FIFTH GRADERS' COMPREHENSION OF EXPOSITORY TEXTS: PERFORMANCE DIFFERENCES BETWEEN POOR AND ADEQUATE READERS

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DECLARATION OF ORIGINALITY

I, Zeynep Gonca Akdemir, certify that

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ABSTRACT

Fifth Graders' Comprehension of Expository Texts:

Performance Differences Between Poor and Adequate Readers

The present study investigated and compared the expository text reading comprehension performances of adequate and poor readers by using a multicomponent model. The participants were 80 native Turkish-speaking 5th grade students. A number of literacy measures were used to collect data which were analyzed by various quantitative techniques including independent samples *t*-test, simultaneous regression analysis, and path analysis. The results of the independent samples *t*-test showed that poor readers had significantly lower performance than adequate readers in terms of their reading (a) collection of description, (b) compare-contrast, and (c) problem-solution texts. In addition, path analysis results presented different patterns for each reading groups. For adequate readers, science reading fluency and depth of vocabulary knowledge contributed most to science reading comprehension. For poor readers, morphological awareness significantly accounted for their science reading comprehension performance in Turkish. The findings revealed that (a) text reading fluency is an important variable for considering the skilled performance of adequate readers, (b) the poorer comprehension performance of struggling readers were also predicted by their automatic reading skills in science texts, and (c) there is the need for further research investigating the science reading comprehension performance of readers in an approach based on multi-component model in Turkish reading.

ÖZET

5. Sınıf Öğrencilerinin Bilgilendirici Metinlerde Okuduğunu Anlaması: Zayıf ve Yeterli Okuyucular Arasındaki Performans Farklılıkları

Bu çalışmada çok bileşenli bir model ile yeterli ve zayıf okuyucuların bilgilendirici metinlerde okuma anlama performansları araştırılmış ve karşılaştırılmıştır. Çalışmanın katılımcılarını 5. Sınıfa giden 80 öğrenci oluşturmuştur. Verilerin toplanması için bir dizi okuma ile ilişkili ölçekler kullanılmış ve veriler bağımsız örneklem *t*-testi, eş zamanlı regresyon analizi ve yol analizi gibi çeşitli nicel tekniklerle analiz edilmiştir. Bağımsız örneklem *t*-testinin sonuçları, zayıf okuyucuların bilgilendirici metinlerde okuma performansları açısından özellikle okuyucunun; tanımlar topluluğu, karşılaştırma-kontrast ve problem-çözüm içeren metinlerde yeterli okuyan akranlarına göre daha düşük performans gösterdiklerini ortaya koymuştur. Buna ek olarak, yol analizi sonuçları, her bir okuma grubu için farklı bulgular sunmuştur. Yeterli okuyucularda fende okuma akıcılığı ve kelime bilgisi derinliği okuduğunu anlama performanslarına katkıda bulunmuştur. Zayıf okuyucular için, morfolojik farkındalık becerisi, Türkçe dilinde yazılmış bilgilendirici metinlerde okuduğunu anlama performansını anlamlı bir şekilde etkilemiştir. Çalışmanın bulguları; (a) okuma akıcılığının yeterli okuyucuların başarılı performansını dikkate almak için önemli bir değişken olduğunu, (b) zayıf anlama performansının fen metinlerinde de otomatik okuma becerileri ile tahmin edildiğini ve (c) Türkçe'de okuduğunu anlamada çok bileşenli model tabanlı bir yaklaşımda okuyucuların fende okuduğunu anlama performanslarının gelecek çalışmalar için araştırmasının gerekliliğini ortaya koymuştur.

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CHAPTER 1

INTRODUCTION

1.1 Importance of reading comprehension

Reading is a complex cognitive activity in which various language-based skills play an important role mainly for understanding and comprehending a written material (Kamhi & Catts, 2012). Consequently, reading comprehension can be stated as the ultimate goal of any reading activity (Woolley, 2011). The term "understanding" is considerable in explaining the importance of reading comprehension because different types of mental processes such as thinking, evaluating, judging, imagining, reasoning, and problem-solving are involved in the understanding process (Kamhi & Catts, 2012). For the students beyond primary grades, comprehension skills gain more importance as these students advance through early adulthood and need not to read more texts in order to be able to perform authentic school-tasks and but also need to learn applying their knowledge into their everyday life. Therefore, it has been stated, that certain literacy acquisition skills are necessary for these students to cope with the flood of information they will encounter (National Institute for Literacy, 2007). In this sense, understanding and comprehending information, especially in written authentic or "expository" contexts (such as science texts) may provide benefits for getting ready to meet the educational and socio-cultural needs of 21st century.

1.2 Importance of reading science/expository texts

By the middle school grades, readers generally become competent individuals who can read simple and familiar texts, such as narratives, based on their many

experience with texts, their sight word knowledge, and familiar language structures (Chall & Jacobs, 2003). However, beginning from Grade 4, the texts used in educational settings will include novel concepts beyond students' everyday knowledge, unlike in the lower elementary grades (Fang, 2006). As students move through the transitional stage of "learning to read" through "reading to learn", they may experience difficulty with reading achievement (Chall, Jacobs, & Baldwin, 1990).

As students grow, the expectation from their reading performances increases as well because structures used in the texts they deal with are getting complex. One of the text types that they commonly encounter after primary years is expository texts which are mainly used in their science education course books, and this genre is generally characterized as apathetic or disinterested especially for middle school students (Fang, 2006). However being disinterested in reading science texts may be given the close association between the development of future modern science literacy of individuals and their ability to read science texts (Norris & Phillips, 2003). Norris and Phillips (2003) also claim that students may remain insufficient in terms of their depth and breadth of scientific knowledge unless they necessarily get exposed to reading practices with various text structures. In addition, learning the language of science by means of reading scientific material is crucial for better communicating about scientific concepts, knowledge, and worldview (Wellington & Osborne, 2001). Not only does it help them experience authentic learning by reading but also engages them into the habit of careful and critical reading performance which indicates better scientific literacy (Norris & Phillips, 2003; Wellington & Osborne, 2001).

Academic success in content-area learning such as science, mathematics, and literature is generally associated with students' reading comprehension performances (e.g., Baş & Şahin, 2012; Bayat, Şekercioğlu, & Bakır, 2014; Göktaş & Gürbüztürk, 2012). Especially in science education, the direct relationship between reading comprehension performances and science achievement through reading science texts comes to the front because reading such texts is important for three main purposes in science learning: (a) getting knowledgeable about the concepts gained by scientific content, (b) being able to apply science process skills, and (c) being capable of doing high-quality reasoning (National Research Council [NRC], 1996). Although National Science Education Standards (NSES) changed its view and emphasis from "learning science by lecture and reading" through "learning science by investigation and inquiry," reading scientific texts is still regarded as a necessity and a particularly critical topic for understanding the nature of the language of science which have an effect on the achievement of children and youth (e.g., Cervetti, Bravo, Hiebert, Pearson, & Jaynes, 2009; Wellington & Osborne, 2001). In this sense, many researchers and educators currently stay skeptical to remove textbook reading in science learning because it has been stated that the content of science material is not arbitrary, virtually common for all countries and cultures as well as a main component of science instruction providing a distinctive way of organizing and explaining scientific and authentic concepts from everyday life (Graesser, 2002). Therefore the importance of reading in science/expository texts should not be underestimated due to its aforementioned contributions to school-aged individuals.

1.3 Expository text reading among students with different reading competencies

Graesser and Britton (1996) define understanding process by a metaphor called as a complex dynamic system in general. That is why there is no surprise that comprehension process of every individual is not identical. Especially in reading expository texts, students have more struggles in understanding the scientific information provided in this type of discourse, and these struggles in content-area reading are generally linked with being unprepared for the challenges of expository text reading as well as lack of exposure to content-area material (Sanacore & Palumbo, 2009).

In Turkey, 17% of the general population has problems in reading and writing however 36% of them are referred as illiterate. Among those, approximately five percent of the students studying at primary and middle school levels of formal education have been diagnosed with learning difficulties, but unfortunately the accuracy of these data cannot be validated due to the lack of enough investigations in this field (Özkardeş, 2012). Although early school dropout was decreased down to 0.7% from 2015 to 2016 (Educational Reform Initiative, 2017), the current rate of school-dropping (36.4%) among the students may indicate that their struggling performances can be related with serious academic challenges they generally face in the school settings (Özkardeş, 2012). Thus, they continue falling behind their adequate reader peers to some extent, and it prevents them to develop skills and strategies necessary to meet comprehension expectations demanded from specific contents (Deshler & Hock, 2007).

