Analysis problem solving about contextual problem of algebraic in junior high school

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Abstract. Problem-solving is an important ability that everyone must have. Especially the ability to solve problems related to everyday life. Contextual problems can train students to solve problems in the real world or everyday life using the knowledge they have. This study is a descriptive qualitative. The research subjects were 20 seventh grade students of Junior High School 16 Surakarta. This study aims to analyze and describe students' mathematical problem-solving abilities about contextual problems of algebraic. Analysis of mathematical problem-solving abilities in this study used Newman's theory. Newman procedure includes reading errors, comprehension errors, transformation errors, process skills errors, and encoding errors. The data were taken using test and interview methods. Test of problem-solving abilities in the form of contextual questions regarding algebraic. The results showed students' success in reading errors was enough (42.78%), students' success in comprehension errors was low (21.11%), students' success in transformation errors was low (6.67%), students' success in process skills errors was low (38.33%), and students' success in encoding errors was low (25.56%). Most students made transformation errors because they could not write mathematical models correctly from the contextual problems given.

1. Introduction
Mathematics plays a crucial role in developing the human mind in problem analysis and solving [1]. Problem-solving is finding the right way to achieve its ultimate goals [2]. Problem-solving skills are considered important aspects of mathematics and even as necessary competencies in 21st-century skills [3, 4]. Problem-solving is the basis of many learning processes because it is considered as the basic goal of education [5]. In the 2013 curriculum, the problem-solving ability is one of the essential mathematics skills that must be possessed by students [6, 7], students in the problem-solving process gain experience in using the knowledge and skills they have to apply in solving problems [8].

In mathematics, problem situations are situations imagined by the teacher to create a reflection space and analysis of problems or questions that must be solved [9]. Problem-solving is an essential activity in mathematics learning because problem-solving skills obtained in mathematics can be used in solving various other problems [10]. Problem-solving connects situational contexts in problems with experience in problem-solving [11].

In mathematics education, there is an increased focus on the usefulness of acquired mathematical knowledge and skills. Mathematical knowledge and skills are focused on resolving real-life situations [3]. In previous studies, many assume that it is important to make students' daily knowledge and experience relevant to their learning in school [12]. However, students are very often unsuccessful in
connecting the mathematical knowledge they obtain in schools to real-life situations given in the form of word problems [13]. Word problems are often used in algebra learning, but it turns out these problems are considered difficult by students [14].

Algebra is a gatekeeper of Mathematics [15]. Algebraic thinking is the basis of conceptual understanding, geometrical reasoning, and processes related to measurement [16]. Thus algebra learning is closely related to everyday life because many cases in everyday life can be solved with algebra. So when students get to know algebra, it is crucial to train or introduce them to contextual problems. The goal is that students can solve everyday problems using the knowledge gained in mathematics learning [17].

Each student has their cognitive style which can affect their ability to solve problems [18]. Hence, students' abilities are not the same in solving a problem. Given the importance of algebra in solving various problems in real life, it is necessary to analyze students' problem-solving skills related to contextual problems so that the teacher can have an overview of students' abilities and the causes of their mistakes. Therefore, this can help them anticipate errors in the next stage of learning.

2. Method
This research is qualitative research using a descriptive method. The research subjects were 20 seventh grade students of Junior High School 16 Surakarta. In this study, the researcher described the results of the survey descriptively based on the results of written tests in solving contextual problems in algebraic material. The researcher also conducted interviews with students to strengthen and enrich the results of the analysis. There are three contextual questions about the form of algebra given to students. The results of student answers will be analyzed using Newman's theory adapted from reference [7] as shown in Table 1. Triangulation is used to establish the validity of the data. Determining the data validity has been done by comparing data on test results and interviews.

