Students’ Problem Solving Behavior On Multiplicative Word Problem

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Abstract. Students in junior high school frequently erroneously solving multiplicative word problems. Students in this stage should be able to understand the known and what is asked, what the strategies properly, and how to execute it become the right one. It has close related with student problem solving behavior, it is given provided description of the students’ behaviour. The purpose is to investigate students’ problem solving behavior on solving multiplicative word problem. This study conducted on a class of 7A$^{th}$ class in SMPN 39 Surabaya, consist of 27 girls and 15 boys, and had chosen purposively from ninth classes. Students had to answer multiplicative word problem, based on result show that there are three category students when solve the task. Three volunteer students were selected as research subject which have different ability that had interpret as context this study, subjects needed for deep interview. The problem solving behavior of subject who solve the tasks multiplicative properly tend to Meaning Based Approach-justification (MBA-$j$), the problem solving behavior of subjects who solve exactly one task multiplicative additively tend to Meaning Based Approach-full context (MBA-$fc$), and the problem solving behavior of subjects who solve at least two task multiplicative additively tend to Direct Translation Approach-not proficient (DTA-$np$).

1. Introduction
Multiplicative reasoning is omnipresent in daily life situations; converting currencies from one thing to other thing. Multiplicative reasoning is the capstone of children’s primary school arithmetic and the cornerstone of all that is to follow. Learning to reason multiplicatively is a major goal in upper primary mathematics education [2]. In fact, many children read mathematics word problem and directly translate them to arithmetic operations [5]. In the other word, students just going with calculation. There is no reason and there is no justification about the taken step. In case, students’ upper primary school frequently erroneously solve additive word problems multiplicatively, while younger children frequently erroneously solve multiplicative word problems additively [2]. The multiplicative word problems can be categorised as various models for multiplication. When students solve word problem, they might construct a model of the problem and demonstrated the way of students reasoning, which typically is an illustration of the specific situation in the problem [6][7]. The way students construct a model and demonstrated can be supported by, the ability to reason multiplicatively. The ability to reason multiplicatively is considered as a significant conceptual leap of students’ understanding [8][9]. In order to distinguish when multiplicative its means engaging in a task for which the solution method is not known in advance. In order to find a solution, students must draw on their knowledge, and through this process, they will often develop new mathematical understanding.
Solving problem is not only a goal of learning mathematics but also major means of doing so [3]. Problem solving behaviour play an important role for any student because problem solving behaviour can given provided description of the students’ behaviour during the process of solving the mathematics problem [1]. When students solve the task given, the process that appear show how the behaviour students when solve the task. The problem solving behaviour divided into two parts that is direct translation approach and meaning based approach [4]. The two original behaviour above separate again become five category that are 1) Direct Translation Approach-Proficient (DTA-p), this students automatically and efficiently translate the problem elements to a mathematical computation without reading or referring to the problem following the initial reading. They provide no evidence of transformative behaviour in the form of recording given information, use the context during calculations, although the answer may be stated within the context of the problem, or provision of explanations; 2) Direct Translation Approach-Not Proficient (DTA-np), this students show a lack of competence in and have difficulty reading the problem, coming to an understanding of the problem, deciding upon a solution path, and/or performing calculations. They reread the problem frequently, which may be their only behaviour. No evidence is provided that the problems’ context supports solution. Their verbal protocols provide no evidence of transformation behaviour. Calculations performed may lack meaning in relation to the problem and serve to complete task; 3) Direct Translation Approach-Limited Context (DTA-lt), this students directly translate the elements of the problem to arithmetic computation. They do so, however, with some, but limited, use of the problem context. Context is limited to single words or rereading followed directly by computation. Limited explanations of arithmetic calculations may be provided; 4) Meaning Based Approach-full context (MBA-fc), this students read or reread each sentence of the problem and record information from the statement with an appropriate context, which is used to support calculation. Final answer are often provided as a complete sentence revealing an understanding of the answer within the context of the problem. Explanations of the mathematical steps, often based on statement of context but not justifications are provided with calculations, and 5) Meaning Based Approach-justification (MBA-j), these students provide evidence of all of the behaviours of the previous category. In addition, they provide justifications for each solution step [5].

2. Methods
2.1. Participant
The purpose of this study is to investigate the students’ problem solving behavior when solving the multiplicative word problems. This study applied a descriptive-qualitative approach. This study is conducted on a class of the 7th grade of SMPN 39 Surabaya. It consists of 27 girls and 15 boys, and had chosen purposively from 9 available classes. All students had to answer multiplicative word problem test consist of three item test.

