



Application of Polya Strategy Assisted by Concrete Media to Improve Numeracy and Learning Outcomes in Elementary School Students

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Abstract: The background of this research is the low numeracy skills of students in solving problem-solving questions, the less attractive learning media used by the teacher and in the learning process, and the teacher's need to use the appropriate model/strategy in the learning process. This study aims to describe the implementation of the Polya Strategy assisted by concrete media to improve numeracy and student learning outcomes. Classroom Action Research (PTK) uses a model developed by Ernest T. Stranger, carried out during II actions. Each action has 3 stages, namely Look, Think, and Act. Researchers researched fifth-grade students at SD Pangudi Luhur Ambarawa with 37 students. This study's data collection techniques included interviews, observation, evaluation tests and documentation. The enumeration results of class V students at SD Pangudi Luhur Ambarawa in action I with a class average value of 70%, while action II achieved a class average of 86%. The learning outcomes of students in Action I with a class average value of 68%, while in Action II achieved a class average value of 80%.

Abstrak: Penelitian ini dilatar belakangi dari rendahnya keterampilan numerasi peserta didik dalam menyelesaikan soal pemecahan masalah, kurang menariknya media pembelajaran yang digunakan oleh guru dan dalam proses pembelajaran guru belum menggunakan model/strategi yang sesuai. Tujuan penelitian ini, yaitu untuk mendeskripsikan penerapan Strategi Polya berbantuan media konkret untuk meningkatkan numerasi dan hasil belajar peserta didik. Penelitian Tindakan Kelas (PTK) menggunakan model yang dikembangkan oleh Ernest T. Stranger yang dilaksanakan selama II tindakan, setiap tindakan terdapat 3 tahap yaitu *Look, Think, Act*. Peneliti melakukan penelitian pada peserta didik kelas V SD Pangudi Luhur Ambarawa dengan jumlah 37 peserta didik. Pada penelitian ini teknik pengumpulan data berupa wawancara, observasi, tes evaluasi dan dokumentasi. Hasil numerasi peserta didik kelas V di SD Pangudi Luhur Ambarawa pada tindakan I dengan nilai rerata kelas 70% sedangkan tindakan II mencapai nilai rerata kelas 86%. Hasil belajar peserta didik pada tindakan I dengan nilai rerata kelas 68% sedangkan tindakan II mencapai nilai rerata kelas 80%.

A. Introduction

Mathematics is one of the subjects that plays an important role in the development of science (Nule et al., 2022). Mathematics learning in elementary school is not only about counting but also trains students to solve problems, and students are expected to develop the ability to solve problems they face in everyday life (Dewi et al., 2022). The purpose of learning Mathematics is not only to improve numeracy skills but to improve mathematical abilities. According to (Septikasari, 2018), as educational institutions, schools must be equipped with creative thinking skills, critical thinking and problem-solving, communication, and collaboration, or what is commonly referred to as 4C.

In 21st-century learning, one indicator of the 4C cognitive aspect, namely facing problem-solving, also plays an important role in learning numeracy. In solving problems presented with numeracy skills, not only with simple numeracy skills but also the ability to think rationally and reactively (Sanvi, 2022). According to Abidin (2017), solving math problems requires understanding, applying knowledge, mathematical skills, reasoning, problem-solving, communicating and having an attitude of respect for mathematics. In mathematics, students need to learn about the final solution and the process of finding the solution.

In finding a solution, numeracy skills are needed to understand problem-solving. As stated (Pangesti, 2018), Numerical ability is a very important ability for students to have because this ability is closely related to solving mathematical problems in everyday life (Silvia et al., 2023). A learner is said to be able to solve problems if he knows how to apply his acquired knowledge to new situations. By giving math word problems, students will be accustomed to using problem-solving steps systematically and coherently so that they can be accounted for. In summary, numeracy skills are the ability to understand and use mathematics in various contexts to solve problems and explain information to others using mathematics (Winata, 2021). As for the numeracy aspects, namely 1) Understanding, namely determining and explaining information; 2) Application is providing settlement solutions; 3) Reasoning, namely analyzing and solving questions (Wahyuni, 2023).