Recent studies showed that literacy instruction becomes more effective when it is tailored to students showing different reading competencies in specific texts and tasks (Catts & Kamhi, 2017). However, it is firstly required to detect students'

challenges regarding their comprehension difficulties about these texts and tasks. Thus, understanding the roles of key reading skills such as fluency and vocabulary capacity in order to find out the nature and the development of comprehension especially for adolescent literacy would be a good starting point (e.g., Deshler & Hock, 2007). In this sense, the nature of different language systems may have different requirements in terms of the cognitive, linguistic and affective domains of reading comprehension because individuals' competency in reading may vary due to the potential differences can occur in each domain of reading comprehension. For example, the systematic orthographic structure and advanced phonological awareness of words and syllables in Turkish accelerate the word identification process of young readers (Öney & Durgunoğlu, 1997). Thus reading comprehension performance of school-aged children starts to be predicted by their language comprehension skills such as vocabulary, reading fluency, listening comprehension and morphological awareness. However it was asserted that there are still missing in-depth studies that examine specific impacts of cognitive, linguistic as well as affective variables on reading comprehension in a model-based perspective in transparent languages such as Turkish (Durgunoğlu, 2017). Therefore, the present study aims to fill this gap by proposing a cognitive model of reading comprehension for middle school students (fifth grade) by investigating the influences of cognitive (naming speed, speed of processing, and working memory), linguistic (morphological awareness, depth of vocabulary knowledge, and science reading fluency) determinants on the intact reading comprehension performances of students with different reading profiles including adequate and poor readers. Additionally, the present study examined reading comprehension performances of different reading groups because as discussed in the previous literature comprehension of academic texts (e.g., expository

texts) beyond primary years and the way reading comprehension progresses are among the understudied in Turkish (Durgunoğlu, 2017). That is why the present study seeks to outline different cognitive and linguistic mechanisms of 5th grade students by developing a model that will shed light on the intervention studies to be carried out in Turkish text reading. Regarding this rationale of the present study, the research questions can be presented as follows:

1. Is there a significant difference between 5th grade adequate and poor readers in terms of their total science reading comprehension performances?
2. Is there a significant difference between 5th grade adequate and poor readers in terms of their science reading comprehension performances on different expository texts including collection of descriptions, problem-solution, compare-contrast and cause-effect?
3. To what extent do cognitive and linguistic correlates of reading comprehension (Rapid Automatized Naming [RAN], Processing Speed [PS], Morphological Awareness [MA], Working Memory [WM], depth of vocabulary knowledge, and Science Reading Fluency [SRF]) contribute to overall science reading comprehension performances of 5th grade adequate readers?
4. To what extent do cognitive correlates of reading comprehension (Rapid Automatized Naming [RAN], Processing Speed [PS], Morphological Awareness [MA], Working Memory [WM], depth of vocabulary knowledge, and Science Reading Fluency [SRF]) to overall science reading comprehension performances of 5th grade poor readers?

Along with the introductory information provided in this chapter, the following section gives theories and literature review related to the research questions above.

CHAPTER 2

THEORY AND LITERATURE

This chapter has four main sections. In the first part, an in-depth literature review on reading comprehension, reading fluency, and vocabulary knowledge as well as their roles and reflection in reading expository texts were presented. In the second part, the theories or models which are closely related to the present study were given. In the third part, cognitive, linguistic and affective determinants of reading comprehension were reviewed based on the findings of the previous studies, and the last section presents the proposed cognitive model of reading comprehension with a focus on previous related model-based studies in the literature.

2.1 Reading comprehension, reading fluency, and vocabulary knowledge

2.1.1 Reading Comprehension

Reading comprehension is generally defined as an overall understanding of a written material (Woolley, 2011). More specifically, the Research and Development Reading Study Group (RRSG) considers reading comprehension as "the process of simultaneously extracting and constructing meaning from the text." (Sweet & Snow, 2003, p. 1). The definition implies that understanding of words and sentences in a text, which is extracting meaning, is not merely enough to fulfill the active process of reading comprehension. Constructing meaning through the interpretation of the existing information in the text is also a required process in order to build an effective reading comprehension development.

To internalize the reading comprehension, it is crucial to understand the differences between mastery and growth constructs in reading acquisition (Duke & Carlisle, 2011). Mastery constructs are the ones that can be learned at mastery level. For instance, learning the alphabet is a mastery construct that can be achieved at the end of the first year of schooling, especially for the readers who learn transparent languages, which requires specific spelling patterns with high grapheme-phoneme correspondences, like Turkish (Öney & Durgunoğlu, 1997). On the other hand, growth constructs can never be mastered due to their complex and continuously developing nature. In this sense, comprehension is assumed as an quintessential construct (Duke & Carlisle, 2011).

According to RRSG, there are three elements that constitute reading comprehension: *the reader* who does the activity of comprehending, or who fulfills the processes of extracting and constructing meaning in the reading comprehension activity, *the text* which needs be comprehended by the reader, and *the activity* where reading comprehension is fulfilled within various written discourses. Among those, the role of reader variables such as cognitive and linguistic abilities and/or disabilities comes to the forefront because understanding adequate reading acquisition and related problems encountered in school-aged children can be achieved by recognizing reader-related difficulties as suggested by the earlier theorists of reading development (e.g., Frith, 1995; Perfetti, 1985).

According Frith's point of view, readers can experience deficiencies due to three essential areas including biological, cognitive, and behavioral levels of reading (Frith, 1995; Woolley, 2011). While discussing the possible causes of reading difficulty, she highlighted the importance of language impairments of these readers (Frith, 1995). In other words, she implies the role of cognitive aspects of reading in

her research. Additionally, cognitive difficulties of readers are viewed as causes and consequences of biological and behavioral aspects of people with reading difficulties (Woolley, 2011). Therefore presenting reading profiles of adequate and poor readers in terms of their cognitive abilities and disabilities can be meaningful to understand the underlying reading comprehension mechanism of these individuals.

2.1.1.1 Reading comprehension of adequate readers

Students who are categorized into the group of adequate readers refer to the individuals who have qualified skills and strategies that facilitate their level of understanding and constructing meaning (Kamhi & Catts, 2012). In the current literature, they are commonly referred by the terminology of proficient, successful, fluent, skilled, and/or fast, all of which indicating the superior performance of these individuals compared to their less achieving reader peers. However, it was suggested that using more general terms in reading research can provide an advantage for defining the competences of these readers in terms of various factors affecting their ability to read (e.g., timing of reading, the complexity of the text) (Pang, 2008). Therefore, this study adopts using a more holistic term, adequate readers, because it is not aimed to refer to some specific attributes of the reader behavior in the present study. Instead, the concept of adequate readers refers to typical individuals who show better performances in terms of their accurate and fluent reading performances compared to their peers who are selected from normal readers' pool which are not belonged into a specific reading disability group such as dyslexics.

Good readers are the ones who can process information more rapidly, accurately, and automatically while reading according to the findings of the recent studies which used sophisticated computer and eye-tracking technologies (e.g., Jian,

2017). For example, Jian (2017) examined the cognitive processes and characteristics of 42 sixth grade students from an elementary school by means of recoding their eye movements while reading scientific text with diagrams. In the study, students were grouped into good and poor readers. Results showed that readers with good reading performance were differentiated from poor readers in terms of their better character recognition ability.

Another study which examined 101 fourth grade students with good and poor reading comprehension performances determined some indicators for good reading performance. These were accurate and automatized naming, reading techniques, comprehension of words, spatial abilities indicating the capability of quick sequential movements, as well as correct utilization of the rules in sentences and the texts (Stopar, 2003). In addition, it was shown that adequate readers generally show superior performance in language knowledge, information processing, and metacognitive strategic abilities (Pang, 2008).

Based on these kinds of characteristics, some common features of adequate readers emerge. These skills can be summarized as automatic and rapid word-recognition which results in fluent reading (e.g., Wolf, Bally, & Morris, 1986), reasonable size of vocabulary capacity (e.g., Lee, 2011), better storage and cognitive use of information (e.g., Daneman & Carpenter, 1980), developed knowledge of the structure of the words (e.g., Champion, 1997; Zhang, 2017), and higher processing skills while creating meaning from the written material (e.g., Catts, Gillispie, Leonard, Kail, & Miller, 2002).

According to the report of National Institute for Literacy (2007), individuals with adequate reading performances are defined as purposeful, strategic, and critical ones who are capable of fulfilling meaning making process in reading any content

area. In adolescence years, adequate readers are able to comprehend textual material by building on precise knowledge to achieve content-area learning (Chall, 1983; Kinstch, 1988; National Institute for Literacy, 2007). However, it is firstly needed to emphasize the importance of the core components which have role on grouping readers into various reading profiles prior to stating the objectives and the goals of any kind of reading activity.

Adequate readers differentiate from their poor reader peers who have struggles in terms of several cognitive, metacognitive, and motivational determinants of reading comprehension. In this sense, Ehrlich, Kurtz-Costes, and Loridant (1993) examined and compared the reading profiles of 220 French-speaking adequate and poor readers by measuring their cognitive, metacognitive, and motivational skills. Two different reading groups were examined by a word-recognition test, which assessed their decoding skills, as well as vocabulary knowledge; findings of the study showed that adequate readers were better at word recognition compared to the poor readers in the study (Ehrlich et al., 1993). Other studies which compared the reading profiles of adequate and poor readers also found consistent results in the sense that adequate readers have superior performance in terms of their word-reading skills (e.g., Stopar, 2003), vocabulary (e.g., Chiappe, Chiappe, & Gottardo, 2004; Doğru, Alabay, & Kayılı, 2010) and speeded reading (e.g., Kairaluoma, Torppa, Westerholm, Ahonen, & Aro, 2013). Only limited number of studies have investigated the comprehension differences between adequate and poor readers by means of a model-based perspective (Oslund, Clemens, Simmons, & Simmons, 2018; Primor, Pierce, & Katzir, 2011).

2.1.1.2 Reading comprehension of poor readers

Students who struggle with reading are commonly referred as *learning disabled* (Kamhi & Catts, 2012). However, this term can account for other forms of learning problems such as math difficulties and may cause misunderstandings for public while providing certain information about struggling readers. Therefore, researchers and practitioners commonly use narrower terms in order to discuss about heterogeneous groups of individuals who have problems both in decoding and comprehension (Chall, 1983; Chall & Jacobs, 2003). Thus, the term of *reading difficulty (RD)* refers to poor readers throughout this study.

Students with RD have deficiencies resulting from extrinsic factors (e.g., less early literacy experience, improper reading instruction, Matthew effects, and low motivation) and/or intrinsic factors (e.g., genetic heritage and/or neurological basis for reading difficulty, as well as deficits based on visual, aural, attentional and language-related abilities), all of which can have positive or negative impacts on reading development (Catts, Kamhi, & Adlof, 2012; Woolley, 2011). However, it has been emphasized that the reading problems of many students are often associated with cognitive impairments or deficiencies stem from early literacy development (Lyon, 2003) and language-based limitations in reading (Kamhi & Catts, 2012).

Defining characteristics of students with RD is not an easy task due to variety of professionals that [such as special educators, reading specialists psychologists, and speech-language pathologists] are concerned with this issue (Kamhi & Catts, 2012). Each field has various theoretical orientations and bases for explaining RD. Therefore they naturally come up with different kinds of solutions and models to understand RD. However it is possible to provide a holistic description to define students with RD or poor readers according to the information provided within

fundamental associations who support and conduct research aiming to understand the needs of poor readers.