Table 1 Grouping Guidelines

| Classed     | Score Interval | Interpreted in This Study                                      |
|-------------|----------------|-----------------------------------------------------------------|
| High        | $80 \leq \text{students'} \text{ score}$                  | All item multiplicative properly and given answer right          |
| Avarage     | $60 \leq \text{students'} \text{ score} < 80$             | Exactly one item task multiplicative additively and given answer for two other items right |
| Low         | $\text{students'} \text{ score} < 60$                     | At least two item multiplicative additively and given answer for one other item right |

Students ability classified [10] interpreted into context of this study, students score above obtained from $\left( \frac{n}{3} \times 100 \right)$, where n is the number of items that right such that we had a new categorized. As shown in Table 1, grouping guidelines [10] had interpreted according context of this study. So that students with high ability namely subjects who solve all item multiplicative properly, subjects with medium ability namely subjects who solve exactly one task multiplicative additively, and subjects with low ability namely subjects who solve at least two item multiplicative additively. Three volunteer students were
selected as research subject which have different ability that had interpreted as context this study (see Table 1). Interviews were conducted to three subjects to explore more deeply about problem solving behaviour.

2.2. Analysis

The data in this study obtained from multiplicative word problem test and semi structured interview based on multiplicative problem solving test. Students had answer the three item of multiplicative word problem test. The different of each indicator of problem solving behaviour briefly separate on the following table.

| Aspects                                        | DTA-p | DTA-np | DTA-nc | MBA-fc | MBA-j |
|-----------------------------------------------|-------|--------|--------|--------|-------|
| Fluency of Declaring the questions that have been read using the own sentence | Unfluently | Unfluently | Unfluently | Fluently | Fluently |
| Relevance of mentioning what is known and asked in the problem | Relevant | Unrelevant | Relevant | Relevant | Relevant |
| Logical basic used in linking information     | Illogical | Illogical | Illogical | Part Logical | Logical |
| The effectiveness of the used strategies      | Ineffective | Ineffective | Effective | Effective | Effective |
| Write down the final answer as a solution     | Not in context | Not in context | In context | In context | In context |
| Given reasoning and justification             | Unrelevant | Unrelevant | Unrelevant | Unrelevant | Relevant |

3. Results and Discussion

Multiplication problem solving behaviour test have been analysed. Subject divided into three categories based on grouping guidelines [10] that already interpreted to this study namely, subject who solve all item multiplicative properly, subjects who solve exactly one item multiplicative additively, and subjects who solve at least two item multiplicative additively (See Table 1). Based on analysis there were seven students solve all item multiplicative properly, nineteen students solve exactly one item multiplicative additively, and last solve at least two item multiplicative additively. This result based on multiplicative word problem can be shown briefly in Table 3.

| Category                               | The Number of Students |
|----------------------------------------|------------------------|
| All item multiplicative properly       | 7                      |
| Exactly one multiplicative additively  | 19                     |
| At least two multiplicative additively | 16                     |

Chosen three subject that represent each category to be as subjects namely, first subject (multiplicative properly), second subject (exactly one multiplicative additively), and third subject (at least two multiplicative additively). The result of multiplicative problem solving test for each subject shown on the following table.
Table 4 Result of problem solving behavior.

| Item Test                                      | First Subject | Second Subject | Third Subject |
|------------------------------------------------|---------------|----------------|---------------|
| Fluency of Declaring the questions that have been read using the own sentence | fluently       | fluently       | fluently      |
| Relevance of mentioning what is known and asked in the problem | Releva        | Relevan        | relevan       |
| Logical basic used in linking information     | Logical       | Logical        | Logical       |
| The effectiveness of the used strategies       | effic         | effic          | effic         |
| Write down the final answer as a solution     | in context    | in context     | In context    |
| Given reasoning and justification             | relevan       | relevan        | releven       |
| Category                                      | MB A-j        | MB A-j         | MB A-j        |

Table 4 show that the problem solving behavior of first subject on all item test include the Meaning Based Approach-justification (MBA-j). The problem solving behavior of second subject on item test 2 and 3 include Meaning Based Approach-full context (MBA-fc), whereas on item test 1 categorized as Based Approach-justification (MBA-j). The problem solving behavior of third subjects on item test 2 and 3 include Direct Translation Approach-not proficient (DTA-np) whereas on item test 1 categorized as Meaning Based Approach-justification (MBA-j).

3.1. Multiplicative Problem Solving of student solve all multiplicative properly

Subject solve all item multiplicative word problem test systematically. This subject solve all item using multiplicative concept and the answer given were right. Here, a part of the result from this subject can be shown in Figure 1 and Figure 2.

![Figure 1](image1.png)  
**Figure 1** Answer item test 3

![Figure 2](image2.png)  
**Figure 2** Answer item test 3

From the figure above, subject begin solving the problem with write down the known, write down what asked in problem, choose an appropriate strategy, make calculation based on chosen strategy, write down the result as a context problem. Here some conversations with subject:

R : What information that you got from problem number three?
S1<sup>st</sup>: There are two marbles, but one is bigger than the other. Then marbles dropped into pool as deep as 2 meters. And there are a situation that when one marble as deep as one fourth pool, the other one half pool. So I should find the position of marble when the other already reach the bottom of pool.

