



## The Relationship Between Reading Comprehension Competence and Word Problem Comprehension Among Third-Grade Students

Birce Başol<sup>1</sup>, Serkan Özel<sup>2</sup>, Z. Ebrar Yetkiner Özel<sup>3</sup>

<sup>1</sup>Boğaziçi University, The Institute for Graduate Studies in the Social Sciences, Primary Education, bircebasol88@hotmail.com

<sup>2</sup>Dr., Boğaziçi University, Primary Education Department, Faculty of Education ozels@boun.edu.tr

<sup>3</sup>Assist. Prof., Fatih University, Department of Educational Sciences, Faculty of Education, zeyetkiner@hotmail.com

### Abstract

This study is designed to investigate the relationship between reading comprehension and word problem comprehension. Participants were third grade students selected using convenience sampling from three different schools in Istanbul: two public schools ( $n = 68$ ) and a private school ( $n = 58$ ). All participants were administered two reading comprehension tests (RCT-I and RCT-II) and one word problem comprehension test (WPCT). Both RCT-I and RCT-II had positive correlations with WPCT for the whole sample ( $r = .46$  and  $r = .51$ , respectively). The relationships between RCT-I and RCT-II and WPCT for females ( $r = .62$  and  $r = .68$ , respectively) were stronger than for males ( $r = .35$  and  $r = .39$ , respectively). Although both RCT-I and RCT-II had strong positive correlations with WPCT for public-school students ( $r = .78$  and  $r = .70$ , respectively), the relationships were quite small for private-school students ( $r = .22$  and  $r = .12$ , respectively). In addition, results showed 31% of the variance in word problem comprehension was explained by reading comprehension.

**Keywords:** Reading comprehension, word problem solving, third graders

### Özet

Bu çalışmada, okuduğunu anlama ve sözel matematik problemlerini kavramadaki başarı arasındaki ilişki araştırılmıştır. Katılımcılar İstanbul'daki üç farklı okulundan seçilmiştir. Bunlardan ikisi devlet okulu ve diğeri bir vakıf okuludur. İki okuduğunu anlama testi ve bir matematik problemlerini kavrama testi 126 üçüncü sınıf öğrencisine uygulanmıştır. Bunların 68'i devlet ve 58'i vakıf okulu öğrencileridir. Örneklemin tümüne bakıldığında kurgusal okumaları kavrama testi (RCT-I) ve kurgusal olmayan okumaları kavrama testi (RCT-II) ile sözel matematik problemlerini kavrama testi (WPCT) arasındaki pozitif ilişkiler bulunmuştur ( $r = 0.46$  ve  $r = 0.51$ , sırasıyla). İlişki cinsiyet bazında incelendiğinde RCT ile WPCT'ler arasındaki ilişki kızlar ( $r = 0.62$  ve  $r = 0.68$ , sırasıyla) arasında erkeklere ( $r = 0.35$  ve  $r = 0.39$ , sırasıyla) göre daha kuvvetli bulunmuştur. RCT-I ve RCT-II ile WPCT arasındaki ilişkiler devlet okulu öğrencileri için güçlü olmasına karşın ( $r = .78$  ve  $r = .70$ , sırasıyla) özel-okul öğrencileri için çok düşük bulunmuştur ( $r = 0.22$  ve  $r = 0.12$ , sırasıyla). Son olarak yapılan çoklu regresyon analizinde WPCT başarısının %31'nin okuduğunu kavrama yetisi ile açıklandığı bulunmuştur.

**Anahtar sözcükler:** Okuduğunu kavrama, sözel matematik problemlerini kavrama başarısı, üçüncü sınıf öğrencileri



The purpose of this quantitative non-experimental research study was to investigate the relationship between reading comprehension and word-problem comprehension among third-grade students. The rationale for this study was students' low mathematics performances, more specifically their difficulties with word-problem solving, on university entrance tests (Aksu, 1997). Because students start to solve complex mathematical problems at third grade, this study examined how reading comprehension competence was related to word-problem comprehension of third graders.

In their report, Naismith, Lonsdale, Vavoula, and Sharples (2004) defined learning from constructivist perspective as “an active process in which learners construct new ideas or concepts based on both their current and past knowledge” (p. 3). This study was conducted to understand the active process in terms of the relationship between reading comprehension and word problem comprehension. The aim of the current study was twofold: (a) examine the relationship between reading comprehension and word problem comprehension and (b) investigate how the relationship between reading comprehension and word problem comprehension differed by gender and school type.