According to the framework of National Institute of Child Health and Human Development (NICHD) for reading difficulties, people who show symptoms such as having trouble in quick reading, lack of reading with correct expression (prosody), and understanding written word as well as having bad handwriting skills are categorized as some of the characteristics of students with RD (NICHD, 2016). Shaywitz, and Shaywitz (2003) define students with RD in the following manner:

> …that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities (p.1). Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge (p.14).

As we can understand aforementioned definition of IDEA, students with RD have core deficiencies in both accurate and fluent word-recognition and this difficulty has been validated by recent empirical studies, especially examining native Turkish students' reading condition in the primary grades (e.g., Baydık, Ergül, & Bahap-Kudret, 2012; Kodan, 2017). For instance, Baydık and her colleagues (2012) asked thirty-nine teachers for giving information about reading situations of their third grade students (n=105) with RD in their studies. Participated teachers stated that most of the deficient students showed errors while reading punctuation marks and they generally read words inaccurately. This result corrected the word-reading problems of students with RD, at least from the perspective of Turkish teachers who deal with such students (Baydık et al., 2012).

However, struggles of poor readers are not only limited to their slow and inaccurate word-recognition skills (Kamhi & Catts, 2012). Findings from studies which compare poor and adequate readers indicated that profiles of children with RD

may show additional impairments in terms of word knowledge which indicates their vocabulary capacity (e.g., Cain & Oakhill, 2006; Chiappe, et al., 2004; Doğru, et al., 2010; Oslund, et al., 2018; Stopar, 2003), working memory skills (e.g., Palladino, Cornoldi, de Beni, & Pazzaglia, 2001; Swanson & Berninger, 1995; Swanson, Zheng, & Jerman, 2009), ability of morphological knowledge which broadly accounts for the ability of understanding the structure of words (e.g. Layes, Lalonde, & Rebai, 2017; Mokhtari, Neel, Matatall, & Richards, 2016), and rapidly spelling, recognizing and processing information located in the text (Kairaluoma, et al., 2013; Layes et al., 2017; Tressoldi, Stella, & Faggella, 2001) apart from their struggles in word-reading accuracy and fluency (Baydık, 2002). In addition, it was stated that poor readers show large differences on recalling academic information when compared to their skilled reader peers (McNamara & Wong, 2003; Taylor, 1979).

As students grow across grades (from primary through adolescent years), the effect of word-recognition on the poor performance of students with RD diminishes as stated by cross-linguistic studies of reading research (e.g., Babayiğit & Stainthorp, 2013; Protopapas, Mouzaki, Sideridis, Kotsolakou, & Simos, 2013; Tobia & Bonifacci, 2015; Torppa, et al., 2016). In addition, the effect of other cognitive and linguistic variables in differentiating poor readers from their adequate reader peers increases across years (e.g., Babayiğit & Stainthorp, 2013). For example, in the longitudinal study by Babayiğit and Stainthorp (2013) on the weight of listening comprehension, grammatical skills, vocabulary, and verbal short-term memory on the reading comprehension ability of 56 Turkish-speaking children revealed the weak relationship between reading comprehension and word-reading as students get older. Results of the study indicated that from kindergarten through Grade 2 the role of word-reading on reading comprehension decreased and word-recognition rapidly

developed in early grades due to the consistent grapheme-phoneme relationship in Turkish. Moreover, the study provided implications from the perspective of poor readers as well. Due to the transparent nature of Turkish poor readers may reveal reading comprehension difficulties in terms of specific language impairments, although they may have adequate word-recognition skills (Babayiğit & Stainthorp, 2013).

Some earlier studies indicated that there are some groups of older students who show reading difficulties despite not experiencing any prior reading problems. Chall, Jacobs, and Baldwin (1990) followed thirty students for two years (from Grades 2, 4, and 6 through 3, 5, and 7) and observed that from Grade 4 through 7, participants showed significant difficulties in defining abstract, academic, and less common words in the word-meaning test. This result supported the argument that most students beyond Grade 4 are lack of fluency and automaticity in reading and it results in reading less and avoiding reading more difficult written materials after this grade level (Chall & Jacobs, 2003; Chall, Jacobs, & Baldwin, 1990). The situation based on the study of Chall and her colleagues (1990) led to the emergence of the term of "late emerging reading difficulties" in reading research. The prevalence of this difficulty type is thought to be stemmed from pedagogical shift that happens in the school system from Grade 3 through upper levels (e.g. Etmanskie, Partanen, & Siegel, 2016).

2.1.1.3 Reading comprehension of expository texts

Reading materials or texts used in science education are generally defined as informational or expository texts. Late emerging reading disability, which is also referred as "fourth grade slump" is generally associated with the difficulties faced

while reading expository text structures after Grade 4 (Chall & Jacobs, 2003). Students who experience transition from primary grades (Grades 1, 2, and 3) through middle school years (beyond Grade 4) meet novel written materials which may include unfamiliar content for these students. As a result, some reading problems can occur during these years due to the increasing focus on reading comprehension with developed vocabulary content in curricula, instruction, and assessments (Leach, Scarborough, & Rescorla, 2003). Especially in the domain of world knowledge, achievement of students begins to decline because students are expected to understand and comprehend large amounts of new information provided by expository or informational texts beyond primary grades (Chall & Jacobs, 2003; Sanacore & Palumbo, 2008). Prior to Grade 4, students are mostly immersed in reading narrative or literal texts including basic word structures which demand less vocabulary capacity for their comprehending performance. Therefore they may not have a chance to develop the reading skills to comprehend information and may fail to be prepared for understanding and comprehending texts with informational content and structure.

Improving reading comprehension is a challenging task. In middle school and elementary grades, reading comprehension becomes increasingly crucial, because expository texts become a primary source not only for learning novel information, but also for gaining knowledge from unfamiliar contents (Mason & Hedin, 2011; Saenz & Fuchs, 2002). The complexity of text structures increases through upper grades and addressing the deficiencies of students who encounter difficulties in reading science texts is required (e.g., Chall & Jacobs, 2003; Fang, 2006).

Being able to recognize text structures during reading is an essential part for successful reading comprehension. Especially in science education learning the

language considered to be a major element to be able to deal with the richness of the words and unfamiliar phrases about the content (Wellington & Osborne, 2001). In addition, understanding the features of the language used in scientific texts can assist researchers in identifying challenges that students face when reading expository texts.

Expository texts have unique macrostructures, or text-level characteristics, compared to narrative texts (Ludline & McCauley, 2016). The different nature of these materials may differentiate between poor and adequate readers, especially in their use of reading strategies (e.g., Kletzien, 1991). The macrostructure of expository reading passages includes four forms: (a) collection of descriptions, (b) cause-effect, (c) compare-contrast, and (d) problem-solution (Meyer & Freedle, 1984). Collection of descriptions describes the association of one element to another. Collection of descriptions can be stated as a combination of text structure categories (a) generalization - based on describing, clarifying and extending the main idea in the text; (b) enumeration - listing facts one after another; and (c) sequence - formed by continuous events of steps in a process. Cause-effect can be defined as causally or quasi-causally related events, such as when it is cold, the temperature drops. Compare-contrast describes the similarities and differences between events; for example snake and worm are both reptiles; snakes is backboned or vertebrate, yet worm is invertebrate. Lastly, Problem-solution is generally formed by overlapping sentences containing problem and solution concepts, as well as understanding the relationship between cause-effect elements in the sentences.

Past studies showed that some structures are more understandable or salient than others in the process of comprehending these texts (e.g., Englert & Thomas, 1987; Nubla-Kung, 2008). For instance, Englert and Thomas (1987) explored the

differential skills of learning-disabled and normal-achieving students and found significant differences between students with learning difficulty and their nondisabled peers in the use of text structure in both reading and writing expository discourse. Their study included four types of expository text structures: (a) sequence, (b) description, (c) enumeration, and (d) compare-contrast. Participants in the related study listed text structures from least to the most difficult ones as According to the participants' of the related study, the hierarchy of salience for the four structures, from least to most, was determined as: compare-contrast, description=enumeration, and sequence (Englert & Thomas, 1987). In addition, two related studies investigated the awareness of expository text structures among middle school students (Englert & Hiebert, 1984; Richgels, McGee, Lomax, & Sheard, 1987). In the study of Englert and Hiebert (1984) evaluated third and sixth grade students' awareness of four types of expository text structures including description, comparison/contrast, enumeration, and sequence. Participants of the study were provided with one or two topic sentences that signaled one of these structures and were asked to rate the topic about how well they "belong" to the related structure. Results of Englert and Hiebert (1984) showed that participants rated sequence and enumeration structures correctly and more frequently than description and comparison/contrast structures. In another study by Richgels et al. (1987) investigated sixth grade students' awareness of expository text structures including collection, comparison/contrast, causation, and problem/solution subgenres. According to Richgels et al. (1987), the awareness of causation text structure identified most difficult for students. On the other hand, students demonstrated higher awareness of comparison/contrast, collection, and problem/solution than of the causation structure. These studies may validate the view of Meyer & Freedle (1984) in the sense that compare-contrast structure may be more

challenging for students because of the organizational components of this structure and its location in the text that determines students' awareness level.

Students may face challenges in reading these texts due to the ineffective performance caused by the difficulty of text-level characteristics of expository reading passages. Saenz and Fuchs (2002) provided four characteristics of expository texts identifying the challenging features of these texts: (a) text structure, (b) conceptual density, (c) the complexity of vocabulary, and (d) prior knowledge. In their study, 111 students with reading difficulties were administrated narrative and expository texts. Saenz and Fuchs (2002) identified deficient performance in students' comprehension and in fluency of reading expository texts as compared to narrative texts. Another study examining the typical readers' reading comprehension performances in narrative and expository texts found that participants from primary grade students had difficulties while comprehending expository reading material than narrative genre (Best, Floyd, & McNamara, 2008). They discussed the importance of the effect of world knowledge on expository reading comprehension competencies and problems especially during elementary grades and highlighted the influence of prior knowledge in content areas rather than decoding skills which demonstrated much lower and inconsistent relations with comprehension of expository text (Best et al., 2008).

