Polya theory to improve problem-solving skills

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Abstract. This research is to improve problem-solving skills in SMP Muhammadiyah 8 Medan students through Polya learning theory in the material of linear equation systems in two-variable. This research method is Classroom Action Research. The research subjects were class VIII SMP Muhammadiyah 8 Medan totalling 29 students. The object of research is the ability to solve mathematical problems — data from research results obtained from observation and test results. The results showed that the use of Polya learning theory could improve students' mathematical problem-solving abilities. In the pre-cycle, there was 10.34% (3 students) of the 29 students who achieved the passing grade. The test results in cycle 1 showed there was 51.72% (15 students) of the number of students who reached passing grade, whereas in cycle 2 there was 75.86% (22 students) of the number of students who reached passing grade. The average value before the cycle is 54.50, while at the end of cycle 1 the average value of the test is 64.60, and at the end of the second cycle is 85.72. Then it can be concluded that the objectives of the research carried out have experienced success. In other words, the application of Polya learning theory can improve students' mathematical problem-solving abilities.

1. Introduction
One of the objectives of learning mathematics in schools is to solve problems that include the ability to understand problems, to investigate problems, to collect problems, to design mathematical models, solve models, and interpret solutions obtained [1, 2]. NCTM, said that problem-solving skills are one of the most important skills in which knowledge and mathematical skills are used at the highest level. [3]. And in this case, every student has different intellectual abilities; this can be seen from the way students solve the problems given. The habit of students hearing and seeing teachers in solving problems without doing it themselves is also one of the factors that weaken students' problem-solving abilities.

In this study, problem-solving ability is a very important ability. With this ability, students must be able to understand the problems students might face in real life [4]. Problem-solving requires understanding the problem situation and the means needed to make decisions, which direct individual understanding [5]. And most students are not right in interpreting the problem given. The main purpose of learning mathematics is to provide understanding to students to solve problems. In solving mathematical problems not only results but more importantly, students must know and understand the thought process or steps to get the results and get used to solve more challenging problems [6-8].
The fact obtained in the eighth grade VIII-B SMP Muhammadiyah 8 Medan shows that students' mathematical problem-solving abilities are very low. Especially in solving problems related to implementation in everyday life. The lack of mathematical problem-solving skills should not be allowed because problem-solving skills are one of the main principles of science and technology and also teaching is important for the advancement of mathematics education [9]. The ability to solve problems is the ability of individuals to use knowledge to solve non routine problems [10, 11].

One way to improve problem-solving skills is to teach learning theory that can be used to solve problems, namely Polya's theory. The four steps of problem-solving introduced by Polya are understanding problems, developing plans, carrying out the plan and looking back [8,11-16].

Based on background, Then the formulation of issues that will be examined in this study are: (1) Whether the use of Polya learning theory improve the ability to solve mathematical problems in students of SMP Muhammadiyah 8 Medan; (2) What about is the percentage of the results of students' mathematical problem-solving abilities using Polya learning theory in students of SMP Muhammadiyah 8 Medan. Therefore, the goals of the research are: (1) to determine whether the use of Polya learning theory improve the ability to solve mathematical problems in students of SMP Muhammadiyah 8 Medan; (2) to find out how to the the percentage of the results of students' mathematical problem solving abilities using Polya learning theory in students of SMP Muhammadiyah 8 Medan.

2. Method
The method of this research is research conducted to help improve the ability of students in class VIII-B Muhammadiyah 8 Medan Middle School through Polya learning theory. The procedure of this study was carried out in two cycles with each cycle carried out in four stages, namely the planning stage, the implementation, development, and reflection stages. The data collection tool in this study is a test and experience. The steps taken in analyzing the data are by reducing and applying data, namely selecting, simplifying, and communicating rough data in the field. The data analysis technique used is to measure the ability to read questions, make tabulations of the data that has been obtained, and calculate the amount of data available.

3. Results and Discussion
The research took place in two cycles and was planned by designing research, and researchers collaborating with classroom teachers. The researcher acts as an observer and also acts as the executor of the action or executor of learning. When the researcher made an observation, the researcher saw that the delivery of mathematics learning at SMP Muhammadiyah 8 Medan, the teacher had not used Polya's learning theory. Besides, the teacher also conducts conventional learning in solving mathematical problems. Therefore, in this case, students are not too enthusiastic and feel bored in learning mathematics, especially SPLDV material. The lack of enthusiasm of students in mathematics learning has resulted in student scores in SPLDV material being low.

| Parameter | Achievement |
|-----------|-------------|
| 1 Average | 54.5        |
| 2 Highest Value | 85         |
| 3 Lowest Value | 20         |
| 4 Lowest Value | 10.34%    |
| 5 The Percentage Is Not Completely | 89.66%    |
| 6 The Number of Students | 29        |
| 7 The Number of Students Who Complete | 3         |
| 8 The Number of Students Who Do Not Complete | 26        |
| 9 Passing Grade | 75        |
From Table 1, it can be used to improve students’ ability to solve mathematical problems. Normally, the condition of students’ achievement at the beginning of learning before the use of learning theory is in a bad category [8]. Meanwhile, that the ability to achieve students’ mathematical problems is good if the individual values of students reach 75% [14].

