sufficient criteria in written mathematical communication are able to correctly state mathematical situations or information in the form of symbols and language, while the indicators change mathematical information in the form of pictures, students with sufficient criteria are less able to fulfill because in the solution is not quite right. In the third indicator, using and selecting mathematical information or images to solve student problems with sufficient criteria, there are 6 students out of 9 students who are able to solve it correctly while the rest finish incorrectly. In the fourth indicator, the criteria for making conclusions in their own language are sufficient that students are not able to complete them correctly.

At the time of the interview, students with sufficient criteria were able to convey the first indicator but not fluently. On the second indicator, students with sufficient criteria assume that changing mathematical information in the form of images does not need to be done. When choosing mathematical information when solving problems, students with the criteria are sufficient to do it directly without drawing. At the stage of checking again the students are unable to do it. Criteria students are quite capable of writing both stages in the Polya procedure even though there are some inaccuracies in the completion. In the second stage aboutdevelop a strategy that will be used by using a picture of students with criteria that are quite less capable of fulfilling these indicators even though all students have written them but are not right. Whilein the fourth stage, it is about looking back at the results of the completion which can be seen during the interview that no one has carried out this stage in the Polya procedure. The problem solving based on Polya's procedure with the criteria of mathematical communication ability is not sufficient to fulfill the stages in Polya.

3. Students' Mathematical Communication Ability Criteria Lack

Based on the data obtained through the test results, students on the criteria lacking in written mathematical communication are less able to state mathematical situations or information in the form of symbols and language, while the indicators

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change mathematical information in the form of pictures of students with inadequate criteria. In the third indicator, using and selecting mathematical information or images to solve problems, students with poor criteria are unable to solve them correctly. In the fourth indicator, the criteria for making conclusions in their own language are that students are less able to complete them properly. Students with inadequate criteria have not been able to change mathematical information in the form of pictures appropriately and on other indicators cannot be met by students with lack of criteria.

At the time of the interview, students with poor criteria in conveying the first indicator of students were not fluent. In the second indicator, students with less criteria think that changing mathematical information in the form of images is not necessary because they do not understand the problems given. When choosing mathematical information in solving problems, students with the criteria of less work without drawing. At the stage of checking again the students are unable to do it. Students with less criteria, oral mathematical communication skills are better than written mathematical communication skills. The criterion student is not able to write down the stages in the Polya procedure. The four stages in problem solving of the pattern are an important unit to implement(Netriwati, 2016).

The criteria for students are good, sufficient, not all students have met the polya stage, but many cannot complete it correctly, while in this study those who are considered fulfilling are students who are able to correctly write the completion with the Polya stage because they see the quality of mathematical communication skills. students too.

In this study, the students' mathematical communication skills in solving problems based on Polya's procedure resulted in 1) at the understanding stage of the problem, many students had understood the situation or mathematical information in the form of symbols or language, but some did not write down 2) at the planning stage, by changing a mathematical information in the form of pictures to strategize many students who do not do it, 3) planning, using and selecting mathematical information or images to solve problems, there are students who work without changing mathematical information into pictures, 4) re-checking stage , by looking back at the results of the completion that have been made by many students who did not do so, there are students with high criteria who meet this stage.

CONCLUSION

There are three criteria for mathematical communication skills in SMP Aisyiyah Muhammadiyah 3 Malang. Students' mathematical communication skills on good criteria are able to solve problems based on Polya's procedures in the Pythagorean theorem material. For students with sufficient criteria students are not able to solve problems based on Polya's procedures in the Pythagorean theorem material, students cannot fulfill them properly at the planning stage by changing mathematical information in the form of images and reviewing the results of the solutions that have been made. In students' mathematical communication skills with inadequate criteria, students are unable to solve problems in the Pythagorean

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theorem material with Polya's procedures, students are not able to fulfill correctly at the stage of making plans by changing mathematical information in the form of images.

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