Many students need help solving story problems. We can see this from the results of the Program for International Student Assessment (PISA) in 2018, the Mathematics scores of students in Indonesia are still below the international average (Shafira et al., 2023). According to the PISA for mathematics, the international average score is 71% of students below the minimum competency, and Indonesia is ranked 72 out of 78 countries.

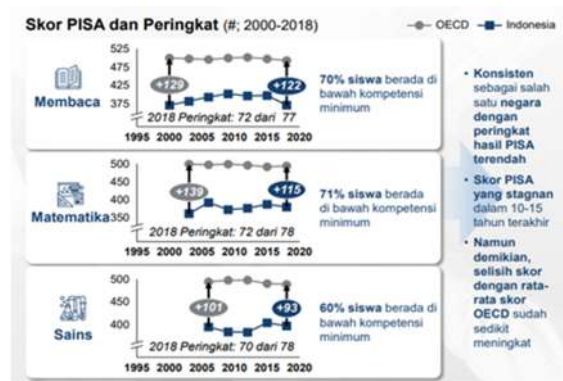


Figure 1. PISA Scores and Ratings

Source : (OECD/PISA, 2019)

Apart from the PISA data, which explains the low mathematical ability of students in Indonesia, it is also found in the results of Education Report Cards. Based on the 2022 Education Report Card results, the numeracy ability of less than 50% of elementary students reaches the minimum competency limit.



Figure 2. Achievement of Learning Outcomes According to Education Report Cards

Students in class V SD Pangudi Luhur Ambarawa experienced the low numeracy skills of students in solving math word problems. Based on the results of observations and interviews with fifth-grade teachers at SD Pangudi Luhur Ambarawa, the ability of students to understand math word problems still needed to improve, so they needed help determining answers. To solve problem-solving questions in the form of story questions, students write down answers immediately, even though the answers asked are simple. However, because they need to understand story questions better, the answers often must be corrected. In the learning process, especially mathematics, the teacher emphasizes the ability to work on certain questions and formulas so that students are only fixated on the textbook from the school or the examples the teacher gave. This causes students to only fixate on one answer. In addition, students also rarely recheck the answers they have obtained. There were 37 students in the class. Of these 37 students, less than 45% needed help solving word problems because their level of understanding needed to be higher, leading to unsatisfactory learning outcomes.

The results of interviews with class teachers found problems in the class in the form of 1) Less interesting learning media that affect the learning process. 2) The teacher's learning media has yet to lead to problem-solving. 3) The model used by the teacher is not by the learning process, so it affects learning outcomes. 4) LKPD made by the teacher needs to follow the problem-solving steps. In Standard Content Number 7 of 2022, educators must facilitate the development of students' competencies and the scope of elementary school mathematics, including arithmetic operations on whole numbers, fractions and decimals is carried out efficiently to solve contextual problems; identification of patterns both numerical and non-numeric to explain things that are repeated; spatial aspects regarding flat shapes and spatial shapes and their properties to explain the surrounding environment.

The low numeracy skills of students in elementary schools will also affect learning outcomes. Learning outcomes are certain competencies or abilities, both cognitive, affective and psychomotor, that are achieved or mastered by students after participating in the teaching and learning process (Kunandar, 2013). Learning outcomes can tell how students' understanding skills are obtained during learning. In Bloom's Taxonomy, the scope of learning outcomes includes cognitive, affective, and psychomotor aspects.

