

Students' Perception on Representation of Addition and Subtraction in Math Word Problems Using Indonesian Language

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Abstract. Words or phrases that represent count operations in word problems are bridges that connect mathematics and the real world. That linguistic structures are known as a semantic structure and influenced the complexity of word problems. This study to identify the type of semantic structure as a representation of addition and subtraction using Indonesian and to find out student perceptions of semantic structures that are difficult to understand. The document analyzed is a collection of word problem that made by teachers. The participants were primary school students and teachers for level five in Central of Java that majority of students use Javanese as the first language. The findings are as follows. *First*, based on semantic structure in word problem, the addition can be classified into merging, unification, change, and comparison. The subtraction of semantic structure can be classified into displacement, separation, change, and comparison. In multi-operations, there are many types which are a combination of that eight types, such as merging-displacement, merging-separation, and unification-separation-change. *Second*, such semantic structures are difficult to understand, especially the phrase "more than" to represent subtraction and "fewer than" to represent the addition.

Keywords: *semantic structure, representation, addition and subtraction, mathematics word problem, Indonesian language*

1. INTRODUCTION

In Indonesia, student difficulties with solving word problems were revealed in the Trends in International Mathematics and Science Study (TIMSS) in 2015, for instance, with a Mathematics score of 397, placing Indonesia in number 45 of 50 countries. Only eight percent of the Indonesian participants were able to solve the word problem. Jupri and Drijvers [1] found that formulating a mathematical model—evidenced by errors in formulating equations, schemas or diagrams—is the main difficulty. Other researcher has identified one of the causes of 'failed' students in learning mathematics in relation to the problem of semantic structure [2].

The semantic structure is a representation of operations in linguistic elements in the form of words, phrases, and other linguistic structures whose meanings serve as a pointer to operation: addition, subtraction, multiplication, and division [3]. In the lower-grade, the student's operation

is the addition and subtraction and at a further level in multiplication and division. The inaccuracy in understanding the semantic structure resulted in inaccurate artificial student operations or mathematical equations made wrong. In fact, the error of mathematical equations resulted in the acquisition of miscalculated results as well.

It is well known that in certain parts the structure of the language used is not natural language or normal language, or language with ordinary meanings, but a language full of symbols. Of course this is a separate problem for students who use Indonesian as a second language because in the matter there are words with new meanings, such as *maju* 'forward', *naik* 'up', *terbang* 'fly', *memberi* 'give', *membeli* 'buy', *untung* 'profit' is a semantic structure that representation of addition relation, but *mundur* 'backward', *turun* 'down', *minta* 'ask', *meminjam* 'borrow', *hutang* 'debt', *hilang* 'loss' is representation of subtraction relation [4]. It makes students equate Indonesian word problems with a foreign language because it is often misinterpreted.

Some research results prove that semantic structure to be one source of difficulty in understanding the word problem for primary students. Ellerton and Clarkson [5] find for early class students, semantic structure is a major factor that contributes to the difficulty of translation of the problem to the counting notation compared to other linguistic variables. The cause is that the semantic structure is not used in the context of natural language, but it refers to a particular relation count so often creates an ambiguous understanding for the student [6]. In the late 1970s, semantic characteristics of word problem began to receive attention [7]. Therefore, the purpose of this study is to map the type of semantic structure in Indonesian to represent the addition and subtraction and the semantic structure that is the source of the difficulties for five-grades students in understanding the word problems.

2. METHOD

To mapping the semantic structure, the data source is the word problems. That problem is taken from student worksheets created by teachers of level five from two districts (Sukoharjo and Karanganyar) in Central Java, Indonesia. That are developed based on the Curriculum 2013. All word problems are presented in the Indonesian language.

From forty two schools were obtained fifteen different student worksheets. In every worksheet contained non-word problems and word problems, so it needs to be selected first to get the word problem as a research material. The boundary of the discourse about the word problem here is a matter of mathematics presented with the language medium and at least inside it contains two discourse components, one of which is a question component. Furthermore, word problems that represent additions and subtractions are used as data.

To obtain data on the type of semantic structure that is the source of the students' difficulties, the data sources are the students' perception obtained through questionnaires. The questions given is that were "which story problem is the calculation operation difficult to understand." The questionnaire contains 20 different semantic structure of math word problem. The participants comprised 110 students. All participants use Indonesian as a second language, while the first language is Javanese. The number of boys was approximately equal to the number of girls. Participant retrieval is also based on different levels of achievement to include the high-achieving, mid-achieving, and low-achieving in Math lesson.

