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Learning Mathematical Modeling: The 7th Grade-Students Skills in Solving Inverse Proportion Visual-Formed Problem

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ABSTRACT
This research aims to determine the 7th grade-students skills in solving the inverse proportion visual-formed problem through mathematical modeling learning. This research type was descriptive research using a qualitative approach. The subjects of this research were 19 students of the 7th grade-student of SMP Negeri 6 Indralaya Utara. We carried out the data collection techniques through the post-test and interviews. Based on the findings, here were found that the mathematical modeling problem in terms of visual provided a significant contribution to the student skills in solving the inverse proportion visual-formed problem. The details of the occurrence percentage of indicators were as follows: the identifying problem was 42,98%, the defining variable was 28,07%, formulating a mathematical model was 45,61%, completing the mathematics model was 52,63%, and applying the model was 50,00%.

Keywords: *Learning mathematical modeling, Problem-solving skills, Inverse proportion visual-formed problem.*

1. INTRODUCTION

Mathematical modeling is a process that uses mathematics to represent, analyze, and design predictions of real-world phenomena or a process that uses mathematics to provide an understanding of real-world phenomena [1,2]. It is a process of solving problems from the real world through mathematics by changing the initial problem to a mathematical problem to be solved mathematically, then the solution obtained is translated back into a real-world problem [3,4].

We can see the importance of mathematical modeling in mathematical learning from the school curriculum used by several developed countries where mathematical modeling is a significant element of the curriculum content [5-8]. Some of the reasons why mathematical modeling is considered essential in mathematical learning are as follows : (1) generating and developing a sense of sensitivity for students regarding the benefits or positive things obtained from mathematics to encourage them to be able to implement the mathematical concepts that they have learned in daily life; (2) bridging the real world with the mathematical world; (3) simplifying the problem-solving process; (4) making it easier for students to understand and master the mathematical concepts; (5) creating and developing positive attitudes towards mathematics [9,10].

It has been previously stated that mathematics plays a very crucial role in solving problems related to the real world or problems of daily life or other disciplines through mathematical modeling [9,11,12]. It proves that it is essential for students to have mathematical modeling competency to be problem solvers in the future.

Using the practical problems in daily life or using real phenomena, such as events in physics, makes the learning attractive [13]. Raising the real problems well known to students proves a positive attitude towards mathematics inversely related to ordinary mathematical content [14]. Besides, studying real-world problems elicits a positive response to mathematics and the pleasure of using mathematics to study the real-world problems they knew [15].

One of the mathematics competencies for the 7th grade-student of Junior High School listed in the 2013 curriculum is solving the inverse proportion [16]. The inverse proportion problem is one of the difficult subjects for students to solve. They have difficulties in

compiling and implementing an appropriate completion plan, so they guess the calculations. Thus, they ultimately do not recheck their answers anymore [17]. They also face problems related to the inability to identify which one is the direct proportion and which one is the inverse proportion [18,19]. It reveals that the inverse proportion material becomes a problem for them.

The students' tendency to like visual-formed problems is higher than word problems [20]. Giving visual-formed problem can help students solve mathematical problems that occur in daily life by representing images in their thinking to bring out lively characters for them [21]. The important thing that encourages giving questions in the form of visuals to students is Piaget's cognitive development theory. Junior High School students aged 12-15 years old still need help with concrete objects because they cannot thoroughly think abstractly [22]. The visualized real-world problems will give more meaning than the visual-based questions.

Interestingly, students can identify the inverse proportion concept if the visual form questions are solved using a mathematical modeling framework.

Based on the description above, the researchers were interested in conducting research entitled "Learning mathematical modeling: the 7th grade-students skills in solving inverse proportion visual-formed problem."

2. RESEARCH METHOD

This research aims to determine the 7th grade-students' skills in solving the inverse proportion visual-formed problem through a mathematical modeling framework. This research type was descriptive research through a qualitative approach. This research subjects were 19 students of the 7th grade-student of SMP Negeri 6 Indralaya Utara who had studied the material subject to the inverse proportion. This research was carried out in the even semester of the 2019/2020 school year.

The research focuses on the 7th grade-student skills in solving the inverse proportion visual-formed problem through a mathematical modeling framework. The indicators and descriptors used in this research are as follows.

Table 1. Indicators and descriptors of problem-solving skills using a mathematical modeling framework.

Indicator	Descriptor
Identifying problem	Defining the information provided in the questions. Formulating the problem asked in the questions to be solved.
Defining variables	Using symbols or signs to represent information whose value is still unknown.
Formulating a mathematical model	Formulating a mathematical model based on the information provided and previously defined variables.
Completing the model/working it mathematically	Completing the model mathematically to get the correct solution.
Applying the model	Stating conclusions based on the solutions obtained as problem-solving.