Moreover, Turkish / regular orthography studies suggested that expository text reading generally pose challenges among school-aged children (e.g. Sidekli, 2005; Temizyürek, 2008). For instance, Sidekli (2005) tested 411Turkish-speaking fifth grade students' reading comprehension in order to investigate whether there is a significant difference in comprehension skills. Narrative and expository texts including 22 multiple-choice and 2 open-ended questions were used in the study.

Sidekli (2005) revealed that narrative text understanding was superior to those of expository ones. Another study of text structure in Turkish was designed by Temizyürek (2008) investigated the different text types and whether they have different influences on the reading comprehension levels of 140 Turkish-speaking eighth grade students. Two different reading comprehension passages were administered with the text structures of informative and fictional texts used to assess participants' reading comprehension levels. Temizyürek (2008) showed that 8th grade students better achieved comprehending informative texts. However, none of these aforementioned studies did in-depth analysis of success of middle school students regarding their performances in different kinds of expository text reading. In other words, it can be stated that a study concerning the performances of students with different reading profiles in reading different kind of expository text structures in Turkish does not exist, according to the knowledge of the researcher of the present study. Although expository texts commonly used in educational settings may cause reading problems for school-aged children who face such novel text structures (Mason & Hedin, 2011), understanding the sensitivity of these students towards specific textual factors is important in considering these students' special needs in reading (e.g., Nubla-Kung, 2008).

Apart from effect of text type on the achievement of students reading in comprehension, reading fluency is one of the main indicators for successful school achievement, especially for the elementary grades (e.g., Bigozzi, Tarchi, Vagnoli, Valente, & Pinto, 2017). Yıldırım, Rasinski, and Kaya (2017) showed that the knowledge or skill in the role of reading fluency contributes to reading comprehension of expository texts and important for understanding the needs of students who study beyond primary grades. Yıldırım et al. (2017) demonstrated that

reading fluency has a considerable value and accountability for predicting reading comprehension of expository materials especially in grades 4 through 8. Therefore, examining the reading fluency performances of school aged children with diverse cognitive backgrounds is an important factor for the purpose of the present study.

2.1.2 Reading fluency

Fluency is defined as one of the core factors explaining and understanding the nature of reading process (Kuhn & Stahl, 2003). Theoretical considerations regarding the role of fluency on reading acquisition highlight three essential contributions including (a) accuracy in decoding, (b) automatic word-recognition (Laberge & Samuels, 1974; Samuels, 1976), and (c) the appropriate use of prosodic features or reading with expression (Downhower, 1991 as cited in Kuhn & Stahl, 2003). Among these components, it is especially important to know that reading individual words in a correct manner is not sufficient to show a fluent reading performance. In other words, accurate decoding of words does not guarantee a reader to be fluent. For both having fluent reading and good reading comprehension performance, the one is required to have "automatic habits" in reading which is a kind of skill beyond the ability of accurate decoding (Samuels, 1976).

In order to have automatic behavior in reading, the readers need to perform reading activity without attention. Samuels (1976) associates automatic reading behavior with the situation of walking. If an individual walks on an icy ground, he or she uses his or her attention to prevent falling and it affects his or her typical walking behavior. The same process accounts for reading behavior as well. Since a less proficient reader mostly gives his or her attention on correctly decoding individual words, the services of attention cannot be devoted to automatic reading as well as

processing meaning from the text. Thus, the focus of reading activity turns to accurate decoding and it reduces the speed of the reader in whole reading performance (Laberge & Samuels, 1974).

Reading fluency can be shown as a better indicator for assessing reading comprehension especially for the languages with transparent speech pattern systems, which have shallow orthographies. There is an agreement in the reading literature that some languages including Turkish, Finnish, Italian, and Greek have relatively shallow orthographies compared to the other languages that have deep orthographies such as English, Dutch, and Hebrew (Seymour, Aro, & Erskine, 2003). More specifically, in languages with shallow orthographies, phonemes and speech patterns are identical, which means that the graphemes of the represented spoken phonemes spelled consistently. Therefore, it allows readers to pronounce a word fluently without decoding (Frost, Katz, & Bentin, 1987). On the other hand, for the deep orthographical languages, grapheme-phoneme translation may be more complex, which generally results in the delays of both decoding words and comprehending the textual information. In a cross-linguistic study demonstrated that word-naming and decoding processes occur more slowly for readers who read deeper orthographies such as English (Seymour et al., 2003).

Fluent reading requires two main abilities: (a) being able to read words with a fluency to free readers' cognitive resources so that comprehension of the written material can be the focus of attention, and (b) being capable of grouping words appropriately into meaningful grammatical units in order to interpret the meaning of the text. Thus, it is possible to divide, the "fluency" construct into categories such as word-reading fluency and text reading fluency, both of which gradually effect reading comprehension performance of the reader. Text reading fluency is regarded

as a separate construct apart from word-reading fluency because it is an indicator of overall reading competence (Fuchs, Fuchs, Hosp, & Jenkins, 2001). Additionally, it is considered a better influential factor for the reading skills of students in upper grades because fluent reading performance of students beyond primary years has a role on differentiating their comprehension performances (Fuchs et al., 2001). Therefore it can be stated that text reading fluency can predict and provide explanations for differentiating the reading performances of poor and good readers, especially for the upper grade-level students (Ritchey, Silverman, Schatschneider, & Speece, 2015).

Reading in a sufficient rate, especially for middle school students, is important for the process of reading to learn. For example, in a meta-analysis study of Reschly, Busch, Betts, and Long (2009) found that average correlation between fluency and comprehension was .67 across studies, however this correlational value appears to be weaken by middle school (Reschly, et al., 2009). Kim and Wagner (2015) reported that the association between reading fluency and comprehension declines across grades from .93 (in first grade) to .72 (in fourth grade) and suggested that an increase in reading fluency may have the potential to overcome comprehension problems among students. However, examination of reading fluency and comprehension of different reading groups is more needed. Therefore, it can be concluded, less is known about the situation among poor and adequate readers regarding their performance on fluency-comprehension relation (O'Connor, 2017).

2.1.2.1 Reading fluency in expository texts

Students beyond early primary grades such as Grades of 4 and 5 generally encounter challenging texts, especially in science education and they may include complex and

technical words (Chall, 1983; Chall & Jacobs, 2003). Fang (2006) stated that many students in middle school level experience struggles due to the difficult language structure of texts. In the later grades, students start dealing with comprehending texts rather than decoding. Therefore the importance of text reading fluency increases in upper levels of schooling. In this sense, Yıldırım et al. (2017) examined the role of reading fluency on expository text comprehension performance in Turkish and found that word reading fluency significantly contributed to science reading comprehension among Turkish students for Grades 4 through 8. Additionally, there are another studies in Turkish that found significant relationship between reading fluency and reading comprehension (e.g., Çetinkaya, Ülper, & Yağmur, 2015; Yıldız & Çetinkaya, 2017). However, the exact relationship between text-reading fluency and reading comprehension performance could not provide causal relationship between fluency and comprehension. In this sense, Babayiğit & Stainthorp (2011) examined 103 Turkish Cypriot children in order to model the relationship between reading fluency and comprehension by including cognitive, linguistic, and literacy skills in Turkish. Babayiğit & Stainthorp (2011) tested some literacy skills including word-reading fluency, text-reading fluency and reading comprehension by 26 oral questions designed to tap their inference making skills as well as verbatim recall of the text. Results of Babayiğit & Stainthorp (2011) provided an overall understanding of the role of reading fluency in reading comprehension because reading fluency explained the variance in reading comprehension especially for students who have high levels of decoding accuracy skills in early ages. Along with the findings of Turkish studies, it could be noted that general reading fluency rather than word-reading speed is one of the good indicators of skilled reading comprehension, for specific reading aged groups such as fifth graders (e.g., Fuchs et al., 2001).

Another important and critical component in measuring students' reading comprehension performances is stated as their vocabulary capacity (Joshi, 2005). Especially the role of vocabulary in comprehending expository texts is worthwhile to consider because these texts may present challenges for students due to the fact that they include technical and multisyllabic words, which may cause them experience problems in decoding, fluent reading as well as comprehending (e.g., Armbruster & Nagy, 1992; Saenz & Fuchs, 2002). Over three decades ago, Gough & Tunmer (1986) tried to give focus on the importance of vocabulary development on reading comprehension performances of the readers however they also stressed that the complicated relationship between vocabulary and reading comprehension in content-area learning is unfortunately ignored. The gap regarding this relation still continues because studies which cognitively and linguistically examine the role of vocabulary in reading comprehension is relatively few especially in middle school reading (e.g., Oslund, Clemens, Simmons, Smith, & Simmons, 2016). Therefore, it is important to present the role and importance of word meaning or vocabulary knowledge for reading comprehension of students with different competencies.

2.1.3 Vocabulary knowledge

Perfetti & Stafura (2014) explain the importance of vocabulary knowledge in reading acquisition by means of their Reading Systems Framework (RSF). According to their point of view, knowledge of the written word forms and their meanings, which may also be called as vocabulary knowledge, is central to reading and comprehension thus it may be a fundamental component for a cause of reading difficulty among readers. Braze, Tabor, and Mencl (2007) provided an interesting and important picture in this sense. They tested participants aging between 16 and 24 years spanning a wide range

of reading ability and explored the role of cognitive and neurocognitive profiles on their reading comprehension performances. Braze et al. (2007) showed that orally assessed vocabulary knowledge of the participants captured unique variance (71 %) in reading comprehension even after their lower-level skills such as decoding and listening comprehension were accounted for. This finding may posit and validate that vocabulary knowledge, especially when it is assessed by oral measures, can provide causal relations in reading comprehension of adolescent aged reading groups.

