

Student Strategy Profile in Solving Word Problems Based on Polya's

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Abstrak

Siswa cenderung mengalami kesulitan dalam menyelesaikan soal cerita. Keberagaman minat belajar siswa terhadap matematika berdampak pada semangat siswa dalam menyelesaikan soal cerita. Tujuan penelitian ini untuk mendeskripsikan profil strategi siswa dalam menyelesaikan soal cerita berdasarkan prosedur Polya ditinjau dari minat belajar. Metode deskriptif kualitatif digunakan dalam penelitian ini. Empat siswa kelas C Sanggar Bimbingan Kepong Malaysia sebagai subjek penelitian. Pengumpulan data dilakukan melalui tes dan wawancara. Teknik analisis data yang digunakan adalah reduksi data, penyajian data, serta penarikan kesimpulan. Temuan mengungkapkan bahwa pada tahap memahami masalah, subjek dengan minat belajar tinggi cenderung bertanya kepada peneliti untuk memastikan pemahamannya sudah benar, sedangkan subjek dengan minat belajar rendah membaca soal berulang-ulang. Pada saat menyusun rencana, subjek dengan minat belajar tinggi menulis rencana penyelesaian tahap demi tahap, sedangkan subjek dengan minat belajar rendah, berdiskusi untuk menemukan rencana penyelesaian. Tahap melaksanakan rencana, subjek dengan minat belajar tinggi menghitung menggunakan kelipatan, sedangkan subjek dengan minat belajar rendah menghitung dengan bantuan jari. Tahap peninjauan kembali, subjek dengan minat belajar tinggi menghitung kembali setiap hasil yang diperoleh, dan tahap ini cenderung tidak dilakukan oleh subjek dengan minat belajar rendah.

Kata Kunci: minat belajar; prosedur Polya; soal cerita.

Abstract

Solving word problems is more complex than solving questions in numerical form. This research aims to describe students' profiles in solving word problems involving whole number operations, analyzed through the lens of Polya's procedural framework. A qualitative descriptive method was employed, selecting four students from Class C at Sanggar Bimbingan Kepong, Malaysia, as subjects. Two of these students exhibited high interest in learning, while the other two showed low interest. Data collection instruments included tests and interviews. Analysis was conducted descriptively, adhering to Polya's procedure. The findings indicate that students with a high interest in learning could systematically and coherently address understanding the problem, devising a resolution plan, executing the plan, and reviewing their results. In contrast, students with low interest displayed varying levels of performance. Subject A managed to progress through to the review stage, developing a coherent plan, arriving at the correct answer, and reviewing their results. Conversely, Subject N only reached the problem-understanding stage.

Keywords: Mathematics; Word Problem; Polya's Procedures.

I. INTRODUCTION

Mathematics is a subject taught from elementary school through higher education levels (Luritawaty, 2019; Saputri & Mampouw, 2018). According to Putri et al. (2019) and Phonapichat et al. (2014), introducing mathematics at an early age aims to develop students' thinking patterns, enhance their reasoning skills, and encourage logical, critical, analytical, and creative thinking. Another goal is to motivate and train students to solve mathematical problems effectively. Quality learning is essential to achieve this, enabling students to solve mathematical problems, particularly word problems (Utami & Endaryanto, 2018).

Word problems are questions presented in narrative form that can be translated into mathematical models (Sari et al., 2017). These problems require students to apply their mathematical skills to solve them deductively, facilitating easier reasoning and comprehension of problem-solving processes (Ekayanti, 2017; Mulyadi & Afriansyah, 2022). Solving word problems is more challenging than solving numerical questions (Dewi, 2022). Therefore, students must master numeracy skills and understand each problem-solving procedure (Utami & Endaryanto, 2018).

One effective procedure for solving word problems systematically is Polya's procedure. Riastini & Mustika (2017) describe Polya's procedure as a structured approach that helps students extend their problem-solving capabilities. It involves more than finding the correct answer; it requires students to develop solution strategies, allowing them to tackle mathematical problems methodically and

draw accurate conclusions (Ariani & Kenedi, 2018).

Polya's procedure is a systematic framework for solving problems, simplifying the process for students (Pitriani & Ocktaviaini, 2020). Its simplicity makes it easily understandable, and according to Lee (2017), using Polya's procedure enhances the effectiveness of student learning by guiding them to find their own answers. The procedure consists of four stages: understanding the problem, planning a solution, implementing the solution, and reviewing the results. In the first stage, students examine the problem's meaning and record all relevant information, including known and unknown variables. In the planning stage, they design solutions by converting the narrative into mathematical models. During the implementation stage, they apply the devised plan. Finally, in the reviewing stage, they verify the clarity, logic, and accuracy of their answers (Yuwono et al., 2018). This research utilizes Polya's procedure to describe students' strategy profiles in solving word problems.