**Table 1. Guidelines for scoring students' ability in problem solving**

| Stages analysis Newman | The reaction of the students against the reserved | Score |
|------------------------|--------------------------------------------------|-------|
| Reading errors         | Identify information and mathematical symbols completely | 3     |
|                        | Identify information and mathematical symbols but not complete | 2     |
|                        | Wrong in determining information and mathematical symbols | 1     |
|                        | Do not answer | 0     |
| Comprehension errors   | Write down what is known and asked a question on demand | 3     |
|                        | Write down what is known and not in accordance with the request asked the question | 2     |
|                        | Wrong in determining what is known and asked question | 1     |
|                        | Do not answer | 0     |
| Transformation errors  | Write down the mathematical model correctly | 3     |
|                        | Write down the mathematical model but not complete | 2     |
|                        | Wrong in determining mathematical model | 1     |
|                        | Do not answer | 0     |
| Process skills errors  | Using a particular procedure right and the answer is true | 3     |
|                        | Using a particular procedure right but the answer is wrong | 2     |
|                        | Using a particular procedure is wrong and the answer is wrong | 1     |
|                        | Do not answer | 0     |
| Encoding errors        | The conclusion is rendered right | 3     |
|                        | The conclusion less precise | 2     |
|                        | The conclusion gave wrong | 1     |
|                        | Do not answer | 0     |
3. Results and Discussion

3.1 Results

The problem solving based on Newman's theory has five stages: reading errors, comprehension errors, transformation errors, process skills error, and encoding errors [7, 19, 20]. Based on the results of problem solving skills on the subjects of the research using a written test consisting of three contextual problems, the following results were obtained.

Table 2. Percentage mathematical problem solving ability

| Stages analysis Newman | Analysis | Students’s score | Maximum total score | Percentage | Qualification |
|------------------------|----------|------------------|---------------------|------------|---------------|
| Reading errors         |          | 77               | 180                 | 42.78%     | Enough        |
| Comprehension errors   |          | 38               | 180                 | 21.11%     | Low           |
| Transformation errors  |          | 12               | 180                 | 6.67%      | Very Low      |
| Process skills errors  |          | 69               | 180                 | 38.33%     | Low           |
| Encoding errors        |          | 46               | 180                 | 25.56%     | Low           |

Table 2 shows a summary of the students' ability to solve contextual problems. In Table 2, it can be seen that the students' success in reading errors in the category is enough, this means that students are quite capable of identifying information in contextual problems completely. The students' success in comprehension errors in the category is low, and this means that students' ability to write down what is known and asked in contextual problems is low. The success of students in the transformation errors stage in the category is very low, and this means that students' ability to write mathematical models of contextual problems is deficient. The success of students in the process skills errors stage is in a low category, and this means that the students' ability to use the settlement procedure correctly is relatively low. The students' success in encoding errors in the category is low, and this means that the students' ability to conclude answers to contextual problems is low.

3.1.1 Analysis problem solving of question 1

Once a week Indah is given by his mother an amount of money of 130,000.00 IDR. 50,000.00 IDR of it must be used to pay the courses, 20,000.00 IDR of it must be used to savings, and the rest for pocket money for 1 week (Monday-Saturday). How much is Indah's pocket money every day?

Money from mom = 130,000
Pay the courses = 50,000
Savings = 20,000
60,000
So, Indah’s pocket money = 60,000

Figure 1. Question 1

Figure 2. The answers of subject S1 on question 1
S1 gets the lowest score from the other subjects for question number 1. Figure 2 shows that S1 made a mistake at all stages of the Newman procedure. In the reading errors phase, S1 did not identify the information thoroughly. S1 did not satisfy the stage of comprehension errors, and S1 did not write down what was known and what was specifically asked, the subject only wrote some known information and immediately operated it. S1 did not satisfy the transformation errors stage, and S1 did not write the mathematical model of question 1. S1 did not satisfy the process skills stage, and S1 did not perform the procedure correctly so that it did not produce the correct answer. Meanwhile, at the encoding error stage, S1 wrote the wrong response to the conclusion.

Based on interviews with S1, it was concluded that S1 did not satisfy the reading errors stage because S1 could not absorb information completely and correctly. S1 did not satisfy the stage of comprehension errors because S1 was not able to understand the information that was known in full. S1 did not understand what was asked in the question. S1 did not meet the transformation errors due to the weakness of prerequisite knowledge, and S1 did not understand how to change mathematics problems into mathematical models. S1 was unable to connect the algebraic knowledge that had learned with the case in question 1. S1 did not satisfy the process skills stage because S1 had made a mistake in understanding what was being asked, and was not helped by the correct mathematical model. The error in the process skills stage caused the subject to make a mistake at the encoding error stage.