The steps taken in this study are to apply the theory learned by Polya which is expected to improve students’ ability to solve the problem of two-variable linear equation systems. In the first cycle, it was carried out two times with each time allocation of 2 x 40 minutes at each meeting. At the end of the cycle, the researcher acts by giving students evaluation of learning to find out the ability of students to solve mathematical problems individually in interpreting the problems given.

**Table 2.** The results of the Cycle I evaluation

| No | Parameter                                    | Achievement |
|----|----------------------------------------------|-------------|
| 1  | Average                                      | 66.6        |
| 2  | Highest Value                                | 90          |
| 3  | Lowest Value                                 | 30          |
| 4  | Lowest Value                                 | 51.72%      |
| 5  | The Percentage Is Not Completely             | 48.28%      |
| 6  | The Number of Students                       | 29          |
| 7  | The Number of Students Who Complete          | 15          |
| 8  | The Number of Students Who Do Not Complete   | 14          |
| 9  | Passing Grade                                | 75          |

From Table 2, during the cycle, we observed the ability to solve mathematical problems with 29 students, and 15 students with scores above the Passing Grade with a percentage of 51.72% and 14 students who still had scores under Passing Grade 48.28%. Because the overall value is still below 75%, the researcher will carry out the meeting to the next cycle. In the initial stages of difficulty in solving students’ problems, the lowest score was obtained. Namely 35 needed to revise the lesson done [14].

The part of the first cycle is observation. Observations made by researchers are based on the answers to student worksheets that are by the steps of Polya’s learning theory to improve problem-solving skills in the discussion of systems of two-variable linear equations (SPLDV). The results of the observation of problem-solving abilities can be seen in the following table.

**Table 3.** Observation results of students capabilities to solve the word problem in Cycle I

| No | Aspects of the observed                  | Score    | Category       |
|----|-----------------------------------------|----------|----------------|
| 1  | Understand the problem                   | 46.55%   | Good Enough    |
| 2  | Planning problem solving                 | 54.05%   | Good Enough    |
| 3  | Carrying out a problem-solving plan      | 54.31%   | Good Enough    |
| 4  | Re-examine the solutions obtained        | 36.21%   | Less Good      |
|    | **Total Score**                          | **191.12%** |               |
|    | **Average**                              | **48.00%**   |               |
|    | **Description**                          | **Good Enough** |         |

From Table 3, it can be concluded that the results of the problem-solving ability in solving the system of linear equations in the two cycles in the first cycle are still relatively low with an average of 48.00% based on a fairly good category. Meanwhile, the quality of learning from the preparation, implementation and results that have been used in the Polya theory learning is of good quality [8].

The first cycle in this study was also to find out the percentage of students' classical completeness which can be seen in Table 4.
Table 4. percentage of overall test of solving mathematics word problem story on Cycle I

| No | Test Results | Pre Cycle | Cycle I | Classical Completeness |
|----|--------------|-----------|---------|------------------------|
| 1  | Highest Value| 85        | 90      | 51.72 % (Good Enough)   |
| 2  | Lowest Value | 20        | 30      |                        |
| 3  | The Average  | 54.5      | 66.6    |                        |

From Table 4, it can be concluded that the score improved the average value of the class at the time of pre-cycle 54.5. Whereas at the time of the cycle I reached 66.6. The percentage of students who hadn't at pre-cycle was 78%. While on cycle I the percentage of students who hadn't was 48.28%. Based on the results of the cycle I, the average value of the class has not yet reached the criteria of research so that research continues to cycle II. Implementation cycle I also measure how many students have the capability of resolving the question of the story while following learning Math Class VIII by applying learning theory Polya shown through Table 5.

Table 5. Test results of students capabilities to solve the word problem in Cycle I

| No | Category            | Number of Students | Percentage |
|----|---------------------|--------------------|------------|
| 1  | Very Good           | 8                  | 27.59%     |
| 2  | Good                | 7                  | 24.14%     |
| 3  | Good Enough         | 7                  | 24.14%     |
| 4  | Less Good           | 7                  | 24.14%     |

From Table 5, we see that in the implementation of Cycle I, there were 8 students have the capability of resolving the question of the story with a very good percentage of 27.59%, 7 students have the capability of resolving the question of good stories with a percentage of 24.14%, 7 students have the capability of resolving the question of the story quite well with the percentage of 24.14%, and 7 students have the capability of solving word problem is less good with 24.14% percentage.

