An Analysis of Student Difficulties in Solving the Word Problem

Habibullah1, Hartono2

1,2Graduate School, Yogyakarta State University, Indonesia

habibullah.2017@student.uny.ac.id

Abstract. This research is a qualitative descriptive research that aims to describe the types and factors of difficulty in solving mathematics problems in the form of word problems. The research subjects were 22 students who were selected by random sampling technique from one of the junior high schools in Indragiri Hilir. The data was collected through diagnostic tests and interviews conducted openly but not structured. In analyzing the students' difficulties, the revised Bloom's Taxonomy theory was used to find the difficulties in factual, conceptual, procedural, and metacognitive knowledge. The results of research showed that 14.77% of students had difficulties in factual knowledge, 17.05% of students had difficulties in conceptual knowledge, 45.46% of students had difficulties in procedural knowledge, and 53.41% of students had difficulties in metacognitive knowledge. The factors that cause difficulties were experienced by students, such as: their sense in lack of time, carelessness, anxiety, giving up easily, and being hasty in doing the given problem.

1. Introduction

Education nowaday is not just to accomplish the curriculum target, but also requires understanding to students. One of subjects that requires students' understanding is mathematics. According to Reys, Lindquist, Lambdin, & Smith, mathematics is a language that uses carefully defined terms and symbols [1]. Meanwhile, Walle stated that mathematics is the science of patterns and rules. Mathematics is a science related to things that have patterns in regularity and logical order. Finding and expressing the regularity or the order and then giving such a sense, is the meaning of completing mathematics [2]. Similar opinion was also said by Karagiannakis, Frank, & Papadatos who stated that mathematics is a complex subject which contains domains of different sciences such as arithmetic, problem solving arithmetic, geometry, algebra, probability, statistics, calculus that mobilizes various basic abilities related to quantity knowledge, symbol of decoding, memory, capacity visuospatial, logic, and others [3].

The problem solving process in learning mathematics in schools is commonly realized through the form of word problems. Ashlock states that word problems are questions that can be presented in oral or written form, and written word problems is a sentence that illustrates activities in daily life [4] Meanwhile, Cummins, Kintsch, Reusser, & Weimer said that word problems are very difficult to be solved [5]. This statement is in line with the research of Carpenter, Corbitt, Kepner, Lindquist, & Reys who said that in general, children do 10% to 30% errors in arithmetic in the form of word problems are compared to the other similar problems, yet it were presented in numerical form [6]. Resolving mathematics word problem is not easy because the word problem does not only depend on the final answer. In the process of solving word problems, the first thing is that students must be able to understand the contents of the story, then drawing conclusions from objects which must be solved by using examples in the form of mathematical symbols. Rasmussen & King stated that word problems in...
Given mathematics word problems are aimed to make students do such practice of thinking deductively and be able to see the relationship and the usefulness of mathematics in everyday life. This is in line with the opinion of Rahardjo & Waluyati which is stated that word problems are very important given to students, because these questions commonly can be used to train students in solving problems [8]. The students ability in doing word problems in mathematics is one of the mathematical abilities that must be possessed by individuals. It is because the mathematics word problems is known as a form of evaluation of students’ ability to the basic concepts of mathematics that have been studied in the form of a matter of applying the formula. A person can be recognized to have such mathematical abilities if they have skills at solving math problems in correct way. In addition, the student’s ability to make decisions is another benefit that can be obtained from the ability to solve word problems. But, claims that research of Berch & Mazzocco there are still many students who have difficulty obtaining the knowledge and skills needed in mathematics learning [9].

Asserts that Singh, Rahman, & Hoon, in the problem solving process, there are several types of errors that prevent students from finding the right answers, namely reading errors, misunderstanding, transformation errors, processing ability errors, and writing errors [10]. Whereas Cooney, Davis, & Henderson categorized mathematical difficulties into three types, namely difficulties in understanding concepts, difficulties in understanding principles, and difficulties in using algorithms [11]. This was supported by the study of Byrnes who said that approximately 6% of mathematics classes contained students who had mathematical difficulties. These difficulties included procedural difficulties which are the difficulties that related to mathematical facts [12].