Learning innovations are needed that can create a learning atmosphere that is by the ability of students to develop understanding in solving story problems (Dwiyanto et al., 2024). The problem-solving steps in important numeracy skills are carried out using sequential steps, namely applying the stages of mathematical problem-solving skills (Fauziah, 2022). By applying Polya theory problem-solving strategies into the learning process, students will better understand problem-solving problems. The Polya model strategy is a special learning strategy in learning Mathematics to solve problem-solving questions. This opinion is reinforced by research results (Putri, 2015). Through the Polya theory, it is hoped that students can solve mathematical word problems systematically based on the steps for completing Polya's theory so that student learning outcomes increase. According to Polya Principles, (1) Understanding the Problem, (2) Planning for Completion, (3) Implementing the Plan, (4) Looking Back. In problem-solving, it is necessary to use learning media. Students in class V SD Pangudi Luhur Ambarawa need to improve their ability to solve problems in math word problems.

Many studies have proven that the Polya Strategy can improve numeracy and student learning outcomes. This is by research conducted (Setiono, 2019) titled "The Effect of the Polya Strategy on Process Ability in Mathematical Literacy Building Materials for Class V Students at SD Negeri 68 Bengkulu City" states that based on data analysis and discussion in this study, it can be concluded that significantly $\alpha = 5\%$ the use of the Polya strategy has a significant effect on the ability to process mathematical literacy in the material for class V SD Negeri 68 Bengkulu City. This is reinforced by Polya's strategy of providing activities in the form of systematic steps to solve mathematical literacy problems that require a process. These systematic steps include understanding the problem, making a settlement plan, carrying out the settlement plan, and rechecking the results. Other research that has been carried out by Yuwono (2020) with the title "Application of Polya Steps to Improve

Mathematics Learning Outcomes of Class V Students of Experiment 2 Elementary School Malang" states that the results of learning mathematics of Class III students of SD No. 2 The share shows that in applying the principle of polya steps in learning it can be well organized and satisfactory learning results in mathematics can be achieved. Observers appreciated that the lesson plans designed during this research could be implemented well. The researcher learned mathematics by applying the polya-step principle to problem-solving questions packaged in word problems to improve students' mathematics learning outcomes.

Polya's strategy will be maximized if assisted by the media. Media is an intermediary in the form of people, material or events that help create conditions that can help enable students to acquire knowledge, skills or attitudes (Aghni, 2018). Learning media appropriate to the material will make it easier for students to receive learning material. Through learning, media can improve student learning outcomes in the cognitive field. Through concrete media, teachers will find it easier to deliver material, and students will easily understand the material so that students can solve problems easily.

B. Method

This research is a type of classroom action research (PTK). Classroom action research is research whose activities can be seen and interpreted as a follow-up to changes in learning activities. Classroom action research requires ideas and ideas to improve teaching and learning activities (Susilowati, 2018). In-class action research with the Polya Strategy, assisted by concrete media at Pangudi Luhur Ambarawa Elementary School, is an innovation to improve numeracy skills and learning outcomes in solving mathematical research problems.

In carrying out this class action research using Ernest T. Stringer's model. The action model has a simple framework that includes viewing (looks), thinking (think), and act (act), which is carried out regularly. 1) Seeing (look) is an activity to understand the problem through collecting data and describing the situation. 2) Thinking is analyzing problems and interpreting how and why they occur. 3) Act (act) is an activity to plan, implement, and evaluate a solution.

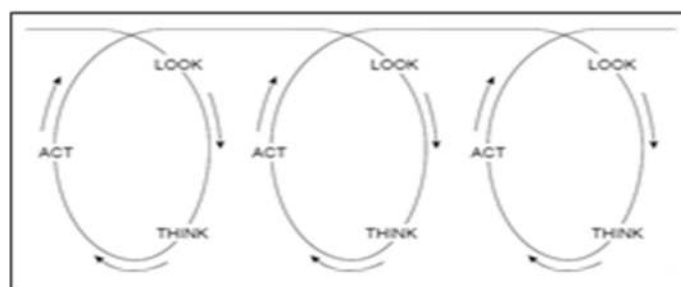


Figure 3. Spiral Action Research Interaction

This activity is carried out repeatedly, meaning that the results of program implementation (Act) can be used as a guideline for planning further activities (Look). The subjects of this study were fifth-grade students at SD Pangudi Luhur Ambarawa for the

2022/2023 school year, with a total of 37 students. This study's subject matter was mathematics in the Elements and Spatial Volume (Cubes and Blocks) chapter.