2.1.3.1 Depth of vocabulary knowledge in reading expository texts

Depth of vocabulary knowledge refers to the ability of orally expressing meaning of words in any context. However, it is defined as a complex construct which gives information about the semantic skills of the readers (Perfetti, 2007). (Colenbrander, Kohnen, Smith-Lock, and Nickels (2016) revealed that knowing the meaning of words is related to the comprehension performances of students with different competencies. Especially in reading expository texts, students generally deal with conceptual density because expository discourse is formed by word meanings which can sometimes limit reader's capability in connecting his/her prior knowledge to new learning processes (Mason & Hedin, 2011). In this sense, the study of Yıldırım, Yıldız, and Ateş (2011) is the only predictive study in Turkish that indicated the role of vocabulary in explaining expository text reading. Yıldırım et al. (2011) examined 120 typically developing fifth-grade students in order to see whether their word knowledge predicts their comprehension performances in different text structures including literal and informational text types. With the study of Yıldırım, et al. (2011), the role of vocabulary knowledge in explaining expository text reading comprehension of middle school students were highlighted.

Vocabulary and reading comprehension have a significant relationship as provided by reading research (e.g., Joshi, 2005; Kieffer & Lesaux, 2007; Oslund, et al., 2016; Ouellette, 2006). However, the cognitive-based nature of the association between depth of vocabulary and reading comprehension for students with different reading competencies remains unclear (Protopapas, et al., 2013). Unfortunately, there is no research which particularly examines the importance of the Turkish word knowledge of students with different competencies in terms of comprehending expository texts. Therefore, studies which investigated the vocabulary depth-reading comprehension relation apart from Turkish were reviewed for the present study. For example, Ouellette (2006) investigated the importance of oral vocabulary skills (depth and breadth) for reading comprehension performances of 60 typically developing Grade 4 students. In the study, decoding, visual word recognition, and reading comprehension were used as literacy skills of middle school students. The results of the hierarchical regression analyses of the study showed that depth of vocabulary knowledge of Grade 4 students significantly predicted their reading comprehension whereas vocabulary breadth did not. According to this finding, it was asserted that the nature of the correlation between vocabulary depth and reading comprehension may be explained by the efficiency of semantic access of students in those years. On the other hand, Tannenbaum, et al. (2006) found that vocabulary breadth provides a stronger relation to reading comprehension of third-grade students than their depth of vocabulary knowledge. These studies may also reveal the fact that the role of vocabulary knowledge in explaining reading comprehension performance increases especially after primary grades (Torgesen, et al., 2007). Studies have revealed that word-reading contributes less to reading comprehension as vocabulary

knowledge continues its strong association with reading comprehension especially after primary years (e.g., Oslund, et al., 2018; Tilstra, et al., 2009).

In conclusion, it can be stated that both fluent reading and vocabulary understanding in the context of science can be regarded as two core components of science reading comprehension. In other words, if reading comprehension is considered to be a very complex cognitive skill, maintaining fluent reading accompanied by knowing the word meanings in the text can strengthen reading comprehension process as a whole and the role of these two in explaining reading comprehension development of students are implicated in prominent theories. However the relative influences of fluency and vocabulary as well as the degree which they function differently among adequate and poor readers via statistical modelling are rarely studied (Oslund, et al., 2018). Thus it is firstly needed to provide a relative theoretical underpinning regarding the reading comprehension profiles of students with and without reading difficulties. The following part describes (a) the theoretical considerations of reading comprehension; (b) the role of cognitive and linguistic variables which have influence on fluency, vocabulary, and reading comprehension; and (c) the proposed reading comprehension model for different reading groups in the present study.

2.2 Theories / models of reading comprehension

There are prominent reading development theories or models (e.g., Aaron, Joshi, Boulware-Gooden, & Bentum, 2008; Chall, 1983; Cromley, Snyder-Hogan, & Dubas, 2010; Ehri, 1997; Frith, 1986; Gough & Tunmer, 1986; Perfetti, 2007; Perfetti & Stafura, 2014; van den Broek, 2010) that provide explanations about the knowledge, processes, and cognitive aspects of reading comprehension. All

aforementioned theorists believed and advocated that reading comprehension has a multicomponent nature however approaches and perspectives to explaining the primacy and emphasis on reading comprehension vary across different models (e.g., Oslund et al., 2018). Therefore, it is almost impossible to provide a single theoretical framework which captures the complexity of the key components and their relevant influence on reading comprehension (Perfetti & Stafura, 2014).

Theoretical models become more complicated while describing and explaining the roles of direct and indirect cognitive correlates of reading comprehension (Oslund et al., 2018). Each theory generally gives focus on the foundational role of a specific construct such as word-reading (Ehri, 1997; Ehri & McCormick, 1998), vocabulary (Perfetti, 2007), as well as speed of processing in reading comprehension (Aaron et al., 2008). Along with the inspiration of some reading comprehension models, this study investigated the reading comprehension levels of adequate and poor 5th grade readers, and provided a new multicomponent reading comprehension model explaining the effects of the cognitive and reading-related constructs (Rapid Automatized Naming [RAN], Processing Speed [PS], depth of vocabulary knowledge [Vocabulary], Working Memory [WM], Morphological Awareness [MA] and Science Reading Fluency [SRF]) of reading comprehension. Prior to giving the developed model of this study, it is meaningful to share the perspectives of closest cognitive models of reading comprehension. The following part of this study presents several multicomponent models of reading comprehension such as Simple View of Reading (SVR) and The Componential Model of Reading (CMR) which can be regarded as the most relevant approaches for the aim of the present study.

2.2.1 The simple view of reading

The Simple View of Reading (SVR) identifies core linguistic components for explaining reading comprehension achievement, while its validity was not aimed to be tested in this study. The motivation of this study was to examine some key constructs posited in reading research as contribute to reading comprehension and to consider these key constructs and variables in terms of the reading comprehension performances of various reading groups. Therefore one of the widely accepted theoretical models of reading comprehension, The Simple View of Reading, was selected as a useful framework for this study.

SVR had been proposed by Gough and Tunmer (1986) and it was validated by a number of reading research studies and has implications for reading disability (Woolley, 2011). It provides a well-defined formula that can help educators and researchers to understand the need of students with reading difficulties. In addition, research that gives emphasis on the nature of younger and older adolescents' reading strategies takes this model as a basis for explaining their intervention model in reading research (Deshler & Hock, 2007; Faggella-Luby & Deshler, 2008).

The SVR theory identifies both decoding ability and linguistic processing skills that have a role on reading comprehension. The relation between decoding and linguistic comprehension is formed by a multiplicative formula. The following equation represents the relationship:

Decoding (D) x Linguistic Comprehension (LC) = Reading Comprehension (RC)

D and LC are considered as independent processes however the model asserts that perfect reading comprehension performance cannot be achieved without the co-

existence of these variables. In other words, decoding or linguistic comprehension is necessary for reading comprehension but absence of one of them may result in loss of comprehension. Gough and Tunmer (1986) explain this relationship by giving two separate examples. If a reader is not mature to learn a language, then his or her linguistic skill (LC) could be counted as 0 in the equation. Thus he / she fail to decode words:

$$RC = D \times LC$$

$$\text{If } LC = 0, \text{ then } RC = D \times 0 = 0$$

On the other hand, a reader who is able to speak a language does not provide evidence that he/she can decode words:

$$RC = D \times LC$$

$$\text{If } D = 0, \text{ then } RC = LC \times 0 = 0$$

In short, both decoding and linguistic skills are necessary, but solely not sufficient to explain reading comprehension.

The first component of the model, decoding (D), refers to the ability of accurately reading words and non-sense words, using the measures of accuracy and pace/speed (Gough & Tunmer, 1986; Hoover & Gough, 1990). It is determined by looking at regular word and non-sense word decoding of the readers because of neuroanatomical evidence that there are different areas activated in the reading of both regular words and non-sense words in the brain (Joubert, et al., 2004 as cited in Ouellette, 2006). Decoding skill is accepted as the fundamental requirement to have

a skilled word-recognition. About grade 4 and beyond, sight-word reading (as represented in the equation below) is considered as an important process for reading comprehension due to the important role of processing speed in reading (Joshi & Aaron, 2000):

Decoding + Speed = Sight-word reading

The second component of the model, linguistic comprehension (LC), which is also named as oral (verbal) language or listening comprehension skills, (e.g., Joshi & Aaron, 2000; Primor et al., 2011) accounts for the ability of processing and comprehending of verbal information provided by words, sentences, and discourse (Gough & Tunmer, 1986; Hoover & Gough, 1990). However, there are still gaps between scientific studies in providing consistent definitions of linguistic comprehension (Santoro, 2012).

According to the American Speech-Language-Hearing Association (1982), there are traditionally five parameters of oral language comprehension including phonology- in which rules of speech sounds and combinations are concerned; semantics- in which word breadth and depth of vocabulary knowledge and their relationships are concerned; morphology- in which the inflectional and derivational structures of morphemes, smaller units of the words, and their existence in words are concerned; and pragmatics- in which the use of language are concerned. In the studies, the measurement of all of these parameters is not consistent whereas the contribution of phonology, semantics and morphology are assessed most often (Santoro, 2012).

Although there are inconsistencies to explain the constructs of linguistic comprehension among reading research, evidence suggest that relationship between linguistic comprehension and reading comprehension increase as children gets older (Kendeou, van den Broek, White, & Lynch, 2009; Tilstra, McMaster, van den Broek, Kendeou, & Rapp, 2009). It was shown that contribution of linguistic comprehension, by amount of variance explained, to reading comprehension increases from fourth- (6%) to seventh-grade (13%) (Tilstra et al., 2009). Thus, examining other components may provide more detailed explanation for understanding reading comprehension performance of younger adolescents for the purpose of the present study. In this sense, The Componential Model of Reading (CMR) can be shown as the secondary reading model which highlights the importance of processing speed component in explaining reading comprehension performance of individuals. The following section explains the perspective of this model by providing its relatedness with the aim of the present study.

