

## **Solving Word problems with Literacy Activities: Investigation of Changes in Two Mathematics Teachers' Practices**

Okuma-yazma aktiviteleriyle dört işlem problemlerini çözmek:  
İki matematik öğretmenin uygulamalarındaki değişikliklerin  
incelenmesi

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### **ABSTRACT**

*This case study discusses the prior experience of two mathematics teachers in solving word problems; the relationship between literacy activities and word problems; attitudes of the teachers toward the word problems and literacy activities in mathematics classroom; and variables that affect how well the students can learn to solve the word problems in mathematics classroom. This study concentrates on whether there is a different type of literacy necessary for success in mathematics beyond comprehension. In other words, the focus will be on whether a student's reading skill develops differently if the student is also developing a mathematical literacy. Finally, discussion will center on importance of using literacy activities in mathematics classroom and mathematical literacy.*

**Key words:** word problems, problem solving, mathematics, literacy activities

### **ÖZET**

*Bu durum çalışması iki matematik öğretmenin dört işlem problemlerindeki deneyimlerini; dört işlem problemleri ve okuma-yazma aktiviteleri arasındaki ilişkiyi; öğretmenlerin matematik sınıfında dört işlem problemlerine ve okuma-yazma aktivitelerine olan davranışları ve matematik sınıfındaki öğrencilerin dört işlem problemlerini daha iyi nasıl çözebileceklerini etkileyen değişkenleri tartışır. Bu durum çalışması matematik için gerekli olan anlamının ötesinde, okuma-yazmanın dışında*

*farklı bir aktivitenin olup olmadığını merak eder. Diğer bir değişle, çalışmanın odak noktası bir öğrencinin okuma- yazma kabiliyeti gelişirken aynı öğrencinin matematiksel okuma-yazmasının gelişip gelişmediği üzerinde olacaktır. Sonuç olarak, tartışma matematik sınıfı ve matematiksel okuma-yazma içinde okuma-yazma aktivitelerinin kullanılmasının önemi üzerinde merkezlenecektir.*

**Anahtar Sözcükler:** dört işlem problemleri, problem çözme, matematik, okuma- yazma aktivitesi

## 1. Introduction

An important emphasis of the NCTM Curriculum and Evaluation Standards for School Mathematics (1989) is an urgent call to return context to mathematical learning. One effective strategy for restoring context to mathematical ideas is the use of children's literature. Most researchers attempted to model good problem solvers as those who can solve the problems. Kintsch & Greeno (1985) tried to enable students to comprehend the problems in a more top-down manner by fitting problems into one of the schematic structures. However, it did not help why so many children have trouble with elementary story problems. Hudson (1983) tested the hypothesis that linguistic deficiencies limit young children's understanding of word problems by asking them to both solve and recall the problems. Similarly, Reed (1999) argued and focused on whether a word problem is to be solved first or recalled first until after the problem had been read. Moreover, Souviney (1984) argued that students must get the relevant information from irrelevant information before a clear understanding of the problem itself arises.

In most textbooks, the class of problems commonly is presented as "story" or "word" problems. In this paper, I will use the same meaning for these two terms. Moreover, problems can be defined into two general categories: word problems and process problems. Word problems are generally presented in a convergent manner. They require the students to read with understanding, the written form of the problems and decide which operations must be applied to values in the wording of the problems.

Research shows that the ability to solve word problems successfully is related to the students' level of literacy activities (in this paper, literacy activities refer to reading and writing). However, it is not very clear in literature whether reading is only factor in improving to solve word problems. Moreover, at which grade this relationship between literacy and word problems is important? For example, Reed (1999) supported the existence of a relationship between the comprehension of language and the development of mathematical ideas and skills at elementary (early secondary) level. He defined three categories of language development: language comprehension, concept formation and mathematical symbolism. He argued that comprehension of the text becomes more important during the early stages of mathematical development. In other words, comprehension of English decreases at more advanced levels requires language of mathematical systems.

NCTM (1989) encouraged teachers to integrate the domains of reading into mathematics classes with the inclusion of Standard 2: "Use the skills of reading, listening, and viewing to interpret and evaluate mathematical ideas" (p.78). It seems clear that with systematic structure and instruction, the process of integrating literacy and mathematics keep students motivated and successful. However, the literature does not say exactly how the literacy activities and mathematics can be integrated at all levels as students write, read and discuss word problems. Especially, in terms of teachers' perspectives and practices in the classroom environment, it is not clear how problem writing and problem reading can provide stimulating learning situations in mathematics classroom for students' success.

