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Thinking Process of Elementary School Students in Word Problem Solving

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Abstract

The aim of this paper is to analyze the thinking process of elementary school students with low-level achievement in mathematics in word problem solving in reading comprehension perspective. Descriptive explorative with qualitative approach was used. A boy and a girl of elementary school students from grade V with low- level achievement were selected as subjects. The data were collected from in-depth interview and task analysis based on the task of mathematics problems solving. Observations were also applied in examining credibility of data regarding triangulation time and member check. Data were analyzed using a flow model covering data reduction, data presentation and conclusion drawing. The results of the study demonstrates that the thinking process of both boy and girl of elementary school in understanding problems are categorized as situation model while their thinking process in solving the problems belong to establish or consolidation group

Key words: thinking process, understanding problems, solving problems, word problem

1. Introduction

The National Council of Teachers of Mathematics (2000) identifies problem solving as one of five principles of basic mathematical areas such as reasoning and proof, connections, communication and representation. Learning how to solve problem is a salient ability for every individual in order to be able to deal with the complexity of social problems. In addition, problem solving is the core of all mathematics studies (NCTM, 2000) and the fundamental role of all mathematics activities (Reys, Lindquist, Lambdin, Smith, & Suydam, 2001).

Student's ability in solving mathematics problems is definitely important and educators must afford attention to design problem solving instruction to enhance student learning. In fact, students with good logical problem solving will also have other intellectual aspects like analogical ability, reasoning ability, well-ground of critical thinking, and good perception, memory and creativity. They are also well-known as a good reader who able to differ analyzing knowledge before designing some plans to solve particular problems (Hembree, 1992). In addition, a good problem solver also equip with meta-cognitive skill, ability to monitor and assess their thinking.

There have been some developed strategies in problem solving. Bransford and Stein (in Arnold, et al, 2005) apply what they called as IDEAL, a strategy to pose the process of problem solving. This acronym stands for *I – Identify the problem*, *D- Define and represent the problem visually*, *E- Explore possible strategies solve the problem*, *A- Act on the chosen strategy*, and *L- Look back and evaluate the outcomes*. Krech and Novelli (2006), Polya (1973) and Posamentier, Jaye and Krulik (2007) has approved similar strategy in mathematics problem solving by conducting four major strategies, they are (1) *understand the problem/ read the problem*, 2) *devise a plan/select a strategy*, 3) *carry out a plan/ solve the problem* and 4) *look back*. Hejný, Jirotková & Kratochvilová

(2006) also found that strategy to solve problem can be identified by two steps, they are *procedural meta-strategy* and *conceptual meta-strategy.*

This study will focus on thinking process of low-level achievement in mathematics of elementary students in solving word problems in reading comprehension perspective. The reasoning of this, in some mathematical problem solving strategies, the most important factor is to understand the problem. Selection low-level achievement students are meant to determine the cause of errors or difficulties they experienced in solving mathematical problems in general and in particular about the word problems. Word problems in this paper are types of mathematical problem to find in the form of story problems dealing with arithmetics in elementary schools in daily life that should be solved. Based on this focus, research problems are formulated as follows:

1) How is the thinking process of boy and girl elementary school students with low-level achievement in mathemathics in understanding word problems?
2) How is the thinking process of boy and girl elementary school students with low-level achievement in mathemathics in word problems solving?
3) Is there any difference in thinking process of boy and girl elementary school students with low-level achievement in mathemathics in understanding and solving word problems?

2. Method

This study uses descriptive explorative with qualitative approach by selecting a boy and a girl from elementary school with low level achievement in math from grade V as the research subjects. To determine the selection group, students must attend mathematics test that the item tests were taken from National Examination with Curriculum 2006 -based for grade V. There are 10 test items in form of multiple-choices that modified into essay test. Students with range score ($0 \leq$ test score < 55) from 0 – 100 will be categorized as low-level group.

The data were collected through in-depth interview and task analysis based on from two equivalent mathematics task designed by the researcher. The task was in form strory problems about arithmetic in elementary schools in daily life with two questions that must be answered. One of the examples is as follow:

> Bu Dewi, the owner of a store, sells candies putting on three different colored jars ; red, green, blue. Each jar has two diffèrent candies flavor yet they have similar shape. Red jar is filled with 81 strawberry candies and 47 orange flavor. Green jar is filled with 23 coffee candies and others are milk candies. Blue jar is filled with 46 pineapple candies and others are melon flavor. Candies in red jar is twice as many as candies in green jar, yet, candies in blue jar is not as many as candies in green jar. How many milk candies in green jar? What is the possibility of melon candies in blue jar ?

In this point, data credibility is applied by conducting continuous observation, triangulation time and member check while interaction model is used to analyse the data by reducing data, presenting data and conclusion drawing (Miles & Huberman, 1992).