Several previous studies have examined solving word problems using arithmetic operations. For instance, research by Mayasari & Habeahan (2021), (Nengsih & Pujiastuti, 2021), and Udil et al. (2021) analyzed students' errors, difficulties, and conceptual understanding in solving word problems. In contrast, the current research focuses on examining and defining the profiles of students' approaches to solving word problems using Polya's technique (Gradini, Yustinaningrum, & Safitri, 2022). This study aims to describe the profiles of students' strategies in solving word

problems involving whole number operations, based on their learning interests and within the framework of Polya's procedure.

II. METHOD

This research employs a qualitative descriptive approach, gathering information from factual circumstances (Barlian, 2016). The study was conducted over one month at Sanggar Guidance Kepong in Kuala Lumpur, Malaysia. The researcher served as the primary instrument, with a test question sheet as the supporting instrument. Data collection techniques included tests, interviews, and documentation.

The research commenced with the selection of subjects based on their learning interests. Grouping was determined by students' interest in classroom participation, activeness and participation during lessons, and communication skills. Four students were selected as research subjects: two with high learning interests and two with low learning interests.

Tests and interviews were conducted with the four subjects. The test comprised three descriptive questions, while the interviews utilized in-depth techniques based on Polya's procedure. The interview process was recorded using a cellphone to capture all information and monitor each student's approach to answering questions.

The collected data was analyzed according to Polya's procedure to describe the profile of students' strategies in solving word problems. This analysis aimed to

provide a detailed account of students' problem-solving strategies.

III. RESULT AND DISCUSSION

Based on the test results for the four subjects, the scores were obtained as shown in Table 1 below.

Table 1.
Test Scores of Subjects Based on Learning Interest

| Subject | Score | Interest in Learning |
|---------|-------|----------------------|
| D | 90 | High |
| R | 80 | High |
| A | 70 | Low |
| N | 10 | Low |

Based on the test results, the two subjects with high interest in learning achieved high-test scores. In contrast, the test results for the two subjects with low interest in learning varied significantly: Subject A received a satisfactory score, while Subject N received a low score. Below is a detailed description of the strategies used by students in solving whole number story problems, organized coherently according to Polya's procedure.

A. Strategies of Students with High Learning Interest in Solving Word Problems

Both students with high learning interests successfully solved all problems using Polya's procedure. However, the test responses revealed that one student inaccurately documented the known information from the problems. Despite this, during interviews, both students were able to accurately articulate all the information contained in the problems. A detailed explanation of the students'

strategies in solving word problems is provided below.

1) Understanding the Problem

In the problem-understanding stage, the subjects extracted all relevant information, including what was known and what was being asked. When explaining their understanding, the subjects tended to rewrite the sentences exactly as they appeared in the problem statement. Below is an example of the students' work in the problem-understanding stage (Figure 1).

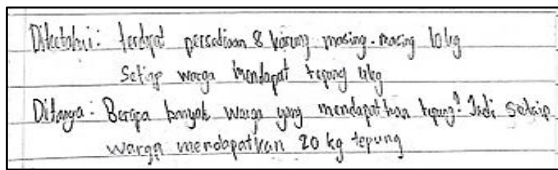


Figure 1. Subject D Writing the Information Contained in Problem No. 2

According to the test results, it is known that subject D was able to comprehend and identify all three problems by writing down what was known and what was asked in each problem. During the interview, subject D was also able to explain all the information contained in the problems. Below is a transcript of the interview conducted by the researcher with subject D.

P : During the task, did you encounter any difficulties?

SD : Not really, ma'am.

P : How many times did you read the problem until you could identify its meaning?

SD : Maybe twice, ma'am.

P : Please explain, in your opinion, what information is known from the problem?

SD : There are eight sacks of flour in stock, each weighing ten kilograms, and then each resident receives four kilograms of flour.

P : What was asked afterward?

SD : How many residents received flour?

In contrast to Subject D, Subject R demonstrates a lengthier process in question identification. Subject R requires multiple readings to grasp the meaning of the questions fully. This finding aligns with the research of Marfu'ah & Julaeha (2021), suggesting that repeated reading is essential for question comprehension among students. Additionally, Subject R exhibits less certainty regarding the written content, albeit mostly accurate. However, in question number 3, the subject's response lacks precision, particularly in articulating the distribution of bread among twenty-five students, as depicted in Figure 2. The subject fails to specify "bread will be distributed evenly to twenty-five students."