Anderson & Krathwohl stated, as it is based on the revised Bloom Taxonomy theory, a person's thinking framework can be identified from two dimensions, namely the dimensions of cognitive processes and dimensions of knowledge. The dimensions of cognitive processes are divided into six categories; namely remembering, understanding, applying, analyzing, evaluating, and creating. While the dimensions of student knowledge are divided into four categories; namely factual, conceptual, procedural, and metacognitive knowledge. Mathematical skills and knowledge must be acquired in the interests of everyday life and in developing careers as a foundation for the development of science and technology [13].

Mathematical difficulties in mathematical problems solving are intended as the inability of students to one or more steps to solve such mathematical problems both related to factual, conceptual, procedural, and metacognitive. As it is mentioned by Anderson & Krathwohl, that factual knowledge includes basic elements used by experts in explaining their scientific disciplines, understanding, and organizing them systematically [13]. Then, Jong & Hessler said that conceptual knowledge is static knowledge about facts, concepts, and principles that apply in a particular domain [14]. Meanwhile, Larkin said that procedural knowledge is the knowledge about how to do the things. Procedural knowledge is often a series of steps that must be followed [15]. In addition, Louca commented that metacognitive knowledge refers to the process of belief, such as feeling something about one's thoughts, thinking about one's thoughts and giving responses to own thoughts by monitoring and managing them [16].

Powell contended that completion of mathematics word problems is a difficult task for students who have learning difficulties because they require many steps and skills [17]. Pierangelo & Giuliani agreed that learning difficulties can cause a person to experience difficulties in using certain skills [18]. Thus, the purpose of this research is to describe the types and factors of difficulties experienced by students in solving mathematics word problems which are included the difficulties in factual, conceptual, procedural, and metacognitive knowledge.

2. Research Methods
This research is a qualitative descriptive research that aims to describe the types and factors of difficulty in solving mathematics problems in the form of word problems. The research subjects were 22 students who were selected by random sampling technique from one of the junior high schools in Indragiri Hilir. In analyzing students' difficulties, the revised Bloom's Taxonomy theory is used to find out the difficulties in factual, conceptual, procedural, and metacognitive knowledge.
The stages in this research are to provide diagnostic tests and interviews to students that conducted openly but not structured. The questions of diagnostic tests is made in the form of word problem which took the form of descriptions in answering so that researchers can easily analyze the problems that are the focus of the research, namely students' difficulties in solving mathematics problems in the form of word problems. The test was carried out by giving the same questions to each sample of research in school which was then analyzed more deeply about the types of difficulties experienced by students in solving the problem. While the interview is done after completing the correction of the students' work in openly way but not structured by recording the things which are considered as important things in supporting the research conducted.

3. Result and Discussion
The data analyzed in this research were the results of diagnostic tests in the form of mathematics word problems given to 22 students by seeing the number of students who have: answered correctly (AC), answered correctly but incompletely (IC), answered incorrectly (AI), and did not answer (NA). Students are said to have difficulties, namely students who score below 75 in diagnostic tests.

Table 1. Results of Diagnostic Test Answered in Problems in 4 Question Items.

| Type of Answer          | Student Answer | Percentage (%) |
|-------------------------|----------------|----------------|
| Answered Correctly (AC)| 37             | 42.05          |
| Incomplete (IC)         | 31             | 35.23          |
| Answered Incorrectly (AI)| 20         | 22.73          |
| Not Answer (NA)         | 0              | 0              |
| **Total**               | **88**         | **100**        |

Based on table 1, the information is obtained that there are still many students who have difficulties in solving the form of word problems. This difficulty can be seen from the errors in the answers given by students, such as the answers given are correct but not complete, even there are still many students who answer incorrectly to the questions given. Each test question is completed by 22 students, there will be 22 answers. Thus from the 4 questions that were done by 22 students, so that there will be 88 answers. Based on the 88 answers which have done by the students, the information was obtained that there were 37 (42.05%) corrected answers, 31 (35.23%) corrected but incomplete answers, and 20 (22.73%) wrong answers. To be able to see more details of the form of student answers on its each item, it can be seen in table 2 below.