Based on observation of the study process using learning theory quite well already though Polya still the existence of flaws in its implementation. As for ability test solve math story on cycle I gained an average of 66.6 from 25 students there are 15 students (51.72%) who managed to reach the level of completeness of learning because most students there are still many that are still lacking in understand the issue and checks back the obtained solution. So the upgrade completed a math story problem the student has not been by the rate overall of the classical set is ≥ 85%, so it needs improvements in cycle II that maximize student learning outcomes with using learning theory Polya. On the implementation of the cycle I, an indicator of the research that has been specified is not reached until the cycle continues to II. Cycle II is implemented in two meetings with the allocation of 2 x 40 minutes each of his encounters. As for the activities performed are the repair of four stages that have been done on a cycle I, namely: planning, execution, action, observation and reflection.

Table 6. The results of the evaluation of Cycle II

| No | Parameter                          | Achievement |
|----|------------------------------------|-------------|
| 1  | Average                            | 85.72       |
| 2  | Highest Value                      | 100         |
| 3  | Lowest Value                       | 70          |
| 4  | Lowest Value                       | 75.86%      |
| 5  | The Percentage Is Not Completely   | 24.14%      |
| 6  | The Number of Students             | 29          |
| 7  | The Number of Students Who Complete| 22          |
| 8  | The Number of Students Who Do Not Complete | 7   |
| 9  | Passing Grade                      | 75          |
From Table 6, during the Cycle II maintained its position of researchers observing skills solve story students against 29 students. Twenty two students have values above the PASSING GRADE with the percentage of 75.86% and seven students who still have a value under PASSING GRADE with the percentage of 24.14%. There is an increase in the percentage of overall the results of the study on cycle II that is above 75%, so the research is done enough until cycle II. In the second stage, it showed that students' problem-solving abilities were 90% of which 27 students were able to solve the problems given and three students were unable [14].

Observations made by researchers at the cycle II began from the start of the implementation of the action until the end of the action learning by using learning theory Polya to improve students ’ math story problem finish on the subject of systems of linear equations two variables. Results observation capabilities of solving a word problem students can be seen in the following table.

**Table 7. Observation Results of the Students Capabilities to Solve word problem in Cycle II**

| No  | Aspects of the observed                          | Score   | Category    |
|-----|-------------------------------------------------|---------|-------------|
| 1   | Understand the problem                          | 75.86%  | Very Good   |
| 2   | Planning problem solving                         | 89.66%  | Very Good   |
| 3   | Carrying out a problem-solving plan             | 80.17%  | Very Good   |
| 4   | Re-examine the solutions obtained               | 75.86%  | Very Good   |
|     | Total Score                                     | 321.55% |             |
|     | Average                                         | 80.30%  |             |
|     | Description                                     |         | Very Good   |

From Table 7, it can be concluded the results of the observation capability of completing a mathematics word problem students in cycle II increased 48.00% to 80.30% which identified that the average capabilities solve math story in learning theory Polya included in category is excellent and meets 75% success indicators. Research on cycle II is also to know the percentage of students of classical overall which can be seen in the table below:

**Table 8. Percentage of completeness test to solve mathematics word problem on Cycle II**

| No  | Test Results | Pre Cycle | Cycle I | Cycle II | Classical Completeness |
|-----|--------------|-----------|---------|----------|------------------------|
| 1   | Highest Score| 85        | 90      | 100      | 75.88%                 |
| 2   | Lowest Score | 20        | 30      | 70       | (Very Good)            |
| 3   | The Average  | 54.5      | 66.6    | 85.72    |                        |

From Table 8, it can be concluded that the results of the study, students in learning Mathematics are included in the category very well as evidenced by the overall classical of 75.86% with an average score of 85.72. Building learning skills using the right theory is very good [12].

Implementation cycle II also measure how many students have the capability of resolving the question of the story while following the math learning using learning theory Polya, shown through the table below.

**Table 9. Observation Results capabilities to solve the word problem in Cycle II**

| No  | Category      | Number Of Students | Percentage |
|-----|---------------|--------------------|------------|
| 1   | Very Good     | 17                 | 58.62%     |
| 2   | Good          | 4                  | 13.79%     |
| 3   | Good Enough   | 8                  | 27.59%     |
| 4   | Less Good     | 0                  | 0.00%      |
From data on Table 9, we know that in the end of cycle II, there are 17 students who have the capability of solving the word problems with score 58.62%, the percentage of students who have the capability of resolving the question of good stories with the percentage of 13.79%, 8 students that have the capability of resolving the question of the story quite well with the percentage of 27.59%, and there were no students who have less good in solving math story problem.

Data can be drawn from the results of conclusions of the occurrence of a change of the learning outcomes increase from I to II cycle. As for ability test solve math story on cycle II obtained an average of 29 students from 85.72, there are 22 students (75.86%) who managed to reach the level of overall study, and only seven students (24.14%) have not yet reached the level of overall learning. So it can be concluded that in the cycle of learning activities using II learning theory Polya shows success in learning. The increase has been achieved then the classical learning did not proceed to the next cycle and stops on cycle II.

4. Conclusion

Based on the results of research and discussion, it can be concluded that the implementation of the learning theory can improve the Polya solve the story of students of SMP Muhammadiyah 8 Medan. It can be seen from the average ability students solve story on learning that applying learning theory Polya cycle I up to cycle II that increases until it reaches the expected percentage.

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