3. Findings and Discussion

a). Thinking Process on Understanding Problems

Based on the result of depth interview with boys' student as the research subject, their first action after reading the mathematics problem is simply answering, what is asked and what is known from the problem. To answer related choice the arithmetic operation, namely addition, subtraction, multiplication, and division. Regarding what is known, the subject knows only that it is known and there are characteristics, but he did not know the characteristics of those. Meanwhile, about what is asked indicating by question words and question words mark. Thus, there is an obvious correlation about what being known and what being asked, that is by adding or subtracting numbers to answer the question.

On the other hand, the girls, firstly, decide to gather complete information or data presenting in task problem, called as what is known, after reading the task. In regard to their understanding about problem is what the problem asked. Description of the what is known is based on the presence of clue to answer the question and there are numbers in the problem. Meanwhile, the description of what is asked based on no answer, there is a question mark and phrase of how much (question word). Thus, there is a correlation between to know and to ask that to know is about clarifying to answer explanation from to ask.

Moreover, the next action of the boys and the girls is understanding "important" words or phrase on the problem and use the mathematics notation. A phrase *" not more than"* was understood by the boys as "not more little" while the girls' perception was "less than" indicating by "–" symbol or read as minus (correct symbol is " ≤ "). Further, a phrase "twice more" was understood by the boys as it is, while the girls give correct examples for their comprehension. Yet, the boys failed to interpret "possibly" phrase, the girls interpret as "*most exist*". Regarding the symbols writing, both boys and girls often use "×" to define *multiply* symbol and the boys mostly indicate "*more or less*" by "<" (correct symbol " ≤ ").

Throughout the findings, the thinking process of boys in understanding problem are: (1) selecting appropriate operation numbers to answer the questions, (2) writing *to ask* (3) writing *to know* from the problem, (4) understanding "important" words or phrase and (5) using mathematics notation. However, the girls' thinking process are (1) understanding the content of to know, (2) being able to write the content of to ask, (3) understanding "important" words or phrase and (4) being able use mathematics notation.

Although at the meantime of understanding "important" words or phrase and using appropriate mathematics notation, the students still meet difficulties, their

thinking process is ”more better” than what have been believed by Polya (1973) and Posamentier, Jaye and Krulik (2007) that the basis point in understanding a problem is being able to detect the content of *to know*, what *to ask* and providing important data. Interestingly, the boys has inverted thinking process that they should write their answer after finishing stage (2) to (5).

Further, the thinking process of both research subjects have successfully integrated through a combination of information on the problem with their previous knowledge on the use of mathematics symbols. This type of thinking process is considered as the highest level of thinking or on the third level called situation model (Österholm, 2006; Van Dijk and Kintsch, 1983). This type as same as with high-ability students (Baiduri and Taufik, 2014) and boys student with moderate-ability (Baiduri, 2014).

b). Thinking Process on Problem Solving

Regarding analysis thinking process of the subjects in problems solving, this figure will present two different works of the subject as in Figure 1 and Figure 2:

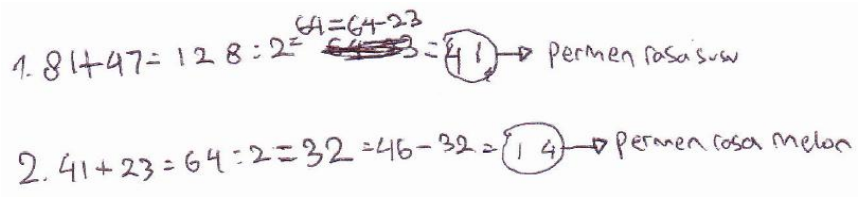

Figure 1. the boys' answer model

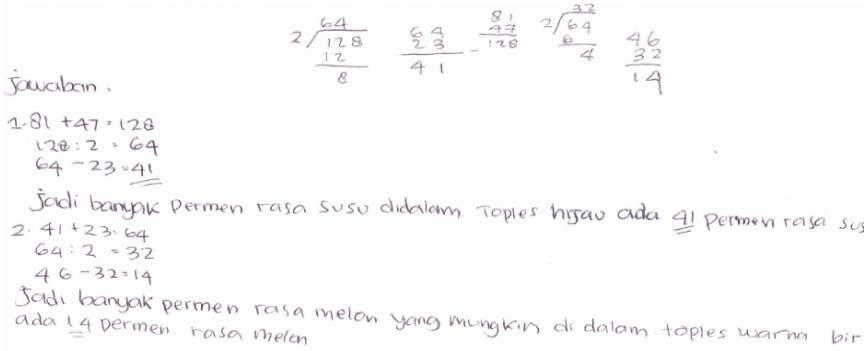

Figure 2. the girls' answer model

As students works model present in Figure 1 and 2 above, it is obvious that the first and second question are asnwered using procedure and numbers operation. The answer of the first question use the procedure of numbers operation like (a) addition, (b) multiplication and (c) subtraction. The thinking proces of the subjects in answering first and second question is called as meta-strategy procedural (Hejnyá et al., 2006)