One of the variables in the current study was achievement. Underachievement is defined as academic inadequateness in school period and national tests. Grimm (2008) investigated cross-lagged relationship between reading comprehension in third grades and mathematics achievement from third through eighth grades. Grimm defined three components of mathematics achievement as (a) problem solving and data interpretation, (b) mathematical concepts and estimation, and (c) mathematical computation. However, in the current study, only problem solving achievement was examined because Grimm stated the most effective changes were seen in problem solving with respect to reading comprehension. Grimm's study showed that early reading skills had a great impact on mathematics achievement, especially on problem solving. Surprisingly, the effect of reading comprehension on problem solving was higher than the effect of early mathematics achievement on problem solving (Grimm). Furthermore, reading comprehension had its highest effect on problem solving achievement among the three components of mathematics achievement in Grimm's study.

Reading comprehension was another variable in the current study. In this study, reading comprehension means to understand the situation and what is implied in it in a question and know what is expected from the reader. Understanding what is being asked is very important in mathematics in order to solve a problem. In Abedi and Lord's research (2001), students' test performances on word problems were examined by doing linguistic modifications on problems in order to understand the differences in achievement between English language learners and proficient speakers of English. According to Abedi and Lord, English language learners had significantly lower scores than students whose mother tongue was English (Abedi & Lord). Abedi and Lord showed how language component and background were important for problem solving achievement. Abedi and Lord also indicated that after they applied some language modifications on test items, English language learners were affected much more than proficient English speakers.

In her study, Guerriero (2010) examined how selected linguistic components impacted performance at each stage of mathematical word problem solving among students with



different levels of achievement in computation. Guerriero indicated three steps of word problem solving as (a) comprehension, (b) equation construction, and (c) computation accuracy. She emphasized that difficulties in a particular step often had a significant effect on other steps of problem solving. Because comprehension of problem is the first step while solving problems, it is obvious how early reading comprehension is important for other steps. In support of Guerriero's finding, Vincent (2009) found that word problem solving was affected by a combination of reading, computation, and reasoning skills. Thus, Vincent concluded that if students did not comprehend a problem, they might not solve the problem. Vincent's research supported the research findings of Abedi and Lord (2001) in terms of the existence of a strong connection between language factor and problem solving achievement. Thus, comprehending problem was a very important and a prerequisite step for solving word problems in mathematics.

Some studies investigated the relationship between problem solving and reading comprehension students with learning difficulties. Fuchs, Fuchs, Carol, and Appleton (2002) examined how clear instruction of problem solving rules had effects on problem solving performances of students with mathematics disabilities. In order to understand how problem solving mechanism worked, Fuchs, Fuchs, and Prentice (2004) compared students with reading disability only (RDR only), with math disability only (MDR only), and students who suffered from both reading and mathematics disabilities (MDR/RDR). In Fuchs et al.'s (2004) study, students with MDR/RDR had lower scores than students with MDR only or RDR only. However, when MDR only and RDR only students were investigated, the effect size of the intervention was smaller for students with RDR only compared to the students with MDR only (Fuchs et al., 2004). Effects were investigated on three parts: understanding, computation, and labeling in solving problems (Fuchs et al., 2004). Computation part was affected the most in students who suffered from both reading and mathematics disabilities; moreover, when researchers compared MDR only and RDR only students, RDR only students had great difficulty in the comprehension part (Fuchs et al., 2004). When considering overall results, Fuchs et al. (2004) reported mathematical learning difficulties had higher effects on problem solving than reading comprehension difficulties did. Nevertheless, Fuchs et al.'s (2004) study showed that reading comprehension had a significant effect on problem solving for students with learning difficulties. In their further research, Fuchs and Fuchs (2005) implemented an extra intervention of small group tutoring in order to increase students' level of understanding of the problem. Their results indicated that understanding the problem had a significant impact on solving problem for both students with normal development and students with disabilities (Fuchs & Fuchs).

There is substantial research that supports the impact of language and reading comprehension on word problem solving. Moreover, the impact was found to be higher when the participants were students with reading disabilities. However, children, who are with normal development, still suffer from under achievement in mathematics. Problem solving is a basis not only for various mathematics topics but also for other interdisciplinary subjects. In the light of the current knowledge and previous research findings, the relationship between reading comprehension and mathematical word problem comprehension was investigated in the current study. The fact that research on this topic is nascent in Turkey increases the importance of the current study.