The research was carried out from 11 March 2020 to 18 March 2020 within three meetings. At the first meeting, 11 March 2020, the students were given the pre-test question to see their initial skills related to the inverse proportion subject. This pre-test was used to form groups that consist of 4-6 students each. The first day of research resulted in four groups for which they learned visual-formed problem using a mathematical modeling framework.

At the second meeting, 16 March 2020, the students carried out the learning with a mathematical modeling approach. Each group was given a visual-formed problem and a student worksheet of inverse proportion material to be solved and discussed in groups. The following is a visual-formed problem that has been developed by the researchers based on the National Exam (UN) questions.

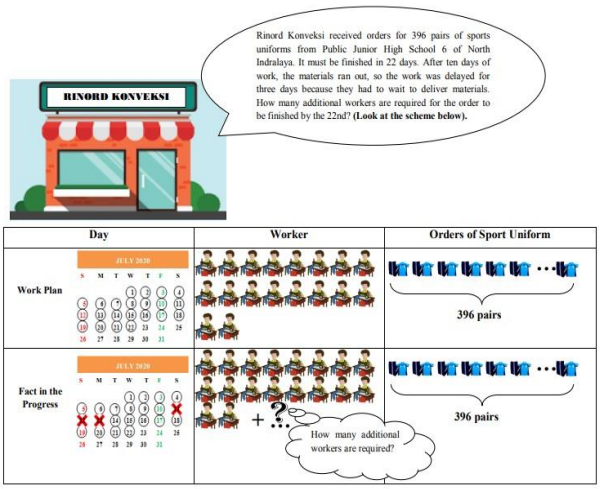

Figure 1. Visual-formed problem.

The visual-formed problem is a problem in daily life related to ordering sports uniforms context presented visually in posters with a combination of pictures and a few words. It is also accompanied by a student worksheet containing the questions that could lead the students to find solutions to these problems following the mathematical modeling steps.

At the third meeting, 18 March 2020, the students were given the post-test question to see their skills in solving the inverse proportion problem through visual-

formed problem. The post-test questions consisted of one essay question (description) in the form of a story question without any pictures based on the inverse proportion material. Moreover, the researchers interviewed two students to find out more deeply about the 7th grade-student skills in solving the inverse proportion problem through visual-formed problem and seeing the students' views on the daily life problems according to the mathematical modeling framework and visual questions.

In this research, the data was collected through post-test and interviews. Then, it was analyzed so that it could be described in written form. After that, a conclusion was drawn to answer the problem formulation. The following are the scoring guidelines for the post-test question.

Table 2. Scoring guidelines for post-test question.

Indicator	Descriptor	Answer Criteria	Score
Identifying problem	Defining the information provided in the questions	No answer	0
		Defining the information provided in the question, but it is still incorrect	1
		Defining the information provided in the question correctly, but it is still incomplete or defining the question's information ultimately, but it is still incorrect	2
		Defining the information provided in the question correctly and completely	3
	Formulating the problem asked in the questions to be solved	No answer	0
		Formulating the problem asked in the question, but it is still incorrect	1
		Formulating the problem asked in the question completely	2
Defining variables	Using symbols or signs to represent information whose value is still unknown	No answer	0
		Using symbols or signs to represent information whose value is still unknown, but it is still incorrect	1
		Using symbols or signs to represent information whose value is still unknown correctly, but it is still incomplete or using symbols or signs to represent information whose value is still unknown completely, but it is still incorrect	2
		Using symbols or signs to represent information whose value is still unknown correctly and completely	3
Formulating a mathematical model	Formulating a mathematical model based on the information provided and previously defined variables	No answer	0
		Formulating a mathematical model based on the information provided and previously defined variables is still incorrect	1
		Formulating a mathematical model based on the information provided and previously defined variables correctly, but incorrect	2
		Formulating a mathematical model based on the information provided and previously defined variables correctly and completely	3
Completing the model/working it	Completing the model mathematically to get the correct	No answer	0

Indicator	Descriptor	Answer Criteria	Score
mathematically	solution		
		Solving the model mathematically to get a solution, but it is still incorrect	1
		Solving the model mathematically to get a solution correctly, but it is still incomplete or solving the model mathematically to get a solution completely, but it is still incorrect	2
		Solving the model mathematically to get a solution correctly and completely	3
Applying the model	Stating conclusions based on the solutions obtained as problem-solving	No answer	0
		Stating a conclusion based on the solution obtained as a problem solving, but it is still incorrect	1
		Stating a conclusion based on the solution obtained as a problem solving correctly	2

3. FINDINGS AND DISCUSSION

3.1. Research Findings

The following are the test results and occurrence percentage of indicators the post-test problem-solving skills.