R: What strategy that you use for solving problem number three?
S1<sup>st</sup>: First, I find the deep of each marbles by changing the unit become cm. Then, I make a cross multiplication for find the answer.

R: Why you change the unit become cm?
S1<sup>st</sup>: It would be easier for me than I still using meters, because it will be decimal or fraction if I don’t change the unit.

R: Then, why you think to solve problem number three with multiplication?
S1<sup>st</sup>: Because when there are two marble with different size dropped, the bigger one will be faster than the other.

Based interviews, the problem solving behaviour tend to read the problem, write the known, what asked in problem, make a relevant information, choose an effective strategy logically, write down the answer as context problem, and give the justification of steps that already taken. This behaviour include MBA-j category.

Both result of multiplicative word problem and interview show that students who solve all item multiplicative properly include MBA-j category. This found have the same result that subject with high ability include the MBA-j [1], which is subject with high ability tend to students who solve all item multiplicative properly (see Table 1) include MBA category.

3.2. Multiplicative Problem Solving of student exactly one multiplicative additively

Subject solve exactly one item multiplicative additively. This subject solve item 1 and 3 using multiplication concept and the given answer were right. But for item 2 using addition concept and the answer given were wrong. Here, a part of the result from this subject can be shown in Figure 3 and Figure 4.

![Figure 3 Answer item test 1](image)

![Figure 4 Answer item test 2](image)

From the figure above, subject make a representation using the information in problem. Find the relevancy of these information, make a strategy and got the answer. Here some conversations with subject for item test 2:

R: What information that you got from problem number two?
S 2<sup>nd</sup>: Aulia will cook water with the same pan and volume but with different stove’ flame. And when the pan was 15°C, the other pan 7°C. And what temperature the pan when the other 14°C.

R: Could you linking the information with asked in problem?
S 2<sup>nd</sup>: Sure, I find the difference between pan one and pan two. Then the value that I got, added to temperature pan.

R: please repeat it, and make it clear?
S 2<sup>nd</sup>: like I said before, mmm I don’t know.

R: That’s why you got 22 as an answer
S 2<sup>nd</sup>: yes, miss.

R: and then how about the initial temperature?
S 2nd : means -4°C? mmm, I don’t think it useful

Based interviews, the problem solving behaviour tend to read the problem, write the own known and asked by itself, make a relevant information, the basic logic used in linking information part logical, the chosen strategy were ineffective, write down the answer not in context problem, and there is no reason steps that already taken. This behaviour include MBA-fc category.

Both result of multiplicative word problem and interview show that students who solve exactly one multiplicative additively include MBA-fc category. This found have different result that subject with medium ability include the DTA-p category [1], which is subject with medium ability tend to students who solve exactly one item multiplicative additively (see Table 1) include to MBA category not DTA category like previous research.

3.3. 

Multiplicative Problem Solving of student at least two multiplicative additively

Subject solve at least two item multiplicative additively. This subject solve item 1 using multiplication concept and the answer given were right. But item 2 and 3 using addition concept and the answer given were wrong. Here a part of the result from this subject can be shown in Figure 5 and Figure 6

From the figure above show that subject directly calculate which is the strategy that used isn’t right. It should be using multiplication concept not addition concept. Here some conversations with subject:

R : What information that you got from problem number two?
S3rd : Will cooking water with the initial temperature was -4°C, temperature of second pan is 7°C, temperature of first pan 15°C.
R : What is asked in problem number two?
S3rd : For knowing the temperature
R : What does it mean by temperature?
S3rd : Temperature by pan.
R : then, what is strategy?
S3rd : I just calculated the initial temperature with each temperature pan.
R : what the answer you get?
S3rd : 3°C and 11°C

Based interviews, the problem solving behaviour tend to read the problem, can’t make a relevant information, the basic logic used in linking information illogical, not write down the answer, and there is no a reason of steps that already taken. This behaviour include DTA-np category.

Both result of multiplicative word problem and interview show that students who solve all item multiplicative properly include DTA-np category. This found have the a little bit similarity with the result that subject with low ability include the DTA-p category [1], which is subject with low ability tend to students who solve at least two multiplicative additively (see Table 1) include DTA-np category. The found in this study and previous research is students with low ability include in DTA whether in DTA-np category or DTA-p category.
4. Conclusion
There are three category students when solving the multiplicative word problem. Students solve all item multiplicative properly, students solve exactly one item multiplicative additively, and students solve at least two item multiplicative additively.
First, students tend to read problem, write down the known, write down the asked, linking well the information, strategy that used are effective, write down the answer in context, and give justification for each step that already taken. Behaviours of this type subjects include the MBA-j category. Second, students tend to read problem, write down the known and the asked using their own representation, the basic logic used in linking information part logical, strategy that used are ineffective, write down the answer in context, and there is no justification for each step that already taken. Behaviours of this type subjects include the MBA-fc category. Third, students tend to have difficulty to read problem, can’t make relation between known and asked, the basic logic is illogical, and directly calculation. Behaviours of this type subjects include the DTA-np category.

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