2.2.2 The componential model of reading

The Componential Model of Reading (CMR) is regarded as a somewhat modified version of SVR model. It suggests that the association between decoding and linguistic comprehension should be additive rather than multiplicative and it is assumed that there should be another cognitive factors which can be labelled as the factor of "X" and proposed the following formula: Reading Comprehension (RC) = Decoding (D) + Linguistic Comprehension (LC) + *X*. This model predicts that poor readers will not be nearly deficient as they are assumed because there could be other variables such as processing speed, vocabulary (e.g., Joshi, 2005) which are affecting the reading performance of such individuals (Joshi & Aaron, 2000).

There exists various empirical research that tested the validity of CMR model in reading (e.g., Aaron, et al., 1999; Dreyer & Katz, 1992; Joshi & Aaron, 2000). Dreyer and Katz (1992) followed 137 monolingual third grade students for two years through fifth grade and found that the componential formula of reading predicted reading comprehension as SVR does. In addition, Joshi & Aaron (2000) tested the validity of CMR by adding the component of processing speed into the model. In the study of Joshi & Aaron (2000) 40 students were examined from third grade. Results of Joshi & Aaron (2000) showed that speed emerged as an important factor at about grade 4. Additionally, a prediction was made regarding the significant variance of fluent reading in reading comprehension beyond this grade (Joshi & Aaron, 2000). As it can be seen from the aforementioned studies, CMR model proposes cognitive variables apart from word-recognition and linguistic comprehension as such subcomponents of RC. All of these studies implied that the lower speed of processing information is linked with deficient decoding skills as well as poor meaning making process from grade-level reading materials of less abled readers. (Joshi, 2012) asserted that there are other factors in SVR that contribute to reading achievement of individuals even though the model is beneficial to explain reading comprehension processes of diverse readers. These factors can be classified into three domains including cognitive, psychological, and ecological. Aaron and colleagues (2008) decided to extend SVR model as "Componential View of Reading" and validated the accountability and the advantages of this model based on the studies that applied reading instruction program (Aaron, Joshi, Gooden, & Bentum, 2008).

As a conclusion, the theoretical underpinnings of reading research are diverse and it is difficult to provide a single theoretical perspective for explaining reading

comprehension. However, both the models of SVR and CMR can provide fruitful evidence for understanding the primary predictors of reading comprehension: decoding, linguistic comprehension as well as fluency. However, these three components do not necessarily explain the puzzle of reading comprehension (Primor et al., 2011). There are other cognitive factors such as morphological awareness (e.g., Deacon & Kirby, 2004), rapid automatized naming (e.g., Kirby, Georgiou, Martinussen, & Parrila, 2010), and working memory (e.g., Swanson, Zheng, & Jerman, 2009) that has been widely studied to understand and explaining the multi-componential nature of reading comprehension. Thus, explaining and then examining the role of fundamental components (decoding, linguistic comprehension, and fluency) as well as other cognitive and linguistic variables (rapid naming, processing speed and working memory, and morphological awareness) on reading comprehension is meaningful to understand the characteristics of both adequate and poor readers for the purpose of the present study.

2.3 Cognitive and linguistic predictors of reading comprehension

While almost each reading theory agrees that reading comprehension is a complex mechanism, they vary in terms of the emphasis they give to different cognitive and linguistic components (Oslund, et al., 2018). In addition, recent reading studies revealed that there are a wider variety of variables stemming from cognitive and linguistic domains which have a great role in comprehension. These variables are: (a) Rapid Automatized Naming (RAN), (b) Processing Speed (PS), (c)Working Memory (WM) as belonging into cognitive domain, and (d) Morphological Awareness (MA) as a linguistic variable. However, researchers do know less about their role in explaining reading comprehension performance of students with and

without reading difficulties, as well as their role in languages other than English (Primor, et al., 2011). Therefore, following part describes the role of these components (RAN, PS, MA, and WM) within their relations with reading comprehension as well as their distinctive role for adequate and poor readers.

2.3.1 The role of rapid automatized naming

Rapid Automatized Naming (RAN) is described as the ability to name rapidly the stimuli or symbols that are visually represented as numbers, colors, objects, diagrams and letters (Kirby et al., 2010; Norton & Wolf, 2012). According to the terminology commonly used in reading research, both naming speed and Rapid Automatized Naming are used to describe continuous / serial naming speed. Researchers generally prefer using the term of *speed* to measure only naming time, either counting responses or eliminating errors. In this study, both the terms of RAN and naming speed were simultaneously used to refer RAN skills of readers.

The stimuli in naming speed tasks have two types: alphanumeric and no alphanumeric. While letters or digits are defined as alphanumeric stimuli, colors and objects are assigned as no alphanumeric symbols. Alphanumeric stimuli in naming speed tasks have higher correlations with reading rather than no alphanumeric symbols and they are accepted as more associated with the nature of reading activity (Bowey, McGuigan, & Ruschena, 2005; Wolf, Bally & Morris, 1986).

2.3.1.1 Rapid automatized naming and reading comprehension

There are enough number of theoretical explanations that share the view that naming speed and reading have similar properties, that is why naming speed is viewed as a

kind of “microcosm or mini-circuit for later developing reading circuit” (Norton & Wolf, 2012, p. 430). For instance, in both, the sequential movement of eyes across page is needed. When eyes are fixated in a stimulus (number/digit, color, letter, object etc.), its encoding is required. Additionally, encoded stimulus is required to be activated at end of the process in order to take a mental representation of the information (e.g., digits, colors). Prior to first stimulus is completely connected or articulated, the eyes should move to the next one and so on. It resembles the action in reading, where the eyes step back to the beginning of the next line.

The relationship between RAN and reading comprehension can be explained by three main cognitive constructs of reading ability including phonological processing, orthographic processing, and general processing speed (Kirby et al., 2010). Wagner, Torgesen, and Rashotte (1994) argued that naming speed and reading are related via phonological processing and it is defined as the ability of using phonological or sound structure of oral language while learning how to decode written information. One of their longitudinal studies done with 244 children from kindergarten through 2 grade revealed that naming speed or serial naming is one of the measured variables that well describe young children’s phonological processing abilities in their learning to read years. They hypothesized that naming speed tasks are related to reading due to the fact that they measure the speed of access to information by retrieving the preserved information in the long-term memory (Wagner et al., 1994).

However the role of phonological processing on naming speed is still being criticized on theoretical grounds due to the fact that it was found as underdeveloped relationship (Kirby et al., 2010). Theorists on the contrary side believe that naming speed cannot be categorized as “a part of phonological family” (Wagner et al., 1994)

because they claim that there should be different cognitive requirements which independently helps RAN predict reading acquisition apart from phonological processing (Wolf, Bowers, & Biddle, 2000). They argue that phonological processing can be an important part in RAN whereas it only represents one component area. In other words, they claim that speed of naming should be regarded as a complicated process in which attentional, perceptual, conceptual, phonological, semantic, motoric as well as memory-related sub processes are involved in (Wolf et al., 2000). Thus there are some studies showing the distinctive role of naming speed from phonological processing in explaining the prediction of reading acquisition by providing the evidence of the low to moderate correlation coefficient ranges (.37 to .43) between these two (Kirby et al., 2010; Swanson, Trainin, Necoechea, & Hammill, 2003).

On the other hand, it was also proposed that RAN is related to reading due to the fact that it contributes to the development of orthographic processing (Bowers & Wolf, 1993). "The ability to form, store, and access orthographic representations (spelling patterns)" was defined as the skill of orthographic processing. As Bowers & Wolf (1993) offered, inducing sensitivity for recognizing common orthographic patterns in words is related with how fast the reader proceeds and identifies letters which accounts for naming speed performance. Although there are some research find evidence for the RAN-orthographic processing relation in explaining reading efficiency (e.g., Georgiou, Parrila, & Papadopoulos, 2016), some contrary studies do also exist because there studies found that RAN accounts for unique variance after controlling for the effect of orthographic processing on reading efficiency (e.g., Georgiou, Parrila, & Papadopoulos, 2008).

Alternatively, some researchers claimed that RAN is related reading due to the fact that it relies on the effective execution of its underlying cognitive processes as indexed by processing speed (Kail & Hall, 1994) however majority of the studies found evidence that procesing speed does not accunt for RAN-reading relationship because in these studies hierarchial regression analysis results showed that RAN made a significant contribution to reading after processing speed was controlled for (e.g., Bowey, McGuigan, & Ruschena, 2005). Although processing speed affects RAN and reading - especially in terms of speed and fluency – the contrary evidence regarding the role of processing speed on RAN-reading relation underscore the idea that RAN is constructed by the existing skill of processing speed of individuals (Norton & Wolf, 2012). That is why examining the contributions of RAN and processing speed in explaining reading skills of readers may provide more certain evidence for the aim of the present study.

2.3.1.2 Rapid automatized naming comparing adequate and poor readers

Naming speed is regarded as a characteristic of both poor and adequate readers' reading comprehension performance because there is a considerable amount of research highlighting that naming speed is closely related to one's reading comprehension development either in skilled reading (e.g., Catts, Matthew, Laurence, Robert, & Carol, 2002) or in less abled reading performance (e.g., Torppa et al., 2010). While slow naming speed performance highlights a problem in reading, fast naming speed is regarded as an asset in the literature (Kirby et al., 2010). Thus studies generally consider continuous naming speed as one of the indicator cognitive processes especially underlying reading efficiency (e.g., Georgiou, et al., 2016; Kail & Hall, 1994; Wood, 2009). Reading efficiency or fluency is one of the best

predictors of reading comprehension that generates smooth and effortless reading (e.g., Georgiou, et al., 2016; Norton & Wolf, 2012). For example, Georgiou and his colleagues (2016) how RAN is related to reading fluency performances of 208 Grade 4 Greek-speaking children by contrasting aforementioned theoretical accounts (the phonological processing, the orthographic processing, and the speed of processing accounts). Three alternative models were developed to explain the relationship between RAN and reading fluency. The study results showed that RAN predicted reading fluency directly and through orthographic processing when it was operationalized by speeded measures (Georgiou, et al., 2016). This finding showed and validated the view of Bowers & Wolf (1993) in the sense that RAN contributes to the development of high-quality word representations of words which is a skill can be used by fluent reading afterwards.