Table 3. Test results of post-test problem-solving skills.

Post-Test Score Range	Frequency	Percentage	Problem-Solving Skill Category
80 ≤ score ≤ 100	0	0%	Excellent
60 ≤ score < 80	4	21,1%	Good
40 ≤ score < 60	7	36,8%	Moderate
20 ≤ score < 40	7	36,8%	Poor
0 ≤ score < 20	1	5,3%	Very Poor
Total	19		
Average Score : 45,07			Adequate

Table 4. Occurrence percentage of indicator of post-test problem-solving skills.

Problem-Solving Skill Indicator				
Identifying Problem	Defining Variables	Formulating a Mathematical Model	Completing the Model/Working it Mathematically	Applying the Model
42,98%	28,07%	45,61%	52,63%	50,00%

The researchers then interviewed two students with a good and moderate problem-solving skill category consecutively, namely LL and H.

LL Subject

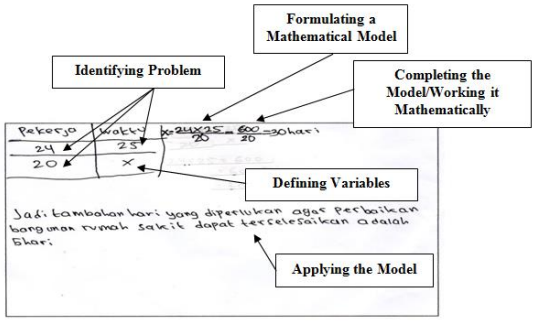

Figure 2. Results of LL's post-test answer.

From the results of LL's post-test answer, LL identified the problem by defining the information provided in the question correctly and completely. However, LL did not formulate the problem asked in the question to be solved. Then, LL defined the variable x to express the time it takes if performed by 20 workers. In this indicator, LL used symbols or signs to represent information whose value was still unknown correctly, but it was still incomplete. After that, LL formulated a mathematical model based on the information provided and previously defined variables correctly, but it was still incomplete. Next, LL solved the model mathematically to obtain the correct solution. Since LL was still incomplete in formulating the mathematical model, it resulted in the incomplete mathematical model solving. At the end of the solution, LL stated a conclusion based on the solution obtained as problem-solving correctly. The following is an interview the researchers conducted with LL.

P : "From the problem, how can LL solve it?"

LL : "By multiplying 24 by 25, then dividing it by 20. Then, 24 times 25 is 600."

P : "So, what is 600?"

LL : "The work that should be completed by 20 workers, Ma'am."

P : "Then how do you get 20 workers?"

LL : "From the rest of the workers, 24 workers minus 4 resigned workers, Ma'am."

P : "Yes. What is 600 divided by 20?"

LL : "30, Ma'am."

P : "So, what is 30?"

LL : "The time it will take if there are 20 workers."

P : "If there are 24 workers, how many days will it take?"

LL : "25 days, Ma'am."

P : "So, how many additional days are needed to complete the building repair if there are 20 workers?"

LL : "5 days, Ma'am. Thirty days minus 25 days."

P : "Does the mathematics that I teach require LL to memorize the formula?"

LL : "Yes, Ma'am. LL uses the subtraction, division, and multiplication operations, Ma'am."

P : "Does the mathematics that I teach make LL happy to learn in the class?"

LL : "Yes, it is because I can work together in groups, Ma'am."

P : "Is the mathematics that I teach more interesting than the mathematics lessons in the books?"

LL : "It is more interesting, according to LL."

P : "Does the mathematics that I teach make LL not bored to learn mathematics in the class?"

LL : "LL is not bored because it contains many pictures, Ma'am."

P : "Should mathematics lessons be added if they are taught just like what I do?"

LL : "That is okay, according to LL, Ma'am."

P : "Are the pictures on the mathematics lessons that I teach help LL understand what to do and look for?"

LL : "Yes, Ma'am. The posters help LL in understanding and solving the problem given."

Based on the results of interviews with LL, LL was able to explain the work LL wrote. It could be seen that LL almost met all indicators. As stated by LL, the pictures used in the visual form helped LL understand the meaning of the problem and assist in solving it. Indeed, there was a contribution from the systematic mathematical modeling learning that had previously been used to support problem-solving skills.

H Subject

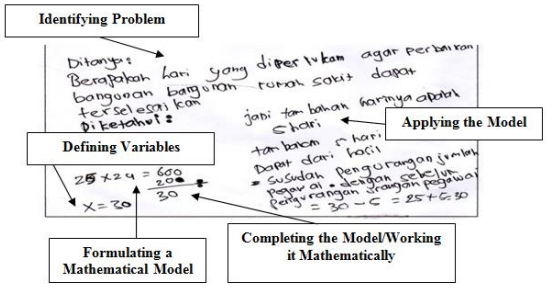

Figure 3. Results of H's post-test answer.