The type of data used is qualitative and quantitative data. Analysis of the data that will be used in the form of tables and graphs in a description. In this study, data collection techniques used test and non-test techniques. The test technique comprises 10 evaluation questions and 4 LKPD questions, while the non-test technique uses observation sheets of teacher and student activities and documentation.

The performance indicator in this study is the success of increasing numeracy and learning outcomes of fifth-grade students after implementing the Polya Strategy assisted by concrete media. In this classroom action research, the success criteria for numeracy skills and learning outcomes of fifth-grade students after the implementation of the Polya strategy assisted by concrete media in achieving the specified minimum level of success, namely 80% of the number of students participating in the teaching and learning process have achieved a KKM of 70. If, In this class action research, students' learning outcomes have yet to be reached, the KKM Action II will be carried out.

C. Result and Discussion

Result

Classroom action research (CAR) was carried out at SD Pangudi Luhur Ambarawa class V with 37 students from 23 May 2023 to 31 May 2023. The research was carried out through three activity steps: Seeing the problem (Looks), Thinking (Think), and acting (Act). This class action research (CAR) was carried out through 2 actions: action I on 23 May 2023-24 May 2023 and action II on 30 May 2023-31 May 2023. In each action, 2 meetings were held in learning. The first meeting is learning activities, while students work on evaluation questions in the second meeting. This classroom action research was carried out in II actions, which aimed to see an increase in numeracy skills and student learning outcomes in each action.

Action I

Action research I was carried out from Tuesday, 23 May 2023 to 24 May 2023. Before carrying out the research, the researcher conducted interviews with class teachers so that they knew the existing problems. The researcher prepared a lesson plan based on the consideration of the teacher and supervisor with the mathematics subject in the Build Space chapter, subchapter Elements and Volumes Build Space. Researchers also distributed observation sheets of teacher and student activities to class teachers. The researcher gives problem-solving questions, divides students into 4-5 children, distributes LKPD and learning media, asks students to analyze problems, plan solutions, carry out solutions according to plan, recheck answers, teacher and students reflect and make related conclusions learning process.



Figure 4. The Polya strategy of Students Solving Problem-Solving Questions using Concrete Media

The following are the research results obtained in action I:

Table 1. Results of Observation of Teacher and Student Activity Action I

Observational Object	Score	Percentage
Teacher Activity	25	89%
Student Activity	22	78%

From the evaluation test results, the average percentage of numeracy skills in Action I was 70%. The following is the numeration of students in Action I, which can be seen from the table below:

Table 2. Percentage per Indicator Mathematical Numeration Action I

No.	Aspect	Action Final Test I Percentage
1	understanding	78%
2	Application	69%
3	reasoning	63%
	Average	70%

From Table 2, it can be seen that the mathematical numeration in action I of implementing the Polya Strategy assisted by concrete media obtained the following percentages:

Understanding

In this indicator, students can determine and explain information or material related to the problem clearly and precisely, with a percentage of 78%. However, some students still need to explain the information related to the problem clearly and precisely. Application. In this indicator, as much as 69% of students can provide correct solutions to problems. Students can plan how to work on the problem, but some still need to provide the correct solution.

Reasoning

In the table above, students completing and rechecking answers get a score of 63%. Some students still need to complete and examine the results of the answers obtained from the questions accompanied by the right reasons. Some students only provide solutions but do not recheck, which causes the results to be inappropriate. As for the learning outcomes of students who have achieved the minimum completeness criteria of 70 out of 37 students, as many as 17 got an average score of 68.2 with a maximum score of 90 and a minimum score of 50 or a percentage value of 46%, 20 students have not reached the minimum completeness criteria. For action learning outcomes I can be seen in Table 3 below:

Table 3. Frequency Action Learning Outcomes I

No	Intervals	Percentage	Frequency
1.	91-100	0	0%
2.	80-90	5	14%
3.	70-79	12	32%
4.	<70	20	54%
		18	100%

Based on the evaluation test for Action I, we can describe it through a picture diagram as follows:

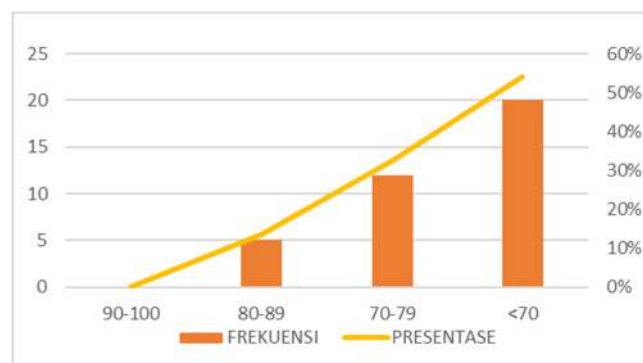


Figure 5. Value of Action Learning Outcomes I

Action research has strengths and weaknesses. Weaknesses of action I include the results of teacher and student activities that are not appropriate because there are still students who have not analyzed the completion of the worksheets that have been distributed, students also have not linked volume with everyday life, and students have not worked in groups. For the advantages of Action I, active students with learning media, students can understand problem-solving in the form of stories.

Based on the results of analysis of the implementation of the action data from tests, non-tests and observations, action research I still needed to meet the success criteria. Because there are weaknesses in Action I, which are obstacles to achieving numeracy skills and learning outcomes, Action II is carried out by maintaining the advantages of Action I.

Action II

Action research II was carried out from Tuesday, 30 May, 30 May, 2023, to 31 May, 31 May, 2023. Before acting, the researcher prepared a lesson plan based on the consideration of the teacher and supervisor with the mathematics subject chapter Building Spaces sub-chapter Elements of Nets and Constructing Volumes. Researchers also distributed observation sheets of teacher and student activities to class teachers. The researcher gives problem-solving questions, divides students into 4-5 children, distributes LKPD and learning media, asks students to analyze problems, plan solutions, carry out solutions according to plan, recheck answers, teacher and students reflect and make related conclusions, learning process.



Figure 6. The Polya Strategy of Students Solving Problem-Solving Questions using Concrete Media

The following are the research results obtained in action II:

Table 4. Observation Results of Teacher and Student Action II Activities

Observational Object	Score	Percentage
Teacher Activity	27	96%
Student Activity	25	89%

Based on the results of the observation sheet for the teacher and students in action II, the teacher's activity got a score of 27 out of a maximum score of 28 with a percentage of 96%, while for the student activity observation sheet, namely 25 out of a maximum score of 28 with a percentage of 89%. From the results of the action evaluation test II, the average value of students' numeracy skills reached 77%, which can be seen in the table below:

Table 5. Percentage per indicator Action Student Numeral Skills II

No.	Aspect	Action Final Test II
		Percentage
1	Understanding	89%
2	Application	87%
3	Reasoning.	82%
	Average	86%

Based on Table 5, it can be seen that the mathematical numeration in Action II implementing the Polya Strategy assisted by concrete media has increased and obtained the following percentages:

Understanding

In this indicator, most students have been able to determine and explain information or material related to the problem clearly and precisely with an increasing percentage of 89%.

Application

The implementation indicator has increased from previously getting a percentage of 69% to 87% capable students provide correct solutions to problems. Students have been able to plan how to work on the problem well.

Reasoning

The table above explains that students can complete and examine the results of the answers obtained from the questions accompanied by the right reasons. In action II, students experienced an increase from the previous action I, 63% in action II to 82%. In action II, the students checked again so that the results obtained were what was planned.