In addition, there has been some research suggesting that naming speed predicts reading only for poor readers (e.g., Johnston & Kirby, 2006; McBride-Chang & R., 1996). In one of the studies, participants were divided into the groups of poor and adequate readers in grades 3 and 4 and the roles of phonological awareness, naming speed and verbal intelligence on word-reading skills were investigated in the study (McBride-Chang & R., 1996). It was found that naming speed was only associated with reading for poor reader group and this result was interpreted as the existence of significant variability of naming speed among only poor readers, not adequate readers. Additionally, the longitudinal study of Johnston and Kirby (2006) examined the predictive role of cognitive constructs (word-decoding, listening comprehension and naming speed) on reading comprehension in elementary grade children. They found that naming speed had a unique contribution to reading comprehension performance after controlling for decoding measure in third, fourth

and fifth graders. Subgroup analyses (for the differences between good and poor readers) revealed that the relationship between naming speed and reading is salient for poor reader group, but not for adequate reader group. It indicated that the effect of naming speed on reading comprehension was primarily significant in less skilled readers (Johnston & Kirby, 2006).

2.3.2 The role of processing speed

The Processing Speed (PS) is considered as a general performance indicator whenever various kinds of activities must be completed in a fixed period (Kail & Hall, 1994) and it has been revealed by the studies that PS skill of the readers is a moderate to strong predictor of success in different kinds of academic domains in the learning process (e.g., Vock, Preckel, & Holling, 2011). While slow processing ability can lead to poor reading performance, a better processing speed can cause faster reading and hence better comprehension performance on the contrary side. That is why PS is regarded as a mental speed which influence, either in positive or negative way, some abilities such as quickly and fluently reading, doing basic arithmetic (Phillips, 2015), higher-order thinking which in turn underlies school achievement (Dodonova & Dodonov, 2012) independent from individuals' different reading competencies (Peter, Matsushita, & Raskind, 2011).

Faster processing information is defined as an important determinant of higher mental ability and considered as one of the basic building blocks of cognitive system (Champione & Brown, 1978 as cited in Vock, et al., 2011). Studies have revealed that it is one of the cognitive predictors of academic reading fluency (e.g., Phillips, 2015) which is an indicator of overall reading competency of individuals (Fuchs, et al., 2001). Thus the relationship between PS and reading fluency is really

important while considering reading comprehension achievement of students with different reading profiles.

There are a large number of studies in the literature that examine processing skills in the most general sense of normal intelligence development (e.g., Coyle, Pillow, Snyder, & Kochunov, 2011) and impairments (e.g., Goupeng, Yue, & Luo, 2007), but there are only a few number of studies which examined how this skill differs in individuals with different reading profiles in children (e.g., Peter, et al., 2011) and adults (e.g., Sabatini, Shore, Sawaki, & Scarborough, 2010). Among those, Peter and her colleagues (2011) investigated whether PS is a latent dimension in children with and without reading impairments or not. For this aim, the cohort of 388 children involving low, average, or high reading scores were examined by the measures of short-term and working memory, verbal reasoning, language processing, handwriting, executive functioning, motor sequencing and it was investigated whether the performances in these tasks loaded on PS skills of all kinds of reading groups. The study results showed that children with poor reading scores showed lower speed factor scores than did their typical peers (Peter, et al., 2011). This finding may show that PS is a kind of cognitive construct which have a role on differentiating adequate and poor readers by means of it is close association with fluent academic reading (Phillips, 2015).

2.3.3 The role of morphological awareness

Morphological awareness (MA) is an important linguistic skill for becoming competent readers in the middle school years and it refers to the ability of considering and manipulating the smallest units, morphemes, of meaning in a specific language system (Carlisle, 2000). There are different constituents of

morphology in reading. A free morpheme, which is also known as a base-word or root, is used as its own (i.e., "run", *koş* in Turkish) in a sentence. There are also other kinds of morphemic constituents involving bound morphemes ("to the ball", *top-a* in Turkish), inflectional morphemes ("flowers", *çiçek-ler* in Turkish) and derivational morphemes (sunglass, *göz-lük* in Turkish). Bound morphemes are the general term of affixes that can be added to a root-word to create other words. On the other hand, inflections and derivations are the specific affixes that can be added to base-words either for changing the tense or number of the base-word (inflections) or for shifting the meaning and/or class of the word (derivations). In addition to these two, there are also compound words which can be created by adding two free morphemes together (Coggins, 2016).

Studies have revealed that most of the novel words encountered in the middle school years have complicated formations as well as morphological structures which require readers to make a reasonable guess for understanding the meaning of the words (Anglin, 1993; Nagy & Anderson, 1984). That is why it is inevitable that the relationship between the reading comprehension and MA is meaningful especially for the students in those years who are supposed to deal with the texts including morphologically complex words (Fang, 2006). Although there are studies showing the relationship between MA and reading comprehension (e.g., Nagy, Berninger, & Abbott, 2006; Levesque, Kieffer, & Deacon, 2017), the contribution made by MA to other literacy skills is defined as an underspecified area of research due to the fact that there are variety of study designs and means of measuring MA (Carlisle, 2000; Coggins, 2016). One of the first studies which investigated the relation between MA and other literacy skills was executed by Apel and his colleagues (2013) in this sense. In their study, it was examined 156 kindergarten, first and second grade

students to see whether their performance of MA differ when they were assessed by different kinds measures by their specific grade. Their study included the tasks of analogy, production, judgment, and affix identification. According to the results, it was revealed that MA had significant and unique contribution to both reading comprehension and vocabulary knowledge of the readers in all of these early primary years of schooling (Apel, Diehm, & Apel, 2013).

2.3.3.1 Morphological awareness and reading comprehension

Knowledge of morphology is essential for understanding the language of texts and for accuracy in reading (Nagy, Berninger, & Abbott, 2006) and it has been revealed by numerous studies that MA and reading ability (including comprehension and fluency) are correlated with each other in various languages with different spelling patterns like English (e.g., Berninger, Abbott, Nagy, & Carlisle, 2010) and Greek (e.g., Manolitsis, Grigorakis, & Georgiou, 2017). For example, Manolitsis et al. (2017) longitudinally examined two hundred and fifteen Greek-speaking children from kindergarten to Grade 2. They investigated the contribution of MA skills to word-reading and reading comprehension performances of their participants. The hierarchical regression analysis results of the study showed that inflectional and derivational aspects of MA in kindergarten significantly explained reading comprehension in the later years. Consistent with the findings of Manolitsis et al. (2017), Berninger et al. (2010) examined the morphological growth of 241 typical students from first through six grades. It was proposed in the study that morphological growth links single words to syntactic structures and semantic concepts during the processes of word identification, vocabulary learning, and reading comprehension. Results of the study showed that the developmental

trajectory of morphological awareness continued after primary grades (3 and 4) In addition, researcher looked for whether vocabulary knowledge is a matter of morphology or vice versa. For the task of comparing the semantic relatedness for a pair of words, which is “comes from” task, vocabulary did predict the growth in morphological awareness. Findings obtained from the latter study may emphasize the importance of the role of vocabulary knowledge while examining MA-reading relation.

2.3.3.2 Morphological awareness and vocabulary

Being able to recognize morphological structure of the words is linked with rapid vocabulary growth from primary years through middle school because as young children learn how to execute morphological word production, new lexical representations of words are generated in a creative way by using different kinds of affixes thus this process allows reader a rapid access for fluent and accurate reading performance (Coggins, 2016). In this sense, the strong relationship between MA and vocabulary knowledge was shown by the study of Nagy, et al. (2006) who addressed three main research questions in their study: (a) the significant contribution of MA to literacy outcomes (reading vocabulary, reading comprehension, spelling, decoding different words in various structures) after controlling for phonological and morphological abilities in the structural equational model, (b) the extent of the contribution of MA to literacy outcomes after Grade 4, and (c) the unique contribution of MA to reading comprehension different from other literacy variables. In their study, 607 typical students from Grade 4 through Grade 9 were examined and study results revealed that MA had significant contribution to all literacy measures in all grade levels. In addition, it significantly predicted vocabulary

knowledge however its effect on reading comprehension was over and above that of vocabulary, at all three levels. Moreover, the lack of a significant direct path from vocabulary to comprehension for the fourth/fifth-grade group was attributed to the strong relationship between vocabulary and morphological awareness. This finding, based on the relationship between vocabulary knowledge and MA may reveal that these two variables can be considered together when examining comprehension performances of students, especially for that study beyond primary years.

2.3.3.3 Morphological awareness comparing adequate and poor readers

As readers get mature, they begin to be exposed and deal with more complex words while reading content-area written materials and MA skill of the readers provides them more developed syntactic, semantic as well as orthographic knowledge in comprehending those texts (Coggins, 2016; Berninger, et al., 2010). However every child may not be able to use morphological awareness skills in the reading comprehension process. In this sense, Tyler & Nagy (1990) reported that there are some groups of children who cannot use grammatical information in words with derivational suffixes. In addition, it was asserted that inadequate MA skills may inhibit both decoding and semantic processing which are two important necessities for better comprehension (Carlisle, 2000; Coggins, 2016). Along with this view, it was found that the consequences of poor MA skills may explain why some fifth grade students are referred as poor comprehenders (e.g., Tong, Deacon, Kirby, Cain, & Parrila, 2011). Additionally, Layes, Lalonde, & Rebai (2017) examined the role of MA in word reading and reading comprehension of Arabic in different reader groups. They tested and compared three groups including the group at 6th grade with and without dyslexia, and the younger group who were at fourth grade level. In the

results, it was found significant differences between dyslexics and other typical groups as expected. More specifically, in terms of MA differences, dyslexics showed inferior performance in specific MA measures including morphological production and pattern recognition compared to other groups. It was also highlighted in the study that MA skills may prevent the ability of forming semantic representations of morphemes and it compromises reading comprehension process in time. Moreover, this study provided clear evidence that the importance of MA increases beyond primary years because students are exposed number of complex words in their content-area text books therefore the association between MA and reading comprehension arises especially for later grades to understand the students' ability to study on smaller meaning units to form words which is essential for understanding the meaning of the text as a whole.

