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An analysis of elementary school students' difficulties in mathematical problem solving

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Abstract

The main purpose of mathematics teaching is to enable students to solve problems in daily life. Unfortunately, according to the latest national test results, most students lack mathematical problem solving skills. This proves to be one of the reasons why overall achievement in mathematics is considered quite low. It also reflects that students have difficulties in comprehending mathematical problems affecting the process of problem-solving. Therefore, in order to allow teachers to establish a proper teaching plan suitable for students' learning process, this research aims to analyze the difficulties in mathematical problem solving among elementary school students. Samples are divided into two groups, elementary school students and mathematics teachers. Data collection was conducted by structured interview, documentary analysis, and survey tests. Data analysis was conducted by descriptive statistics, and content analysis. The results suggest that there are several difficulties in problem solving, namely 1) Students have difficulties in understanding the keywords appearing in problems, thus cannot interpret them in mathematical sentences. 2) Students are unable to figure out what to assume and what information from the problem is necessary to solving it, 3) Whenever students do not understand the problem, they tend to guess the answer without any thinking process, 4) Students are impatient and do not like to read mathematical problems, and 5) Students do not like to read long problems. Therefore, the results found in this research will lead to the creation and the development of mathematical problem solving diagnostic tests for teachers, in order to improve students' mathematical problem solving skills.

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1. Introduction

Mathematics plays a big role in developing human thoughts, bringing strategic, systematic reasoning processes used in problem analysis and solving. It helps people to be able to anticipate, plan, decide, and properly solve each problem in daily life. Mathematics is also a tool to study technological sciences and such. Thus mathematics is useful to our living, helping to improve the quality of life (The Basic Education Core Curriculum, 2008). Moreover, the National Council Teachers of Mathematics (2012) stated that problem solving skills are the main expectation of mathematics subject. On the other hand, the main purpose of mathematics teaching is to enable students to solve

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daily life problems. Hence, it can be said that mathematics is a tool to train students to be able to solve problems, and to build thinking processes that lead to further ability to solve non-mathematical problems.

In Thailand, the results of the national examination on mathematics achievement of nationwide sixth grade students between 2007-2009 shows that most students are in an improvement-needed level (NIETS, 2012). The analysis of the O-NET examination for students in grade 6 suggests that mathematical problems in the examination consist of both symbolic and long text problems. According to the results, most students have difficulties in applying their mathematical knowledge into solving problems, especially in text-based problems that need comprehension skills in addition to mathematical thinking processes.

Many scholars have studied mathematical problem comprehension. Bruckner and Grossnickle (1947), Suydam and Weaver (1977), and West (1977) have studied difficulties affecting mathematical problem solving. The biggest obstacle is the lack of reading, computational and mathematics skills. When students cannot understand what the text implies, they cannot start the thinking process to solve the problem. Students know only limited keywords or technical terms. They lack interest in mathematical problems, due to the problems length and complexity. Some the problems' scholars also studied the relationship between reading comprehension and mathematics achievement, such as Helwig et al. (1999), Fuchs et al. (2000). A study of indicators affecting mathematics study shows that a key factor is reading. (Lamb, 2010; Jiban & Deno, 2007)

From all the above mentioned, reading comprehension, computational and mathematics skills are key factor to solving mathematical problems. In order to solve a mathematical problem, students need reading skills, especially reading comprehension and text analysis. Therefore, the researcher is interested in conducting a study on difficulties in mathematical problem solving among elementary school students, to be a guideline for teachers and associated people to create the proper method of mathematics teaching that is suitable for students. This will lead to further development of tools used to analyze student's mathematical problem solving difficulties.

1.1. Research question

What are the difficulties for elementary school students in mathematical problem solving?

1.2. The purpose of the study

To analyze the difficulties for elementary school students in mathematical problem solving.

2. Mathematical problem solving

2.1. The definition of mathematical problem

This section is going to introduce the definition of “mathematical problem”, which several mathematics educators have already attempted to define as follows.

Anderson & Pingry (1973) suggest that a mathematical problem is a situation or a question that requires the answer in the form of a quantitative or numerical answer. In order to solve the given problem, you need to find the right method for the situation, using knowledge and experience.