3. RESULT AND DISCUSSION

From the identification of fifteen student worksheets obtained 278 word problems made by the teacher which included the addition and subtraction. Judging from the type of operations, the word problem are divided into two, namely (1) the word problems with a single operation

and (2) the word problems with multi- operations. The single operation is word problem that contains one operation only, but word problem with multi-operations is represent more than one operation. The details of word problem viewed from the use of operations presented in Table 1.

Table 1. The Distribution of word problems made by teachers based on the operations used

Math operation	Sum	Percentage
Addition	23	8.27
Substraction	18	6.47
Addition – Addition	37	13.31
Addition – Subtraction	52	18.71
Subtraction – Subtraction	32	11.51
Addition – Addition – Addition	41	14.75
Addition – Addition – Subtraction	58	20.86
Addition – Subtraction – Subtraction	17	9.71

3.1 Types of Representation of Addition and Subtraction

Based on the identification of several previous researchers and the results of the analysis of the teacher-made word problem that is the source of this research data, the type of semantic structure of the operation indicator includes 8 types for single operation and 2 types for mixed operation so that there are 10 types.

The type of semantic structure to represent an addition

1. merging: the sum of two quantities possessed by two subjects/objects
2. unification: the sum of two quantities on the same subject/object
3. change: the sum of two quantities due to changing position/state
4. comparison: the sum of two quantities of the comparison result marked by the phrase "more/larger/longer than"

The type of semantic structure to represent a subtraction

5. displacement: subtraction of one quantity to be moved on another subject/object
6. separation: the subtraction of one quantity to be separated from the other
7. change: subtraction of one quantity due to change of position/state
8. comparison: the subtraction of one quantity of the comparison result marked by the phrase "fewer/smaller/shorter than"

The type of multi-semantic structures

9. changes (addition) – change (subtraction)
10. comparison (addition) – comparison (subtraction)

The word problem with an addition operation that has a semantic structure of merging refers to the action of summing up the two quantities held by two or more actors. The example of word problem with merging type:

- (1) *Naufal drinking water is still there $\frac{2}{3}$ glass. Mother added water $\frac{1}{3}$ glass again. How much water is there in Naufal's glass?*

The word problem with an addition operation that has a unification semantic structure refers to the action of summing up two quantities possessed on the same subject/object. Example of word problem with unification:

- (2) *Tama checks all the oranges. It is known that 63 citrus trees are attacked by pests. While 644 orange trees are free from pest attacks. How many orange trees Pak Tama?*

The word problem with a sum arithmetical operation that has a semantic structure of change refers to the action of summing two parts or things caused by changes, eg distance / time / temperature, on the subject/object. An example of a word problem with change type.

- (3) *A piece of ice with a temperature of -5 degrees Celsius is heated to melt. Heating continues until the water boils with a temperature of 100 degrees Celsius. What is the increase in ice temperature to boiling water?'*

The word problem with the addition operation that has a comparative semantic structure refers to the action of summing two quantities of one of its quantities as a comparator of other quantities of "more/larger/longer than" sizes. An example of a word problem with comparison type as follows.

- (4) *White sharks are more dangerous sharks than leopard sharks. Its length reaches 7.5 meters. Long leopard shark $4\frac{3}{5}$ meters longer than the white shark. How long the length of long leopard shark?'*

The word problem with the subtraction operation which has a displacement semantic structure refers to the action of subtracting one quantity by another because of the transfer of a thing from one object to another. Example of a word problem with the structure of semantic displacement

- (5) *A grandfather has a patch of rice fields. Covered $\frac{2}{7}$ sold to Mr. Ahmad. The rest is distributed to his grandchildren. How much is the share?'*

The word problem with the subtraction operation which has a displacement semantic structure points to the action of subtracting one quantity by another because of the separation of a subject from another subject. The following is an example of a word problem with a semantic structure of separation.

- (6) *The village of Madumulyo builds a $4\frac{1}{2}$ path road km. Throughout $3\frac{1}{3}$ km of the road has been finished paved. How many miles of unpaved roads?'*

The word problem with the subtraction operation that has the semantic structure of change points to the action of subtracting one quantity from another by the change, e.g. distance/time/temperature/price, on a subject/object to obtain a smaller quantity. Examples of word problem with changes type for grade 4 are as follows.

- (7) *Mr. Hasan harvested as much as 50 tons of wet rice. After drying weighs $37\frac{1}{2}$ ton. What is the difference between wet paddy and dry rice of Mr. Hasan?'*

The word problem with the subtraction which has a comparative semantic structure refers to the action of subtracting two quantities of one of its quantities as a comparator of other quantities of "smaller/less/long than". An example of a word problem with comparison type as follows.