In this study, I seek to examine the issues related to literacy activities in solving word problems in terms of mathematic teachers' perspectives. This case study attempts to explore whether the ability to solve word problems are affected by prior experience of students' literacy activities and willingness to use literacy activities for word problems. It has been suggested that while mathematics teachers present the word problems, it is very crucial to set up a dynamic support that enable students' success in solving them (Melser & Leitze, 1999; Souviney, 1984). It is obvious that the nature of the word

problems is very different since they include long verbal sentences and requires the levels of language comprehension, the numerical content and the complexity of the problem. This case study discusses the prior experience of two mathematics teachers in solving word problems. This is followed by the teachers' experiences and their perspectives on word problems and literacy activities in mathematic classroom. My discussion of the findings focuses on teaching differences and then instructional practices of the teachers that may be related to solving word problems. Specifically, I address the following research questions:

1. What are the mathematics teachers' beliefs about using literacy activities/techniques in solving word problems?
2. How the ability to solve word problems is related to the students' literacy activities/techniques?
3. How does mathematical literacy differ from reading literacy?

## **2. Method**

### **2.1. Participants**

Two mathematics teachers were selected based on their teaching experience in mathematics classes and other teaching experiences like tutoring. In this study, I used purposive sample. These teachers were selected because they teach mathematics at different levels. While Ms. Brown teaches middle grade mathematics, Mr. White has 10 years experience at high school level and good experience at college level tutoring. This kind of diversity would enable researcher to understand participants' beliefs about word problems in terms of nature of the research questions. Second, the aim is to compare and contrast these two mathematics teachers at different levels and try to find a working relationship between word problems and literacy activities.

### **2.2. Design and Data Collection**

This case study was divided into two sections: interview section, follow up email section. For the first section, I made an interview (see Appendix) with Ms. Brown and

Mr. White about word problems. Also, the interview included their beliefs about using literacy activities in word problems. Some questions directly focused on their own opinions toward word problems. For example, “Do you believe that students who are successful with literature classes will be more successful with solving word problems?” My purpose was to understand Ms. Brown’s and Mr. White’s literacy experiences in the context of solving word problems. Second phase was a follow up email for two teachers. This was needed in order to make clear some ambiguity within answers and try to understand what the teacher means exactly about some questions. Some questions (e.g., “What are some ways that students can solve word problems more efficiently?”) were generalizable questions for all mathematics teachers through this case study. By doing that, I tried to capture some common answers to examine how mathematics teachers’ attitude might be similar or different from each other. The time of the each interview was planned before.

### **2.3. Data Analysis**

#### *Ms. Brown and Mr. White*

Compared to Mr. White, Ms. Brown was a new middle-grade teacher and did not have so much experience in full-time teaching. During the interview, she mentioned several times she did not have actual experience which she can draw from, but she indicated that she was answering the questions based on her student-teaching experience with a 7<sup>th</sup> grade class she worked with. However, Mr. White did spend most of his teaching at a private Christian school. Also, he taught pre-algebra to 6<sup>th</sup> and 7<sup>th</sup> graders; consumer math to 10<sup>th</sup> and 11<sup>th</sup> graders; and algebra II to 11<sup>th</sup> and 12<sup>th</sup> graders at a Christian Academy. Currently, he is a tutor at a Community College working one-on-one with students needing help with the subjects of Remedial Math, Algebra I, Algebra II, Pre-Calculus, and Discrete Mathematics.

In her responses on the email and in her discussions, Ms. Brown has seemed more informative and insightful. She thinks proper use of language in the wording of a problem is important. It must be very clear what the question is asking, so that there’s

no ambiguity. However, she believes knowledge process in word problems is independent from literacy activities. She believes that people think according to the structure and syntax of our language, and we do it subconsciously, for the most part. We interpret a question and give an answer based on our familiar language structure. However, for mathematical word problems, she indicated that although cultural context used within a language can impact our understanding of a problem, reading skills and understanding literature and solving word problems are not strongly correlated. In other words she mentioned:

I think the skills needed for reading and understanding literature are not significantly related to solving word problems. For word problems, you must know how to read and you must understand the language, but then you must apply your mathematical knowledge/understanding. Reading and analyzing literature requires a different set of skills.