## Research Questions

The following research questions were examined in the current study:

1. What is the relationship between fiction- and non-fiction- reading comprehension and word problem comprehension among third-grade students?
2. What is the relationship between fiction- and non-fiction- reading comprehension and word problem comprehension among third-grade students, disaggregated by gender?
3. What is the relationship between fiction- and non-fiction- reading comprehension and word problem comprehension among third-grade students, disaggregated by the school type?
4. What is the relationship between reading comprehension, regardless of fiction- or non-fiction, and word problem comprehension among third-grade students?

## Method

### Participants

Participants were third grade students selected using convenience sampling from three different schools in Istanbul: two public schools ( $n = 68$ ) and a private school ( $n = 58$ ). The two public schools were similar in terms of physical environment, classroom sizes, student SES, and parental education. Students were mainly from middle- and low-SES families. The public schools were located in the same district and were very close to each other. Initially, 77 students were selected from the two public schools. However, nine of these students did not take at least one of the tests and so were not included in the analysis. In the public-school sample, there were 38 boys and 30 girls.

The private school in this study was very different from the two public schools in terms of physical environment, instructional materials, social opportunities, student SES, and parental background. Different from the public schools, the private school had a story lesson. Students were mainly from high-SES families. Of the 58 participants from the private school, 33 were boys and 25 were girls.

### Instruments

Two reading comprehension tests and one word problem comprehension test were used in the current study. Reading comprehension tests were developed by one of the authors and were subsequently reviewed and revised by an expert. Each reading text was written using an appropriate font, style, and language for third grade students (Woods, Davis, & Scharff, 2005). In one of the reading comprehension tests, fiction stories, named “Emre and His Dog,” and in the other test a nonfiction story, named “Journey of Wheat,” were used.



There were six factual and two inferential questions about the stories in each test. Factual questions required understanding of the events occurred in the story (e.g., Who came while Emre was listening music?), and inferential questions required understanding of the whole text (e.g., What kind of problems does a child face with if he does not get protein?).

The Word Problem Comprehension Test (WPCT) was developed by Mayer et al. (1997) and consisted of 12 questions. The WPCT is aimed to assess students' comprehension of the problem rather than assessing the ability of solving the problem arithmetically. The original test was translated into Turkish using back translation. Names and some items were translated with some modifications considering Turkish culture. Translation was done by one of the researchers and was checked by a research assistant. Another research assistant from the Foreign Language Education Department did the back translation.

### **Procedure**

All students were administered three tests: a fiction-reading comprehension test, a non-fiction reading comprehension test, and a word problem comprehension test. The two reading comprehension tests were administered on the same day, and the word problem comprehension test was administered two weeks after the reading comprehension tests. For each reading comprehension test, students had 20 minutes (10 minutes for reading and 10 minutes for answering questions). Directions were read at the beginning of the test. First, students were given the fiction story text and were allowed to read the text silently for 10 minutes. At the end of the 10 minutes, the fiction-story texts were taken from the students, and the question sheets were distributed. Students were given 10 minutes to answer the questions. A few minutes after all students finished the fiction reading comprehension test, non-fiction reading comprehension test was administered in a similar fashion. In each classroom, the order in which the reading comprehension tests were given was the same (i.e., fiction followed by nonfiction).

The Word Problem Comprehension Test (Mayer et al., 1997) “intended to assess a child's ability to mentally represent and understand an arithmetic word problem rather than to compute a numerical answer” (The Fifth Dimension, n.d.). Thus, students were told that they did not need to solve the problems. Total time for this test was 18 minutes. Mayer et al. recommended 15 minutes for this test. However, Turkish students were not used to solve these kinds of problems, so they were given more time than what was recommended.

### **Data Analysis**

Initially, relationships between RCT-I and WPCT and RCT-II and WPCT in the whole sample were examined using Pearson  $r$  product moment correlations. Subsequently, results were disaggregated by gender and school type. To investigate the relationship between reading comprehension, regardless of fiction and non-fiction, and word problem comprehension, a multiple regression analysis was run.



## Results

In the whole sample, the Pearson  $r$  correlation coefficients between RCT-I and WPCT and RCT-II and WPCT were .46 ( $p < .01$ ) and .51 ( $p < .01$ ), respectively. Thus, there was a moderate correlation between word problem comprehension and both fiction- and non-fiction reading comprehension.

When results were disaggregated by gender, the relationship between RCT-I and WPCT was larger for females (Pearson  $r = .62$ ,  $p < .01$ ) than for males (Pearson  $r = .35$ ,  $p < 0.01$ ). Similarly, the relationship between RCT-II and WPCT was also larger for females (Pearson  $r = .68$ ,  $p < .01$ ) than for males (Pearson  $r = .39$ ,  $p < .01$ ).