Based on H's post-test answer, H did not define the information provided in the question. Nonetheless, when interviewed, H was able to answer and understand the information provided in the question. H identified the problem by formulating the problem asked in the question, but it was still wrong. The problem formulation written by H was, "How many days does it take to complete the hospital building repair?" Meanwhile, what was asked in the question was the additional days. Then, H defined the variable x to represent information whose value was still unknown correctly, but it was still incomplete.

Furthermore, in H's work, it unveiled that H was able to formulate a mathematical model correctly, even though it was still incomplete. H was able to solve the model mathematically to get the correct solution even though it was still incomplete since H did not mathematically write the result of 5 on H's worksheet. At the end of H's work, H wrote a conclusion based on the solution obtained as an initial problem-solving. The following is an interview the researchers conducted with H.

P : "From the problem, how can H solve it?"

H : "From the information provided, Ma'am. H multiplies 25 by 24, which is 600."

P : "So, what is 600?"

H : "The building repair work that should be completed."

P : "Then how do you get 20 workers?"

H : "20 can be obtained from 24 minus 4, Ma'am."

P : "So, are the 20 workers the remaining workers?"

H : "Yes, they are. 600 is divided by 20, which is 30."

P : "How do you get 5?"

H : "If there are 24 workers, it will take 25 days."

P : "Yes."

H : "Yes, 24 minus 4. It takes 30 days."

P : "Yes. So, how many additional days are needed?"

H : "5 days, Ma'am."

P : "Does the mathematics that I teach require H to memorize the formula?"

H : "No, Ma'am. H only uses the subtraction, division, and multiplication operations, Ma'am."

P : "Does the mathematics that I teach make H happy to learn in the class?"

H : "Yes, Ma'am. H feels happy since we can discuss with each other in the group."

P : "Is the mathematics that I teach more interesting than the mathematics lessons in the books?"

H : "Yes, it is because it contains many pictures, Ma'am."

P : "Does the mathematics that I teach make H not bored to learn mathematics in the class?"

H : "Not bored, Ma'am."

P : "Should mathematics lessons be added if they are taught just like what I do?"

H : "Yes, Ma'am. H agrees."

P : "Are the pictures in the mathematics lessons that I teach help H to understand what to do and look for?"

H : "Yes, Ma'am. The pictures make it easier for H to solve the problem given."

From the interview results, H was able to explain how to solve the problem given even though H did not meet the indicators of the problem-solving skills completely. In the indicator of identifying the problem, H did not define the information provided in the question. Nonetheless, H understood and was able to explain it during the interview. If seen from the results of H's answer, H could answer and solve the problem correctly. During the implementation of the visual-formed problem, H also played an active role in the group discussion. As expressed by H, pictures on the posters made it easier for H to solve the problem given. H also mentioned that visual-formed problem could be useful in daily life.

3.2. Discussion

Based on the post-test and interview results, it could be seen that the visual-formed problem had a significant contribution to the 7th grade-students' skills of SMP Negeri 6 Indralaya Utara to solve the inverse proportion problem. The mathematical modeling indicators consisted of identifying the problem, defining variables, formulating a mathematical model, solving the model/working it mathematically, and applying it. Based on GAIMME book [2], the students solved the inverse proportion problem given to see the skills to solve it then adjusted it using those indicators. The results portrayed that the skills of the 7th grade-student in solving the inverse proportion problem through the visual-formed problem with details of the occurrence percentage of the indicators were as follows: the identifying problem was 42,98%, the defining variable was 28,07%, formulating a mathematical model was 45,61%, completing the mathematical model/working it was 52,63%, and applying the model was 50,00%.

The visual-formed problem helps the students understand and identify the inverse proportion problem in which the story question related to the inverse proportion material becomes the problem for them [18,19]. They can explore to solve the problem given by using the visual objects on the posters so that the question can become easy to understand. The visual-formed problem can potentially improve the students' skills to solve the inverse proportion problem. The results are in line with the research conducted by [20] that the questions presented in the visual form are more attractive compared to the text/descriptive questions.

4. CONCLUSIONS

Based on the above discussion, it could be concluded that visual-formed problem significantly contributed to the 7th grade-student skills in solving the inverse proportion problem. It helped them understand and identify the inverse proportion problem since they could explore to solve the problem given by involving pictures. It is recommended that teachers use visual-formed problem to assist the students in obtaining problem-solving skills.

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