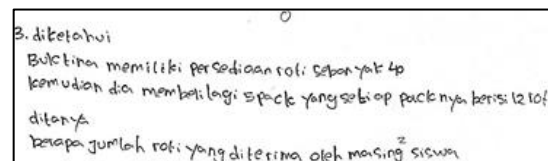


Figure 2. Subject R Writing Information Contained in the Problem No. 3

During the interview, the subject exhibited an improvement in comprehension, as evidenced by their ability to accurately articulate all the information contained in the three problems, both known and queried. The following is a transcript of the interview conducted by the researcher with Subject R.

P : Why did you appear less confident in your work earlier?

SR : Hmm... I somewhat forgot how to do it, ma'am.

P : How many times did you read the problem until you could identify its meaning?

SR : Several times, ma'am.

P : Can you please explain what you understood from the problem?

SR : Mrs. Tina has a stock of forty loaves of bread. She then buys an additional five packs, each containing twelve loaves of bread. The bread will be distributed evenly among twenty-five students.

P : What is being asked afterward?

SR : How many loaves of bread will each student receive?

2) Planning Solution

In this stage, the subjects are tasked with transforming the narrative sentences into mathematical models. Once the subjects have successfully understood the problem, they proceed to devise their solution plans. Based on the test results and interviews, it is evident that both subjects are capable of formulating solution plans. The solution plans drafted by both subjects are nearly identical. While both articulate correct solution plans, they have yet to apply the properties of arithmetic operations in formulating their solution plans.

This observation aligns with the findings of Sapitri & Utami (2019), indicating that students are capable of devising correct solution plans using a formula they believe to be accurate. An example of a student's work in the stage of planning the solution can be observed in Figure 3.

$$8 \times 10 = 80 \quad 80 : 4 = 20$$

Figure 3. Subject D Writes the Solution Plan for Problem Number 2.

3) Implementing the Solution Plan

In this stage, the subjects execute the solution plan accurately, with no errors observed in their calculations, as depicted in Figure 4 below.

$$40 + 5 \times 12 = 100$$

$$100 : 25 = 4$$

Figure 4. Subject R Executing Solution Plans in Question No. 1

From Figure 4, it is evident that the subject was able to determine the answer to question number 1 by listing multiples of the number 9, resulting in the answer 8. This finding aligns with the research conducted by Asri et al. (2023), which indicates that students possess effective strategies and abilities in implementing their solution plans.

4) Reviewing

At this stage, the subject can review the outcomes of their work before the submissions are finalized, although this may not be explicitly documented on the answer sheet. When interviewed, the subject mentioned conducting a re-evaluation upon completing the task, where they reassessed the results of their work. Essentially, they are capable of verifying the accuracy of their answers, albeit not accustomed to providing written proof of their checks on the answer sheet. This observation is consistent with the findings of research by Indrawati (2019), which suggests that students with high learning interest typically refrain from documenting re-evaluations on the answer sheet, preferring to conduct such reviews before submitting their answers.

B. Strategies of Students with Low Learning Interest in Solving Word Problems

Among the two subjects categorized as having low interest in learning, it is noted that Subject A successfully completed the story problems tested using the Polya procedure as a solution framework. In contrast, Subject N only attempted question number 1 and proceeded to the stage of understanding the problem. Further elucidation regarding students' strategies in solving story problems is provided below.

1) Understanding the Problems

Both subjects comprehended the questions by thoroughly examining the information provided within them. Subsequently, they documented both the known information and the queries presented in the questions on the answer sheet (See Figure 5).

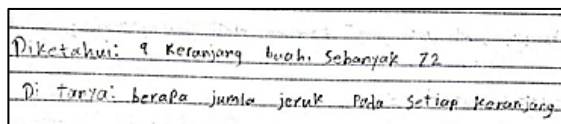


Figure 5. Subject A Writing the Information Contained in Question No. 1

According to the test results, Subject A successfully completed the two-story questions that were administered. Despite having a relatively low interest in studying, Subject A exhibited competence in solving the tested questions. This observation aligns with the findings of research by Darmawati et al. (2022), indicating that students categorized with low interest in learning can effectively explore and comprehend problems.

However, in the process of understanding the questions, Subject A needed to read them repeatedly and

occasionally appeared confused. This confusion stemmed from the subject's tendency to forget, particularly when the questions being tested differed from the example questions previously taught. Presented below is a transcript of the interview conducted by the researcher with Subject A.

P : Did you have any difficulties?

SA : Yes, ma'am, I often get confused when the questions are different from the examples we had yesterday.