Hence, the girls answer model as shown in Figure 2 looks comprehensible than the boys. Considering the mathematics theory, the boys perform incorrect answer, they write 81+ 47 ≠ 128 : 2, 64 ≠ 64 – 23. Yet, through interview, the boys emphasize their correct answer is 81+ 47 = 128 : 2 = 64= 64 – 23 in which they start by 81+ 47 = 128 then

128 : 2 =64, dan 64 – 23 = 41 and similar to 41+ 23 ≠ 64 : 2, 32 ≠ 46 – 32. It is obviously explained that the boys have different thinking to what they write while the girls draw their answer systematically and apply correct operations before writing the final results. Besides, as seen in works of both subjects, they have use some operation symbol like "+" for addition, ": " for division and " –" for subtraction as well as relation symbols "=" for equality. To use operation symbols and relation correctly, it is suggested to understand the problem and have previous knowledge. In other words, the subject of the study must involve previous knowledge and mathematical symbols relating to solve the problems.

Referring on students' answer model, the researcher conducted a depth interview that students prefer to design some planning before answering the questions so that the answer have passed some thinking and consideration. For example on the process of answering question number one, students simply write numbers operation of total candies in the red jar that is 81+ 47 and dividing by two. The result from dividing and subtraction of coffee flavor is 23. Meanwhile the implementation of the answer for number two there is difference with previous thinking, the results of dividing subtracted with the number of pinneaple flavor or 32 – 46 becomes number of pineapple flavor subtract with the result of multiplication or 46 – 32. The boys believed that the answer for number two must not be minus but there is no clear reason why it shouldn't be minus. In line with boys, the girls also agree that the pineapple flavor is 46 greater than the result of division or 32. If the division numbers subtract with pineapple flavor or 32 – 64, then the results is minus though the answer for number two must not be minus. If the result is minus means there is no melon flavor, yet it is.

It could be concluded that in solving the word problems, the girls always think about their understanding problem that the boys do not apply either. It is obvious the boys meet difficulties when trying to answer question number two. More to the point, both boys and girls can define information they use as well as clear reason and purpose on deliberating the use of addition, division and subtraction to correctly answer question number one. Similar to question number two, the subjects mention a lot of information to decide the use of operation arithmetic, understand the purpose of conducting the operations of addition and subtraction, and using division though the answer as well as the reason is not completely correct. The researcher, then, identifies that students did incorrect answer for question number two is because they feel hard to understand "not more than" phrase. They understood the phrase by applying dividing operation or division by 2.

Thinking process of boy and girl in solving word problems is to make the planning problem-solving as well as to understand the purpose and reason for doing arithmetic operations. However, the girls tend to be a better planner than the boys in solving word problems by defining the steps to solve the problems then clarifying the purpose and reason to use arithmetic operation. Both subjects correctly answer of first question. According to Stephens and Wang (2008), this type of subject thinking process is categorized as establish model, that is understand what to do and why it was done. Meanwhile, in answering the second question, students correctly define the information

is used, they still meet difficulties on how to know the purpose and reason to use arithmetic operation. This type of thinking process called *consolidation* type (Stephens and Wang, 2008). This type as same as boys student with moderate-ability (Baiduri, 2014).

4. Conclusion

Thinking process of the boys in understanding the problem are (1) answering question by selecting appropriate operations numbers, (2) seeing what to ask, (3) seeing what to know, (4) understanding "important" words or phrase and (5) applying mathematics notation. Meanwhile, the thinking process of the girls are (1) understanding what to know, (2) understanding what to ask, (3) understanding "important" words or phrase and (4) applying mathematics notation. Yet, both subjects still hard to decide appropriate important words or phrase and use mathematical notation when defining a problem. Thinking process of both boys and girls in solving word problems is to make the planning problem-solving as well as to understand the purpose and reason doing arithmetic operations. Both still have difficulty in knowing the purpose and reason for doing arithmetic operations. Hence, drawing mistakes on interpreting important words or phrase of particular problem will cause fatal answer in problem solving. Being able to detect core problem is an influential part of problem solving to deal with the complexity of problems.

This study is limited on elementary school students who have low-level achievement in mathematics specifically with word problem. Thus, detecting thinking process of elementary students could be revealed to determine moderate and high achievement not only for elementary level but also in secondary even in university level by promoting different level of problem solving task.

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