When results were disaggregated by school type, the Pearson  $r$  correlation coefficients between RCT-I and WPCT and RCT-II and WPCT were .70 ( $p < .01$ ) and .78 ( $p < .01$ ), respectively, for the public-school sample. The relationships between RCT-I and WPCT (Pearson  $r = .12$ ) and RCT-II and WPCT (Pearson  $r = .22$ ) were very small and not statistically significant at the 0.01 level for the private-school sample.

Finally, the relationship between reading comprehension, regardless of fiction and non-fiction, and word problem comprehension for the whole sample was investigated using multiple regression analysis. A result showed that 31% ( $p < .05$ ) of the variance in word problem comprehension achievement was explained by fiction- (RCT-I) and non-fiction-reading (RCT-II) comprehension. In the regression model, non-fiction reading comprehension was a statistically significant predictor of word problem comprehension, whereas fiction-reading comprehension was not.

## Discussions

In this study, relation between reading comprehension and word problem comprehension achievement was investigated. In a previous study, Grimm (2008) examined the relationship between early reading skills and problem solving ability. In Grimm's study, the correlation between early reading skills and problem solving ability was quite small (correlation coefficient = .16). However, in the current study correlations between both fiction reading comprehension and word problem comprehension (Pearson  $r = .46$ ) and non-fiction reading comprehension and word problem comprehension (Pearson  $r = .51$ ) were recognizable. Findings of the current study were consistent with the literature that showed the importance of the language component and comprehension of a problem on problem solving achievement (e.g., Abedi & Lord, 2001; Guerriero, 2010; Vincent, 2009). Current study's results showed that relationships between fiction- and non-fiction reading comprehension and word problem comprehension (Pearson  $r = .46$  and 0.51, respectively) were similar. This was also the case when results were disaggregated by gender and school type. Indeed, non-fiction stories could be considered more similar to word problems than fiction stories. Non-fiction stories include facts like word problems do. However, in fiction stories there is a sequence of events to be followed during the story, which is different from necessities of word problem comprehension items. Nevertheless, the magnitude of the relationship between non-fiction story and WPCT achievement was similar to the magnitude of the relationship between fiction story and WPCT achievement in every correlation analyses in the current study.



Research questions were targeted to disaggregate the relationships between fiction- and non-fiction-reading comprehension and word problem comprehension by gender and school type. Both the correlation between fiction reading comprehension and word problem comprehension and the correlation between non-fiction reading comprehension and word problem comprehension were quite larger for females than for males. Although the current study's findings cannot establish a causal relationship, female students' word problem comprehensions may be more affected by their reading comprehension. Male students, on the other hand, might use word problem solving procedures that are less affected by their reading comprehension skills.

Although results showed statistically significant and large correlations between word problem comprehension and both fiction- and non-fiction-reading comprehension among public-school students, both relationships were small and not statistically significant among private-school students. A possible reason for the low correlation among private school students may be the mathematics teaching methods used in that particular school. Because the school had various materials for teaching mathematics, students' problem solving achievement may not be affected by their reading comprehension difficulties. Similarly, these private school students may be used to solving problems and problem solving procedures; hence, their low or average achievement on reading comprehension could not show its effect on WPCT achievement.

Reading comprehension achievement, fiction- and non-fiction together, explained a considerable amount of variation in students' word problem comprehension. Whereas non-fiction reading comprehension was found as a statistically significant predictor of word problem comprehension, fiction reading comprehension was not a statistically significant predictor of word problem comprehension. In all, the current study provided some evidence to the important relationship between reading comprehension and word problem comprehension achievement.

This study found an important correlation between reading comprehension and word problem comprehension achievement. Because problem solving is an indispensable ability, necessary in life, thinking about increasing the achievement on word problem solving is reasonable. Reading ability is also a required skill for not only school achievement but also for outside-of-school life. Moreover, students with poor reading skills are at risk for behavioral problems and have a tendency to drop out of school (Grimm, 2008). Reading skills are also important in the development of self-confidence and motivation to learn (Grimm, 2008). Given the importance of reading and problem solving abilities in and out-of-school life, students should be provided with ample opportunities to improve these skills. Reading and mathematics teachers may work together and establish interdisciplinary lessons that simultaneously facilitate the improvement of reading and word problem comprehension skills.



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