P : Why weren't you able to finish working on question number three earlier?

SA : Because I was running out of time, ma'am.

P : Well then, what information did you know from the question No. 1?

SA : Mr. Tono has nine baskets of oranges and has a total of seventy-two oranges.

P : What was asked afterwards?

SA : What is the number of oranges in each basket?

In contrast to Subject A, Subject N only managed to address question number one and reached solely the stage of understanding the problem. At this juncture, Subject N was able to document and elucidate the information provided in question number one, encompassing both the known facts and the inquiries, albeit with some inaccuracies. For instance, incomplete phrases such as "Pak Tono has 9" were noted on the answer sheet, which should have been written as "Pak Tono has 9 baskets of oranges." Similar to Subject A, Subject N also required multiple readings of the question to grasp its meaning. This observation aligns with the perspective of Mukhith & Fitri (2022) that students categorized in the low interest in learning category tend to exhibit less precision in comprehending problems (See Figure 6).

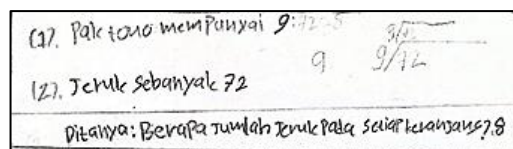


Figure 6. The work of Subject N on question number 1.

For further clarity, here is a transcript of the interview conducted by the researcher with Subject N:

P : In your opinion, what is known from the problem?

SN : Mr. Tono has nine baskets and has a total of seventy-two oranges.

P : What is being asked afterward?

SN : What is the number of oranges in each basket?

2) Planning Solutions

At this stage, Subject A transforms the story sentences into a mathematical model. In question number 1, the solution plan devised by Subject A closely resembles that of Subject R, who exhibits high interest in learning. However, a disparity arises in the notation: Subject A uses "72:9" while subjects with high interest in learning employ sequential or long division.

On the other hand, Subject N did not progress to this stage as they only worked up to the understanding of the problem, specifically identifying all the information within the question. Subsequently, at the stage of formulating a solution plan, Subject N leaves the answer sheet blank. This finding is congruent with the research conducted by Anggraini (2022), suggesting that subjects categorized with low learning interest tend to omit the documentation of solution plan preparation on their answer sheets.

During the interview, when questioned about this, the subject expressed forgetting how to proceed. Symptoms of

forgetfulness often manifest when individuals struggle to organize their knowledge or may be attributed to inadequately understood learning methods employed by students (Mahmuzah et al., 2014).

3) Implementing the Solution Plan

Subject A, despite having low interest in learning, demonstrates the ability to solve questions number 1 and 2 coherently and clearly. Despite being classified as having low interest in learning, Subject A successfully implements a solution plan to arrive at the correct final solution. Moreover, during the interview, Subject A accurately elucidated each stage of completion, albeit some questions requiring additional time to answer.

4) Reviewing

Students review their answers briefly by giving them a cursory glance. During the interview, the subject mentioned that as the time for working on the questions was almost finished, the review was conducted hastily, merely to ensure that there were no errors in the calculations.

IV. CONCLUSION

Based on the results and discussion, students with high interest in learning exhibit proficient problem-solving strategies, particularly in tackling story problems using the Polya solution procedure. During the understanding stage, students effectively grasp and identify the problem by documenting known information and inquiries, although some may require multiple readings to comprehend. When devising a solution plan, students formulate mathematical

models leading to correctness, although the application of arithmetic operation properties is sometimes overlooked. Despite this, during the implementation stage, students successfully arrive at the correct final answer, even without fully applying arithmetic operation characteristics. In the review stage, students refrain from providing evidence on their answer sheets, opting instead to conduct a post-work review by recalculating each obtained result.

Conversely, for students with low interest in learning, there is a divergence in outcomes. While both subjects can document problem information during the understanding stage, precision varies. Only one subject progress to formulating a solution plan, while others stall at the understanding stage. Here, subjects translate story sentences into mathematical models using their language. During the implementation stage, one subject executes the solution plan to find correct answers for questions 1 and 2. In the review stage, a brief review is conducted by glancing over the work to ensure calculation accuracy.

Among the two learning interest categories, subjects with high interest exhibit robust problem-solving strategies, evidenced by coherent and precise resolution of all three questions. Conversely, subjects with low interest demonstrate a disparity between learning interest and problem-solving abilities. Notably, one subject in the low learning interest category completes questions up to the reviewing stage, showcasing relatively proficient problem-solving

strategies despite diminished interest in learning.

Future research is encouraged to delve deeper into students with low interest in learning yet possess commendable abilities in solving story problems.

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