Adam et al. (1977) suggest that a mathematical problem can be defined as a word problem, a story problem, or a verbal problem. It is a description of a situation, in words or in figures, that requires a quantitative or numerical answer. You have to find a way to solve it.

Cruikshank & Sheffield (1992) suggest that a mathematical problem is a mathematics-related question or a situation, but is not only related to figures. It is possible that some mathematical problems involve physical properties or logical reasoning, not relating to numbers at all.

Therefore, a mathematical problem in this study means a mathematics-related question or situation that highly varies. It is a real situation seen in real life which requires a proper method and mathematical knowledge in order to be solved.

2.2. Reading and mathematics

The importance of reading skills to mathematics has been studied in several aspects, like the interrelation between reading and mathematics achievement. It shows that these two things are highly interrelated. It can be said that the better their reading skills are, the more students can understand text-based mathematical problems, leading to greater mathematics achievement (Helwing et al., 1999; Fuchs et al., 2000). There are also studies on indicator affecting mathematics achievement that suggest reading skill is a significant indicator to the achievement (Lamb, 2010; Jiban & Deno, 2007). Walker et al. (2008) found that reading difficulties have a significant impact on students with low mathematics achievement.

2.3. Difficulties affecting mathematical problem solving

Difficulties affecting mathematical problem solving can be classified as; 1) Students cannot understand the whole or some parts of the problem due to the lack of imagination and experience needed to consider the problem. 2) Students have difficulties in reading and comprehension, unable to understand what important information is in a problem and organize it accordingly. Thus they cannot invert the text into mathematical symbols. 3) Students lack interest in solving mathematical problems due to the length and complexity of the problems, which is demotivating. (Bruckner & Grossnickle, 1947; Suydam & Weaver, 1977; West, 1977; Sombat Phothong, 1996). 4) Teachers do not present daily life matters as problems very often. 5) Teachers are likely to make students memorize "keywords" in the problems to use in formulae. 6) Teachers focus on following examples given in textbooks rather than teaching the principles behind each problem. 7) Teachers teach without concern with thinking process orders. (Uthai Petchuay, 1998)

2.4. Mathematical problem solving process

Mathematics educators studied the process of solving mathematical problems and found that there were different processes as described in Table 1.

Table 1. Mathematical problem solving process

Polya (1973)	Leblance (1977)	Krulik & Rays (1980)	IPST (2011)
1. Understanding the problem	1. Understanding the problem	1. Understanding the problem	1. Understanding the problem and analysis
2. Devising a plan	2. Choosing a way to find the answer	2. Devising a plan	2. Devising a plan
3. Carrying out the plan	3. Solving the problem	3. Carrying out the plan	3. Carrying out the plan
4. Looking back	4. Looking back	4. evaluation	4. evaluation

3. Methodology

3.1. Participants

As this research is an analysis of mathematical problem solving difficulties among elementary school students, in order to produce more obvious and accurate results, the population was separated into 2 groups; mathematics teachers of grade 5 and 6 and students in the same grade. Samples consist of 10 teachers, 2 males (20%) and 8 females (80%) and 98 students, 50 males (51.02%) and 48 females (48.98%)

3.2. Instruments

Instruments used in this research consist of a structured interview on mathematical problem solving difficulties that is used to interview mathematics teachers, and a written survey test, similar to an O-NET test, which was used to evaluate students.

3.3. Data analysis

The data analysis was done through descriptive statistics and content analysis, using content interpretation to draw conclusions about the situation from an analysis of mathematical problem solving-related documents, interviews, and data from survey tests.

4. Results

4.1. The result of the mathematics teachers

The result of the analysis of problem solving difficulties taken from the interview of mathematics teachers shows that, 1) Students cannot read text or have difficulties in reading, leading to difficulties in mathematics problem solving, 2) Students always misinterpret the text, 3) Students dislike long problems, 4) When students do not understand a problem, they are like to make a guess without using any mathematical thinking process, 5) Students are impatient and do not like to read problems, 6) Students are unable to figure out what to assume and what information from the problem is necessary to solving it, and 7) Students have difficulties in understanding the keywords appearing in problems, thus cannot interpret them into symbols.

Teacher A: “...Some students cannot read the problem very well, cannot understand the problem, are unable to interpret and make mistakes in symbolic formulae. Some students see the words in the problem but are unable to figure out whether they need to plus, minus, times, or divide. Some do not even know how to start solving a problem. They do not know what information they need to use...”