3.1.2 Analysis problem solving of question 2

Mr. Eko has four daughters, namely Adel, Brina, Carla, and the last daughter Dita. Their age difference respectively is 2 years, and the total of the age of four of them is 72 years. What is the age of each Eko’s daughters?

**Figure 3. Question 2**

| Child       | Age Difference | Age |
|-------------|---------------|-----|
| First child |               | 18  |
| Second child| 2             | 16  |
| Third child | -2            | 14  |
| Fourth child| -2            | 12  |

**Figure 4. The answers of subject S2 on question 2**

S2 gets the lowest score from the other subjects for question number 2. Figure 4 shows that S2 did not identify the information given in the question. S2 did not satisfy the stage of comprehension errors, and S2 did not write down what was known and what was asked. S2 did not satisfy the transformation errors stage, and S2 did not write the mathematical model of question 2. S2 did not satisfy the process skills stage, and S2 did not use the correct procedure so that it did not produce the correct answer. Meanwhile, at the encoding errors stage, S2 did not write the conclusion of the answer.

Based on interviews with S2, it was concluded that S2 did not meet the reading errors and the stages of comprehension errors because S2 could not absorb all the information correctly. S2 felt
no need to write down what was known and asked because all of it was written in the problem. This happens because S2 was accustomed to solving the problem directly in computing. S2 did not satisfy the transformation errors stage because S2 did not understand how to change problems into mathematical models. S2 was unable to relate algebraic knowledge that had learned with the case in question 2. S2 should use algebraic knowledge to change problems into mathematical models such as $x + (x - 2) + (x - 4) + (x - 6) = 72$ for $x$ is the age of the first child. S2 did not satisfy the process skills stage because S2 carelessly carries out and did not write the mathematical model at the stage of transformation errors so that S2 used the wrong procedure. S2 did not write the conclusion of the answer because S2 was not used to writing conclusions of the answer.

3.1.3 Analysis problem solving of question 3

Both Ardi and Riki have marbles. Ardi’s marbles are 2 times more than Riki's marbles, while the number of Ardi and Riki marbles is 18 marbles. How many marbles do each of them have?

**Figure 5. Question 3**

| Arithmetic | Algebraic |
|------------|-----------|
| Ardi’s marble $2 \times 18 = 36$ | |
| Riki’s marble 18. | |
| Their marbles are 36 and 18 respectively. | |

**Figure 6. The answers of subject S3 on question 3**

S3 obtained the lowest score from the other subjects for question number 3. Figure 6 shows that S3 did not identify the information given in the question. S3 did not satisfy the stage of comprehension errors, and S3 did not write down what was known and what was asked. S3 did not satisfy the transformation errors stage, and S3 did not write the mathematical model of question 2. S3 did not satisfy the process skills stage, and S3 did not use the correct procedure so that it did not produce the correct answer. Meanwhile, at the encoding errors stage, S3 wrote the wrong answer as a conclusion.

Based on interviews with S3, it was concluded that the subject did not satisfy the reading errors and stages of comprehension errors because S3 could not absorb the information correctly. S3 did not understand what was known from the question. S3 did not satisfy the transformation errors stage because S3 did not understand how to change the problem into a mathematical model, S3 was unable to connect the algebraic knowledge that had learned with the case in question 3. S3 should have turned the problem into an algebraic form. S3 did not satisfy the process skills stage because of negligence in understanding the information that was known, so S3 used the wrong completion procedure. Error answers in the process skills stage resulted in S3 being wrong in drawing conclusions at the encoding error stage.

3.2 Discussion

Based on the description of three subjects selected based on the lowest scores on each question, they have not been able to satisfy all stages of problem-solving based on Newman’s theory. During the reading errors, S2 and S3 did not identify the information contained in the question, because they were not able to absorb the information correctly. They are confused in
determining what is known in the material. Meanwhile, S1 did not identify the information completely, because S1 did not understand some of the information provided.