Ms. Brown generally favors a clear distinction for word problems in terms of using literacy; because from her explanations, it seems clear that students who are successful with literature classes might not be more successful with solving word problems. She expresses the importance of using symbolic language in mathematics that according to her, this is totally different structure, and she finds it much easier than written math words. Her feelings about using literacy in word problems as follows:

Some [the students] may, some may not. It depends how they are oriented toward learning, for example visually oriented vs. language oriented. Also, students who are not mathematically oriented may find it easier to understand “math written with words” rather than symbols. I find symbols much easier.

According to her, there are some differences between literacy activities and written word problems. She thinks literacy activities are only the first step for word problems. However, when it comes to solving word problems, the students need some kind of application of the rules and procedures that are needed to find the correct answer for the problem. Finding the solution is the ultimate goal for solving problems and it does not

require only comprehension of the problems. This contrasts her situation with Mr. White that there are some differences between her approach toward word problems and Mr. White's approach. She generally defines mathematics as a symbolic system. What she means by symbolic system is that she tries to define a kind of representational approach for mathematics. She sees mathematics as a kind of graphical/symbolic/visual representational system, while literacy as oral/verbal system. She thinks getting familiar with word problems are very crucial for middle grade students to see their growth mathematically.

In her class, she gave an example that if she simplifies the language so that students can understand better, it may be helpful. However, if she simplifies too much it may change the meaning of the question. The students need to learn mathematical vocabulary in her class, and this is usually where they have difficulty with word problems. There is not this kind of clearness in Mr. White's situation, because, to his understating, having a background of 10 years in the teaching helped him to decide that to his knowledge, his students' reading and verbal skills were not an issue in the classrooms. During the interview and also follow-up email, he kept saying that he does not have much experience to use literacy activities in high school and college level mathematics. However, Ms. Brown clearly stated three aspects about reading and problem solving abilities. She pointed out:

I don't think reading and problem solving abilities are so much related. If a student can read and understand the language of a word problem, they should be able to [attempt to] solve it provided they have a certain level of mathematical understanding required/expected from that particular problem. I know many students who are very good readers but not very good at word problems because: (a) they don't understand the math vocabulary [i.e. they don't know what the question is asking]; (b) they get confused when they see a math problem in words rather than symbols [they don't know how to process it and make sense of it]; and (c) they simply don't know how to do the math!

Ms. Brown appeared to see the role of literacy activities as a kind of external factor to students' existing learning for word problems that this factor actually has nothing to do with mathematical skills and mathematical comprehension. She believes that every single student would best learn mathematics by having some kind of mathematical understanding and mathematical vocabulary. Her judgment comes from her class practices that students also would need some memorization at the beginning of the development of mathematical skills rather than having literacy practices. Throughout the interview, her expectations about students' achievement were quite clear, and these expectations show that literacy activities are part of the solving word problems. She mentioned:

They should translate the words into symbols and set up the problem in mathematical language. This is what I do, and what I tell my students to do (although most don't listen to me). I tell them to first write down everything they know [information given by the problem, and related formulas, relationships, understandings] and then re-read the question to make sure you understand what it is asking. Then set up an equation and/or try to find relationships. Solving the problem should then become more apparent.

Two mathematics teachers at different grades, occasionally, gave similar tasks that students are supposed to do in order to be successful in solving word problems. Mr. White also thinks that in order to solve word problems very efficiently, students have to focus on the relationships among the sentences after reading the problem. He indicated, "I find that helping student write down numbers, expressions, and diagrams from within the word problem helps them understand what is being asked of them."

Table 1 The process of Solving Word problems

<i>Ms. Brown</i>	<i>Mr. White</i>
<i>Read the question</i>	<i>Read the question</i>
<i>Write the information given by the question</i>	<i>Write numbers, expressions, etc.</i>
<i>Relate formulas, relationships</i>	<i>Focus on key words (and, or, less than)</i>
<i>Re-read the question</i>	<i>Try to understand what is being asked for</i>
<i>Try to understand what it is asking</i>	

Based on the similar ideas (of Ms. Brown and Mr. White), this study suggests that mathematical literacy, mostly, is based on students' understanding and finding the patterns/relationships between different written sentences (Table 1). In this structure, other literacy activities like reading and writing play a partial role. According to Mr. White, the students need help to write the numbers and find the expressions when a word problem is given. In other words, he emphasizes the importance of finding number sentences in word problems. This idea is different from Ms. Brown's situation. Mr. White generally preferred to talk about his own tutor experiences and seemed comfortable doing that. He mostly emphasized that there is strong relationship between reading and solving word problems. Although his beliefs were quite clear, I could not get so much information from his own experiences; because he seemed to need more time to remember, indicating that in high school mathematics it is difficult to find this relationship. Thus, he preferred to give very broad ideas. He said, "I find that students' ability to decipher word problems is directly related to their reading ability. If they cannot read well, they have difficulty with word problems."