Teacher B: “...Students do not know how to solve a problem. Sometimes they cannot interpret the problem, not understand it, and make a wrong symbolic formula...”

4.2. The result of the elementary school students

The result of formula writing survey test by students shows that 1) Students do not understand what the problem asks, 2) Students often make mistakes in writing mathematical sentences, 3) Students have difficulties in interpreting keywords in problems, such as "Distribute", which is meant to be to divide in some problems, but they interpret it as minus, 4) Students are sometimes careless when they read problems, such as when most of them mistake "How much money did the Nadech have previously?" and answer the problem as if they think it asks "How much money does the Nadech have now?" which is totally different, 5) Students' process of solving problems is not well-organized. They cannot write an orderly process as described in Table 2.

Problem: Nadech has an amount of money. After he distributes it among 4 children, 1,250 baht each, he still has 4,000 baht left. How much did he have previously?

Answer: What the problem asks ... "How much did Nadech have previously?"
Mathematical Sentence ... $(4 \times 1250) + 4000 = \square$

Table 2. A sample from elementary school students' survey test on problem solving difficulties.

Student	What the problem asks	Symbolic Formulae
1	Money Nadech has	$(4 + 1250) + 4000 = \square$
2	How much did Nadech have previously?	$1250 \times 4000 = \square$
3	How much did Nadech have previously?	$(1250 - 4) + 4000 = \square$
4	How much will Nadech have?	$(4 \times 1250) + 4000 = \square$
5	Distributes money to 4 children, 1,250 each, has another 4,000. How much did he have previously?	$(4 \times 1250) + 4000 = \square$

The analysis result of problem solving-related documents and research, the interview of Prathom 5-6 mathematics teachers, and students' survey test shows that 1) Students do not like to read very long problems, 2) When students do not understand a problem, they are like to make a guess without having any mathematical thinking process, 3) Students are impatient and do not like to read problems, 4) Students are unable to figure out what to assume and what information from the problem is necessary to solving it, and 5) Students have difficulties in understanding the keywords appearing in problems, thus cannot interpret them into symbols. These findings are important to students' problem solving process.

5. Conclusions and discussions

5.1. Conclusions

This research aims to analyze mathematical problem solving difficulties among students in grade 5 and 6. It is found that students' mathematical problem solving difficulties are namely, 1) Students have difficulties in understanding the keywords appearing in problems, thus cannot interpret them into mathematical sentence. 2) Students are unable to figure out what to assume and what information from the problem is necessary to solving it, 3) Whenever students do not understand the problem, they tend to guess the answer without any thinking process, 4) Students are impatient and do not like to read mathematical problems, and 5) Students do not like to read very long problems. These findings are important to students' problem solving process and it will lead to the development of mathematical problem solving diagnostic tests.

5.2. Discussions

Findings from the analysis of mathematical problem solving difficulties among elementary school students suggest that students do not like to read very long problems. When students do not understand a problem, they are like to make a guess without having any mathematical thinking process. This result is in accord once with the studies of Lamb (2010) and Jiban & Deno (2007) that states that the level of reading skill is a significant indicator to mathematics achievement. In the same way, a study of Sombat Phothong (1996) says that students lack analytical and reading skills, and are unable to analyze the problems given. They also lack mathematical thinking processes. Another study of Bruckner & Grossnickle (1947) that says students lack interest to do mathematical problems because they are too long and complex, hence not motivating students to feel like doing them.

Another finding shows that when students do not understand a problem, they are likely to make a guess without using any mathematical thinking process, and are unable to figure out what to assume and what information from the problem is necessary to solving it, and have difficulties in understanding the keywords appearing in problems thus cannot interpret them into symbols. This is in accord with Bruckner & Grossnickle (1947) who say students cannot understand what the text implies, and cannot start the thinking process to solve the problem. Students know only limited keywords or technical terms. This also supports Suydam & Weaver (1977) who say the reason why students do mathematical problems wrong is because they lack knowledge about principles, rules, and processes. Calculation and comprehension skills are also lacking. Thus they cannot interpret the meaning of some words correctly and fail to catch smaller details. This research still goes along with a study by Uthai Petchuay (1998) that claims teachers tend to make students memorize only "keywords" in problems just to make formulae.

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