As for the learning outcomes of students who achieved KKM scores were 31 students or 84%, and students who did not achieve KKM scores were 6 or 16%. The mean score of students in Action II is 80%, with the highest score of 95 and the lowest score of 50. The learning outcomes in Action II can be seen in the following table:

Table 6. Frequency of Action Learning Outcomes II

No	intervals	Percentage	Frequency
1.	91-100	3	8%
2.	80-90	15	49%
3.	70-79	12	27%
4.	<70	7	16%
		18	100%

Based on the evaluation test for Action II, we can describe it through a picture diagram as follows:

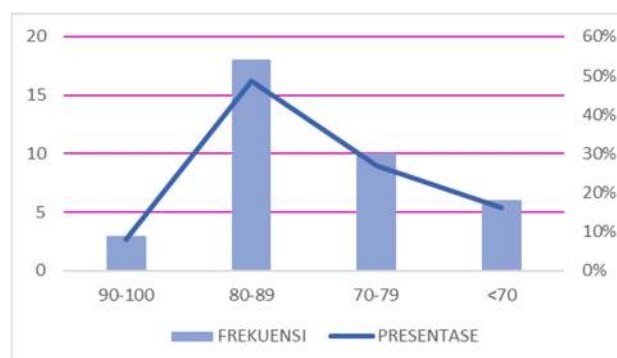


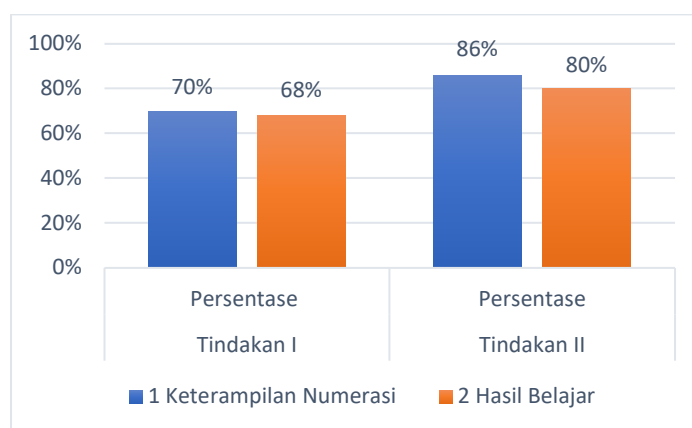
Figure 7. Value of Action Learning Outcomes II

From the description above, the comparison of numeracy skills and the learning outcomes of each action has increased. We can see this through the following table:

Table 7. Comparative Analysis of Action Completeness I and II Students of SD Pangudi Luhur Ambarawa Class V

No	Aspect	Action I	Act II
		Percentage	Percentage
1.	Numeration Skills	70%	86%
2.	Learning outcomes	68%	80%
	Average	67.85	80.04
	Maximum	90	95
	Minimum	50	50

Based on the table above 7, there is an increase in the numeration in Action II, which is 86% from Action I, which is 70% in the very good category. The learning outcomes carried out by SD Pangudi Luhur Ambarawa researchers in class V related to implementing the Polya Strategy assisted by concrete media have increased in action I, 68% and in action II, 80%. In action I, as many as 20 students achieved KKM; in action II, as many as 31 students reached KKM. The graph of increasing student learning outcomes is presented in the following diagram:

**Figure 9.** Comparison of Improved Numeracy and Learning Outcomes Action I and Action II

In action research II, there was an increase in the numeracy skills and learning outcomes of class V students. In action I, the students' numeracy skills were 70%, while in action II, the skill scores of students were 86%. For student learning outcomes in action I, namely 68%, while in action II, it reaches 80%.