However, what is clear about his own teaching methods that he does not use literacy activities in his teaching, although he believes that this relationship is important. As indicated by Ms. Brown, he also thinks that students need to focus on expressions/key words and numbers in word problems and synthesize them together to solve the problem successfully. He said:

As a tutor, I do not use formal literacy activities to increase students' ability to do word problems. With word problems, I have the student focus on keywords (sum, difference, product, greater than, etc.) to increase their comprehension of what the question asks for.

Word problems include some key points/ideas that students have to separate them very carefully. Therefore, as both teachers indicated, reading the word problem would not be enough to move on to next step. Students are supposed to link these ideas together and find a working relationship in order to find a meaningful solution. These are the key issues how mathematical literacy differs from reading literacy.

At this point, a question can come to mind. Do solving word problems have to be related to literacy activities? Is that always the case? As Mr. White indicated, students might be successful at solving word problems if their reading and writing abilities are quite well. That is the question this case study is trying to examine. But what students need more is that they need more decoding and analyzing the word problems, although there is a relationship between word problems and reading. For example, some teachers (like Mr. White) would expect a strong correlation between the two. Students who succeed in literature class may also succeed with word problems. That may be due to their ability to decode the question, but it may also be their facility with mathematics in general.

One thing is clear that literacy activities do not provide direct support for the hypothesis that linguistic activities produce the strong correlation/relationship between correct recall and correct solutions for word problems. As two mathematics teachers pointed out, perhaps children (especially young children) simply lack the schematic structures for the word problems and this prevent both recall and solution of these problems. As was seen in both teachers' situation, appropriate structures (numbers, expressions etc.) in word problems help students to recall text and solve the problems.

### **3. Discussion**

Based on two mathematics teachers' beliefs about word problems, this case study suggests that it is essential for students to be able to read problems. Reading and writing can provide context and motivation as well as receiving and sharing information. However, it is not enough to read and understand the word problems. To identify relevant and irrelevant information, and organize information in such a way will allow students to develop successful solution strategies. At this point, students need application of mathematical skills and mathematical knowledge to solve the problems.

Sometimes, two teachers' experiences with word problems conflicted with each other in terms of their teaching experience and attitudes toward the word problems. But, from their informative suggestions, it seems clear that children's' ability to solve and analyze

the word problems start with the skills required for reading the problems. From this case study, it is hard to determine how literacy activities play important role in different grades. As suggested by literature, the importance of literacy activities seems more important in middle-grade level. Based on two mathematics teachers' own experiences, mathematical literacy seems different than reading literacy in all grades. That is the consensus two teachers agreed on. This consensus supports the idea of Reed (1999) that students need part-whole, transfer, and more-less schemas that are needed to solve word problems. Although understanding linguistic terms can contribute to the difficulty of children's comprehension of word problems, it would be misleading to blame all errors on linguistic activities. As indicated by this case study, some researchers (e.g., Okamoto, 1996; Littlefield & Rieser, 1993) suggest mathematical knowledge/mathematical vocabulary determines the relative difficulty of word problems. Keeping this fact in mind, in terms of mathematical literacy, understanding word problems also requires constructing a problem that focuses the part of the written text that is required to solve the problem.

The analysis of Ms. Brown's and Mr. White's experiences with solving word problems reveals different factors that may contribute students' difficulty with solving word problems. In this sense, reading and understanding the word problems seems the first step. After that, a mathematical procedure, such as an arithmetic or algebraic procedure, is needed to solve the problem. In this process, while reading the word problems, students need to get the necessary information from the text and use this information to plan the arithmetic computations necessary to solve the problem.

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## Appendix

1. I just wonder if you can give me some background information. How long have you been teaching? Which grade? Or do you have other teaching experiences?
2. From your own teaching experiences, can you tell me that there is not actually a strong
3. Is the processing of knowledge in word problems dependent on a student's language system?
4. Do you believe that students who are successful with literature classes will be more successful with solving word problems?
5. Do students find linguistically simpler items easier to comprehend in mathematics compared to symbolic systems?
6. Does modifying the linguistic structures in math affect students' performance in word problems?
7. What is the nature of interaction between students' reading abilities and problem solving abilities?
8. What are some ways that students can solve word problems more efficiently?