Table 2. Results of Diagnostic Test Answered in Each Question Item.

| Question Number | Type of Answer | AC  | IC  | AI  | NA |
|-----------------|----------------|-----|-----|-----|-----|
| 1               |                | 15  | 4   | 3   | 0   |
| 2               |                | 10  | 6   | 6   | 0   |
| 3               |                | 5   | 13  | 4   | 0   |
| 4               |                | 7   | 8   | 7   | 0   |
| **Total**       |                | **37** | **31** | **20** | **0** |

Based on table 2, the information was obtained, that in item number 1, there were only 15 students who answered correctly, 4 students answered correctly but those were incomplete, and 3 students answered incorrectly. In item number 2, there were only 10 students who answered correctly, 6 students answered correctly but were incomplete, and 6 students answered incorrectly. In item number 3, there were only 5 students who answered correctly, 13 students answered correctly but were incomplete, and 4 students answered incorrectly. Meanwhile, in item number 4, there were only 7 students who answered correctly, 8 students answered correctly but were incomplete, and 7 students answered incorrectly. Thus, from the 4 question items, the most of mistakes were made by students are located in item question number 3, while the answer that mostly were corrected answered by students lies in item question number 1. However, from all the questions given, none of the questions were not answered, this means that all research subjects tried to complete each diagnostic test question given.
Table 3. Percentage of Types of Student Difficulties in 4 Question Items.

| Type of Difficulty       | Number of Difficulties | Percentage (%) |
|--------------------------|------------------------|----------------|
| Factual Knowledge        | 13                     | 14.77          |
| Conceptual Knowledge     | 15                     | 17.05          |
| Procedural Knowledge     | 40                     | 45.46          |
| Metacognitive Knowledge  | 47                     | 53.41          |
| **Total**                | **115**                | **130.69**     |

Based on table 3, the types of difficulties which have been experienced by students in solving mathematics word problems, obtained information that there are 115 (130.69%) difficulties of 352 difficulties that site in factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge. 14.77% of the 352 difficulties were experienced by students in factual knowledge, 17.05% site in conceptual knowledge, 45.46% site in procedural knowledge, and 53.4% site in metacognitive knowledge.

Table 4. Percentage of Types of Student Difficulties in 4 Question Items.

| Types of Difficulty       | Question 1 (%) | Question 2 (%) | Question 3 (%) | Question 4 (%) |
|---------------------------|----------------|----------------|----------------|----------------|
| Factual Knowledge         | 3             | 6              | 4              | 7              |
| Knowledge                 | (13.64)       | (27.27)        | (18.18)        | (31.82)        |
| Conceptual Knowledge      | 3             | 6              | 4              | 7              |
| Knowledge                 | (13.64)       | (27.27)        | (18.18)        | (31.82)        |
| Procedural Knowledge      | 7             | 13             | 17             | 8              |
| Knowledge                 | (31.82)       | (59.09)        | (77.27)        | (36.36)        |
| Metacognitive Knowledge   | 7             | 13             | 17             | 15             |
| Knowledge                 | (31.82)       | (59.09)        | (77.27)        | (68.18)        |
| **Total**                 | **20**        | **20**         | **45**         | **52**         |
|                           | **90.91**     | **90.91**      | **204.55**     | **236.36**     |

Based on table 4, the information is obtained, that in item number 1 to number 4 showed the type of difficulty site in factual, conceptual, procedural, and metacognitive knowledge. On problem solving number 1, there were 20 (90.91%) difficulties, meanwhile in problem number 2, there were also 20 (90.91%) difficulties. Thus, in problem number 3, there were 45 (204.55%), and in problem number 4, there were 52 (236.36%) difficulties. Referring to questions number 1 to 4, the most dominant type of student difficulty in solving mathematics word problems is sited in procedural and metacognitive knowledge.

To able find out more about the types of difficulties students experience in completing a diagnostic test, it can be identified from the steps of students’ completion on each of the following items.

1. An amoeba will split into two separate parts once every 15 minutes. As if at first there are 30 amoeba, how many amoeba is there for 2 hours?

**Incorrect answer**

1\) 120 \div 15 = 8 kali Pembelahan
   2\) 8 x 30 = 240 amoeba
   3\) 240 + 240 = 480 amoeba

**Correct answer**

1\) 120 \div 15 = 8 kali Pembelahan
   2\) 8 x 30 = 240 amoeba
   3\) 240 + 240 = 480 amoeba

**Figure 1.** Student’s answers to item number 1
2. Elsa bought 2 kg of apples and 6 kg of melon for Rp 46,000.00. Dewi bought 4 kg of apples and 3 kg of melon for Rp 47,000.00. Determine the price of 5 kg of apples and 3 kg of melon?