Table 8. Comparison of Teacher and Student Activity Observation Results for Action I and II

Observational Object	Action I	Action II
Teacher Activity	89%	96%
Student Activity	78%	89%

Discussion

In Classroom Action Research (PTK) conducted at SD Pangudi Luhur Ambarawa using the Polya Strategy with the help of concrete media to improve numeracy and student learning outcomes, which were carried out in 4 meetings in 2 actions with the mathematics subject chapter Build Space, Build Space Volume subchapter. This study aims to describe the application of problem-solving using Polya learning strategy steps assisted by concrete media in improving numeracy and learning outcomes in elementary school students. In carrying out the study, the researcher has implemented the Polya Strategy into the lesson plan according to the scenario that has been designed. This Polya strategy uses 4 stages: 1) Understanding the problem, namely, students identify the problems contained in the problem; 2) planning a solution, namely students looking for strategies that are appropriate to the existing problems; 3) solving problems according to plan, namely students solving problems with a predetermined strategy, 4) check again, namely by double-checking the answers that have been generated, you can also use other formulas. Implementing the Polya Strategy can improve numeracy and student learning outcomes. The results of this study are in line with previous research conducted (Setiono, 2019) titled "The Effect of the Polya Strategy on Process Ability in Mathematical Literacy Building Materials for Class V Students at SD Negeri 68 Bengkulu City" states that based on data analysis and discussion in this study, it can be concluded that significantly $\alpha = 5\%$ the use of the Polya strategy has a significant effect on the ability to process mathematical literacy in the material for class V SD Negeri 68 Bengkulu City. This is reinforced by Polya's strategy of providing activities in the form of systematic steps to solve mathematical literacy problems that require a process. These systematic steps include understanding the problem, making a settlement plan, carrying out the settlement plan, and rechecking the results.

After carrying out classroom action research on actions I and II using the Polya Strategy assisted by concrete media, it showed increased numeracy and student learning outcomes. Students can understand problem-solving story problems using the Polya Strategy. This can be shown by comparing the average increase in each action. The comparison of the increase in students' numeracy in Action I was 70%, and it experienced an increase in Action II, namely 86%. As for the learning outcomes in Action I, the learning outcomes obtained an average of 68% and experienced an increase in Action II to 80%. Of the 37 students, 80% of students with mathematics learning outcomes reached the KKM.

This research is in line with research conducted by Rahmawati (2022) with the title "Mathematical Literacy Skills of Elementary Teacher Education Students through" Mathematics in Life" Approach" which explained that the ability to master mathematical literacy of PGSD students after implementing the stages of mathematical literacy in solving

everyday problems, the students' mathematical literacy skills were said to be quite good, this was supported by the results of the assessment 9 out of 23 students got a perfect score and also by Sumartiningsih (2022) with the title "Increasing the Ability to Perform Fractional Counting Operations in Solving Problems Through Polya Learning Class VI Students of SD Negeri Gombang, Slahung District, Ponorogo Regency for the 2018/2019 Academic Year" the results obtained show that the participation and learning outcomes of class VI students at SD Negeri Gombang, Slahung District, Regency Ponorogo continued to improve in semester I of the 2018/2019 academic year in mathematics by implementing the Polya model problem solving strategy. Most of the students mastered the operation of calculating fractions by being able to present their group results in front of the class.

Based on the research described, implementing the Polya strategy assisted by concrete media improves numeracy skills and learning outcomes in mathematics in class V students at SD Pangudi Luhur Ambarawa. Completeness achieved in action II meets the average value of 80% of students' completeness.

D. Conclusion

Based on the results of the research and discussion, it can be concluded that the implementation of the Polya Strategy, assisted by concrete media, can improve numeracy and mathematics learning outcomes in fifth-grade students at SD Pangudi Luhur Ambarawa semester II of the 2022/2023 school year in the mathematics subject chapter Build Space, Elements and Space Build Volume.

The increase in numeration and student learning outcomes can be seen through the scores of students' numeracy skills in action, I with an average of 70%, then an increase in average II with an average of 86%. As for the increase in mathematics learning outcomes, namely in action I with an average of 68%, increased in action II to 80%. Of the 37 students, 80% of students with mathematics learning outcomes reached the KKM.

Through the research conducted, the suggestion to be conveyed is that teachers should train students to use the Polya strategy steps to improve their numeracy processing skills so that students can quickly understand what is meant by a problem-solving problem and students understand how to solve mathematical problems systematically. So that student learning outcomes can be increased.

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