- (8) *Vitamin C is indispensable for maintaining immunity. The daily consumption of vitamin C needed by a child of your age is 50 mg. Infants aged 5 - 12 months require vitamin C 15 mg less. How many mg of vitamin C do babies need 5 -12 months old?'*

The characteristics of word problem with the addition - subtraction operation in the type of the merges is indicates an act of addition some quantity possessed on some subject/object, then moving it to another subject/object. Below is an example.

- (9) *Wida has the money of 7,500 rupiah, Ina has the money of 5,000 rupiah, and Sita has the money of 5,500 rupiah. The money was made into one, then bought textbooks worth 13,500 rupiah. What is the rest of their money?'*

The word problem with the addition - the subtraction operation that belongs to the semantic type of unification - displacement refers to the action of summing up some quantity possessed/contained on the same subject/object, then transferring it to another subject/object. An example::

(10) *Initially Fitri took savings in the bank as much as 35,000 rupiah. Fitri also took school savings of 15,000 rupiah. The money is to buy a book for 45,000 rupiah. What is the rest of Fitri's money?*

3.2 The Type of Semantic Structures that Difficult to Understand

From students' perception, the types of semantic structures that are difficult to understand by are changes (on subtraction), comparisons, and multi-semantics structure. In detail, the questionnaire given to the student contains the word problem with semantics structure, namely: (1) change (on subtraction), (2) comparison with phrase "more" to refers addition, (3) comparison with phrase "more" to refers subtraction, (4) comparison with phrase "fewer" to refers subtraction, (5) comparison with phrase "fewer" to refers addition, (6) merging-displacement, (7) unification-separation, (8) merging-displacement-merging, (9) unification-separation-separation, and (10) comparison-comparison. Each type consist of two word problems, so that the given questionnaire contains 20 word problems.

About 110 students were allowed one hour to complete it. Each question is provided with a "difficult" and "not difficult" response option. "Difficult" perceptions indicate that the problem is difficult to translate into mathematical equations.

Based on the data analysis identified the difficult word problem to understand include: (1) comparative type with "more than" to represent subtraction, (2) comparative type with "less than" to represent the addition, (3) multi-comparative type, (4) addition-subtraction with no represent in antonymous. The conclusions are based on the high percentage of students (same or higher than 70%) who said it was difficult. The data can be read in Table 2.

Table 2. The difficulties of semantic structure types

Tip of semantic structure	Percentage of the response
comparison with phrase "more than" to refers addition	78
comparison with phrase "more than" to refers subtraction	92
comparison with phrase "fewer than" to refers subtraction	84
comparison with phrase "fewer than" to refers addition	86
merging-displacement no with antonymous	75
unification-separation no with antonymous	70

The results of this study further emphasize that linguistic factors are the cause of difficulties in understanding word problems for most students, especially those delivered in the second language. Especially for most elementary school students in the village, Indonesian is a language that is being studied formally. According to the teacher's information, to help students understand the word problem, the teacher must describe the problem in a clearer context. In fact, the context of the teacher-made word problems have been pursued according to the experience of students. For example for the word problem "*Uncle has a garden. Uncle planted guava on 1/7 part and orange on 2/7. How much is the remaining land?* ", at least described as "*Uncle has a garden. Uncle planted guava in 1/7 part. Uncle also planted oranges on 2/7 parts. The remaining parts have not been planted with fruit. How many parts of the garden that have not been planted?* As a result, students become easier to understand the contents of the story and successfully choose the operation to calculate it correctly. The strategy by Cummins [8] is termed rewording which is exemplified as follows: "*There are five marbles. Two of them belong to Mary. How much does John have?* which was restated as "*There are five marbles. Two of them belong to Mary. The rest belongs to John. How many marbles are John?*" This kind of

conceptual rewording has is proven to be effective in improving student performance in solving word problems [9, 10, 11]. Beside rewording technique, to overcome students' difficulties in identifying mathematics, the teacher also translates the word problem into Javanese. This is done mainly on word problems with comparison type, including reverse comparisons, such as "more than" which represent subtraction and "fewer than" to represent additions. This kind of translating has been shown to be useful to improve children's performance on word problems, especially the complex word problems [12, 13]

4. CONCLUSION

The conclusion of the research results includes two things. *First*, in terms of the semantics structure of addition and subtraction, there are eight types in the word problems. The top of eight types represents one operation so that is called a word problem with single-operations, whereas four of lowest types are word problem with more than one operation so that it is called as multi-operation word problem. The details are as follows: (1) in the addition there is merging, unification, change, and comparison types and (2) in the subtraction there is displacement, separation, change, and comparison types. *Second*, the difficult type of semantic structures are (1) comparative type with "more than" to represent subtraction, (2) comparative type with "less/fewer than" to represent the addition. Finally teachers were suggested to help students in solving the difficulties and unfamiliar contexts word problems by using appropriate strategies, such as conceptual rewording and translating in mother language.

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