![Incorrect answer](image1)

![Correct answer](image2)

**Figure 2. Student’s answers to item number 2**

Based on Figure 2, the students experience such errors in determining what kind of information that is known and being asked from the question. These errors can be seen in the first row, namely the students directly sum all information up that is known from the problem. So that it can be said, that the difficulties which are experienced by students are in a type of factual knowledge. In addition, the students also experience such difficulties in conceptual, procedural, and metacognitive knowledge. This can be seen from the errors in the second row and so on, that is the students are mistaken in making mathematical models of systems of linear two-variable equations and done incorrect in determining the formula used. As the result, the mathematical calculations which are performed are inappropriate with what is asked in the question.

3. In every morning, Budi do cycling from his house to school. Started from his house, Budi rides his bike as far as 3 km to the East, then he continues to 5 km to the North. How much the number of closest length to school from Budi’s house?

![Incorrect answer](image3)

![Correct answer](image4)

**Figure 3. Student’s answers to item number 3**
Based on Figure 3, the mistake which is made by students is their act in summing all the information obtained without previously making a mathematical model, such as one of them which is making a map of the location based on the wind direction which can show the positions where Budi house is also his school. This case makes the students cannot do determine what kind of formula which will be used to solves the problems given. So that the students are mistaken in using the exact completion steps to draw such a relevant conclusion, as it is seen in the third row and so on. Hence with the condition above, it can be said that the types of difficulties which have been experienced by students are factual, conceptual, procedural, and metacognitive knowledge.

Figure 4. Student’s answers to item number 4

Based on Figure 4, the students are mistaken in determining the formula which will be used. In other words, the type of difficulty which is experienced by students is conceptual knowledge. In the process of resolving a given problem, the students must use only the formula of the phytagoras theorem. However, the unique thing that is done by students is the act of applying the sine rule in determining the length of the lower point of the stairs from the wall. It makes the students have the experience of errors in determining the final answer or it can be said that the students experience such difficulties in procedural and metacognitive knowledge.

After the diagnostic test was completed, the research is continued by conducting in-depth interviews with three respondents to obtain detailed information about the types and factors of difficulties experienced by students when completing the process of mathematical problems. The event was conducted based on interview guidelines, but only the semi-structured. Throughout the interview process, the information is obtained that the factors that cause students to have experienced difficulties in solving mathematical word problems. The details of characteristics in students here such as: (1) who are incapable of reading and understand problems properly, (2) who are unable to remember the principles or concepts that will be used in solving these problems, and (3) who are unable to interpret the problems that exist in the problem so that it results difficulties in choosing and use appropriate procedures to solve the problems given. This statement is supported by a research of Jitendra, Brown, Lein, Zaslofsky, Kunkel, Jung, & Egan which stated that in the process of solving word problems, it was not only depends on taking answers from memory. Yet, it also requires an understanding of the text, the characteristics of the problem correctly, planning strategies, implementing planning, and verifying the solutions obtained [19].

In addition to the above factors, there are other various factors that influence students' difficulties in completing the mathematics problem solving process in the form of words problem. As for the factors of difficulty, among others, students’ sense in lack of time, carelessness, anxiety, giving up easily, and being hasty in doing the given problem.
4. Conclusion

It can be concluded that the types of difficulties experienced by students in solving mathematical problems in the form of words problem are sited in factual knowledge (14.77%), conceptual knowledge (17.05%), procedural knowledge (45.46%), and metacognitive knowledge (53.41%). In addition to student difficulties in the dimensions of knowledge, there are other factors that cause the students experience difficulties when the process of solving a given problem is that students tend not to be able to read and understand the problem properly, students are unable to remember the principles or concepts that will be used in solving these problems, and students are not able to interpret the problems that exist in the problem so that it results in difficulties in choosing and using appropriate procedures to solve the problems given. In addition, students might sense that lack of time, carelessness, anxiety, giving up easily, and being hasty in doing the given problem.

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