In the stage of comprehension errors, the three subjects made the same type of error, not writing what was known and what was asked. The error was carried out by the S1 and S3 because they did not understand what was known and asked from the question, they read all the words in the question correctly but had not understood the overall meaning. Meanwhile, S2 did not write down what was known and asked because felt that did not need to write it down because it was written in the question. In addition, they were also used to solve problems directly with computing.

In the transformation errors, the three subjects made the same type of error. They did not write mathematical models and steps to solve the problem given. The error was caused by the weakness of the prerequisite knowledge, and they did not understand how to change the problem into a mathematical model. They were unable to connect the algebraic knowledge they had learned with the problem given. Subjects did not have a strong concept of the material given.

In the process skills errors, the three subjects made the same type of error. They did not use the correct procedure so that they did not produce the correct answer. The error was caused by the three subjects having made mistakes in understanding what was asked and was not helped by the correct mathematical model, they did not master the prerequisite concepts related to the material provided, so they used the wrong settlement procedure. They only operated numbers that they knew with wrong operations because they did not really have a relational understanding. At the encoding errors stage, S1 and S3 wrote the wrong answer as a conclusion. This was due to an error in the process skills stage which results in the subject being wrong in concluding. Meanwhile, S2 did not write the conclusion of the answer because S2 was not used to writing conclusions with complete answers. If S2 write the conclusion of the answer, it will be wrong because S2 made a mistake in the previous stage so that it produces the wrong answer too. In this study, subjects tend to rush through the work process without first reviewing the right concept to solve the problem, and not checking the answers that have been written.

Based on the results of the percentage of problem-solving abilities for all subjects, the success in the reading errors stage was higher than the percentage at other stages. That means that students are quite capable of identifying information in contextual problems. This finding is supported by previous findings in reference [19] which concluded that success in the reading error stage was higher than the other stages. This is because in the contextual problems given in this study using everyday language so students easily read the questions given and do not use symbols that are difficult for students to understand.

The success of transformation errors is lower than the percentage at other stages. This finding is supported by previous findings in reference [20] which concluded that the success of transformation errors was lower than the other stages. Students are unable to determine the method of mathematical solutions. In this study, the ability of students to write mathematical models of contextual problems is very low, thus influencing them in determining the settlement method. This can be seen from students who cannot determine the variables and identify the relationship of all available information. Thus, students cannot change the problem given to mathematical forms, especially algebraic forms. So, students try to solve problems without doing modeling which causes them to use the wrong solving method.

Students cannot do modeling because they have no conceptual knowledge of the material provided. Students do not have sufficient conceptual knowledge because they do not concentrate on attending lessons. Besides conceptual knowledge, complete and correct information is also very important in conducting modeling. Therefore, the comprehension stage must be correct because in converting contextual problems to mathematical forms requires complete information.

The result of solving contextual problems using the Newman procedure is still relatively low because the percentage of success at each stage is below 50%. This is due to the lack of students'
experience in solving contextual problems and they are not used to solving problems according to the stages of completion. They tend to ignore every settlement process.

4. Conclusion

The problem-solving ability of seventh-grade students of Junior High School 16 Surakarta is not optimal. This is evidenced by the results of a review of five aspects of problem-solving skills based on Newman's theory, namely: 1) the percentage of success in the reading errors stage is 42.78%; 2) the percentage of success in comprehension errors stage is 21.11%; 3) the percentage of success in the transformation errors stage is 6.67%; 4) the percentage of success in the process skills errors stage is 38.33%; 5) the percentage of success at the encoding errors stage is 25.56%.

The error factor in solving contextual problems in algebraic material is that students cannot gain and understand the information well, students do not understand the transformation of problems, weaknesses in the concept of prerequisites possessed by students, lack of student experience in working on contextual problems. Most students are not able to transform contextual problems into algebraic forms. Mathematics teachers are expected to provide much practice in contextual problems for students. Therefore students are accustomed to solving problems related to daily life. Teachers are also expected to conduct learning that focuses on the process, so students are trained to do the best planning in solving various problems faced.

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