Studies found that the role of MA on explaining the variance in reading comprehension of different reading groups differ to some extent (e.g., Mokhtari, Neel, Matatall, & Richards, 2016). For instance, Mokhtari et al. (2016) examined (a) the contribution of morphological knowledge to the reading comprehension performances of 7th grade American high school students and (b) looked at the differences between skilled and less skilled 7th grade students in terms of their morphological knowledge in their cross-sectional reading research. Fifty-three students participated in this study. To investigate the contribution of morphological knowledge, multiple regressions was used and the findings showed that the sensitivity of all 7th grade students on morphological forms of words accounted for 18% of variance in reading comprehension. In addition, *t*-test results between reading groups (22 skilled readers, 15 less skilled readers) showed that skilled readers showed higher sensitivity to the morphology in reading compared to their less skilled

reader peers. Their mean scores taken from the task measuring morphological knowledge were found significantly superior compared to their less skilled peers. This study can be argued in terms of the number of reading-related variables considered in the scope because it is apparent that morphological awareness was assumed as a single component which affected reading comprehension in the study. However the number of studies examining the differences between adequate and poor readers by means of their performances on literacy measures is almost absent (Primor, et al., 2011) and it was suggested to work on more research to understand the specific impact of cognitive, linguistic, and affective variable on reading comprehension, especially in Turkish (Durgunoğlu, 2017). Therefore only examining the role of MA on reading comprehension and fluency may cause limitations for understanding the reading needs of students beyond primary years.

2.3.4 The role of memory

Memory is one of the important components that affects reading comprehension development (Baddeley & Hitch, 1974). It helps readers actively store information in the brain by regulating controlled processing while reading. It is also defined as a processing system that works as a buffer – that is, a balance system for limited capacity. In other words, it facilitates reader to combine components or segments of speech or orthographic units during listening and reading a task. (Engle, Kane, & Tuholski, 1999 as cited in Swanson, Zheng, & Jerman, 2009).

Cognitive models developed for explaining the functions of memory mention about three types of active memory systems: (a) working memory (WM), (b) short-term memory (STM), and (c) long-term memory (LTM). Research on memory-reading relationships has revealed that skilled readers are able to store information in

the mind for a long time, which is a function of long-term memory. Since their memory processing systems, working memory and short-term memory, work better compared to their less skilled peers, it enables them to link their prior knowledge with novel information. Additionally, accumulated information can be easily stored by the facilitation of processing and storage systems (working memory and short-term memory), which benefit readers extract and construct the meaning in the reading comprehension process. Therefore, the role of working memory and short-term memory is highly important to explain underlying cognitive mechanisms of reading comprehension.

2.3.4.1 Memory and reading comprehension

Working memory is a processing system that helps individuals maintain, process, and accumulate information (Baddeley & Hitch, 1974; Swanson et al., 2009). Children who have struggles to hold a person's address in mind while listening instructions about how to get there or failing to take notes during their teacher mention about a topic in the course can be illustrated as specific problems related to working memory deficits. During reading, it is required to rehearse information provided in the text. Working memory, in this process, is regarded as one of the indicators that differentiates students with and without reading difficulties (Baddeley & Hitch, 1974; Engle et al., 1999; Swanson et al., 2009).

Empirical research has indicated that the relationship between working memory and reading comprehension shows a spectrum from moderate through high correlations (e.g., Cain, Oakhill, & Bryant, 2004) whereas there also exists some research that has postulated low levels of association between two (e.g., Tighe &

Schatschneider, 2014). These inconsistent correlational results in different studies can be attributed to the domain-specific role of working memory when explaining its relation to reading comprehension by various task modalities (Carretti, Borella, Cornoldi, & De Beni, 2009; Nouwens, Groen, & Verhoeven, 2017). In other words, the structural and functional role of working memory in reading can change across different measures while differentiating individuals with reading difficulties between typical ones.

The capacity of working memory has been generally measured by different kinds of task modalities including simple span task (e.g., Chrysochoou, Bablekou, & Tsigilis, 2011; Torgesen & Goldman, 1977), complex span tasks (e.g., Goff, Pratt, & Ong, 2005) and measures that evaluate executive functioning mechanisms including shifting, inhibition (e.g., Kieffer, Vukovic, & Berry, 2013 as cited in Follmer, 2017), and planning (e.g., Cutting, Materek, Cole, Levine, & Mahone, 2009 as cited in Follmer, 2017). The differences between working memory measures is originated from the different component of working memory. It is composed of three major components including the *(a) phonological loop*, which encodes verbal information; *(b) visuospatial sketchpad*, which encodes visual-spatial information as well as generate and manipulate mental images; and *(c) central executive system* where complex cognitive processes are coordinated including comprehension monitoring, and updating no-longer relevant information with novel ones (Baddeley & Hitch, 1974; Swanson, Howard, & Saez, 2007).

While simple span tasks measures the phonological coding ability of individuals during listening the information, complex span tasks (verbal and visual-spatial) and executive functioning mechanisms (attentional/executive control component) require individuals not only storing information but also manipulating

and merging it with previous knowledge in reading comprehension process. In detail, readers mostly use verbal information to facilitate memory to form a better comprehension process in these two complicated tasks compared to simple recall measures. Therefore a reader actively engages in processing incoming information while dealing with complex span tasks and the tasks that measures attentional/executive controls (Carretti et al, 2009; Daneman & Carpenter, 1980).

Studies which examine the working memory-reading relation have revealed that the role of complex span tasks and executive functions in contributing to reading comprehension is more significant compared to simple span tasks which requires specific phonological working memory system (e.g., Nouwens et al., 2017). Additionally, poor readers generally show inferior performance than adequate readers on the measures of complex-span and executive functions, especially when task requires verbal ability to form memory-reading relationship (Swanson, 2003). Thus understanding the subcomponents of working memory is important to highlight the different aspects of readers with varying reading abilities. In this study, the subcomponents of verbal short-term memory, which is measured by forward digit span task, and verbal working memory, which is assessed by backward digit span task are explained in detail because a single working memory task was used to investigate working memory-reading relationship.

Short-term memory is defined as a source for explaining the differences of individuals which can be attributed to phonological system of memory (Baddeley & Hitch, 1974; Swanson et al., 2009). More specifically, it is described as short-term recalling mechanism that requires a strong phonological domain of working memory. Short-term memory is generally measured by simple span tasks in reading. Verbatim/oral forms of presented words/digits are preserved by phonological

memory during reading and then they are kept active and accessible while performing more complex memory activities (complex span and attentional/executive control) (Baddeley & Hitch, 1974). Whereas some researchers place working memory and short-term memory in a similar category, studies apparently shows that they aren't (Swanson, Zheng, & Jerman, 2009). It is because of the unique contribution of semantic rehearsal system of the working memory. In other words, working memory places heavy demands on central executive system compared to short-term memory. Additionally, it has been recently revealed that semantic storage controlled by working memory explains individual variation in reading comprehension, in addition to the variation explained by phonological system of working memory (short-term memory) (e.g., Nouwens et al., 2017).

In short-term memory, readers do not have to do inferring and transforming the information provided (Swanson et al., 2009). Instead, they are expected to recall sequences of items (words and/or digits) in a direct serial order in which they were presented. Thus they execute two functions: (a) storing a speech-based phonological input, and (b) rehearsing what it has been orally presented. While classifying students or children with reading difficulties among typical ones, short-term memory tasks are generally used although some researchers argue with its power to determine reading disabilities (e.g., Swanson et al., 2009). However, both in the past and the current, it has been implying that short-term memory measures are as important as tasks that evaluate complex span and executive functions in differentiating students with and without reading difficulties (e.g., Torgesen & Goldman, 1977; Nouwens et al., 2017).

2.3.4.2 Memory comparing adequate and poor readers

Students with reading comprehension deficiencies have low working memory spans and it results in poorly performing on the measures that require using strategies derived from language comprehension skills (Daneman & Carpenter, 1980). Poor readers differ from their skilled reader peers in two aspects: (a) latency in reading, and (b) deficiency in recalling information. It can be reasoned by immature brain functioning of poor readers compared to their aged-matched typical reader peers (e.g., Francis, Shaywitz, Stuebing, Shaywitz, & Flecther, 1996). The proponents of this view state that these kinds of readers can catch up with their peers when their brain gets mature enough. Additionally differences between students with and without reading disability are weaker in older than younger samples according to the view.

On the other hand, there is a second point of view related to memory deficits. It advocates that students with reading difficulty show memory problems across age irrelevant from the maturation status of the brain. This view claims that students with reading difficulty fail on different kinds of memory tasks due to their limitations in their general memory capacity (Engle, Kane, & Tuholski, 1999) regardless of which age they belong in and therefore they can show insufficient, constrained and gradually disordered brain organization, especially in verbal domain, which affect other cognitive processes required for skilled reading comprehension (Swanson et al., 2009).

2.4 Proposed multicomponent model of this study

In the present study, the direct and indirect effects of cognitive and linguistic correlates of reading comprehension (RAN, PS, MA, and WM) and the mediating effects of reading-related variables (Science Reading Fluency [SRF] and depth of vocabulary knowledge [Vocabulary]) on the outcome variable, Science Reading Comprehension (SRC) were tested. Figure 1 represents the hypothesized or proposed model of the present study. In the Figure 1, all paths and relations between variables were shown for both adequate and poor reader groups participated in the present study.

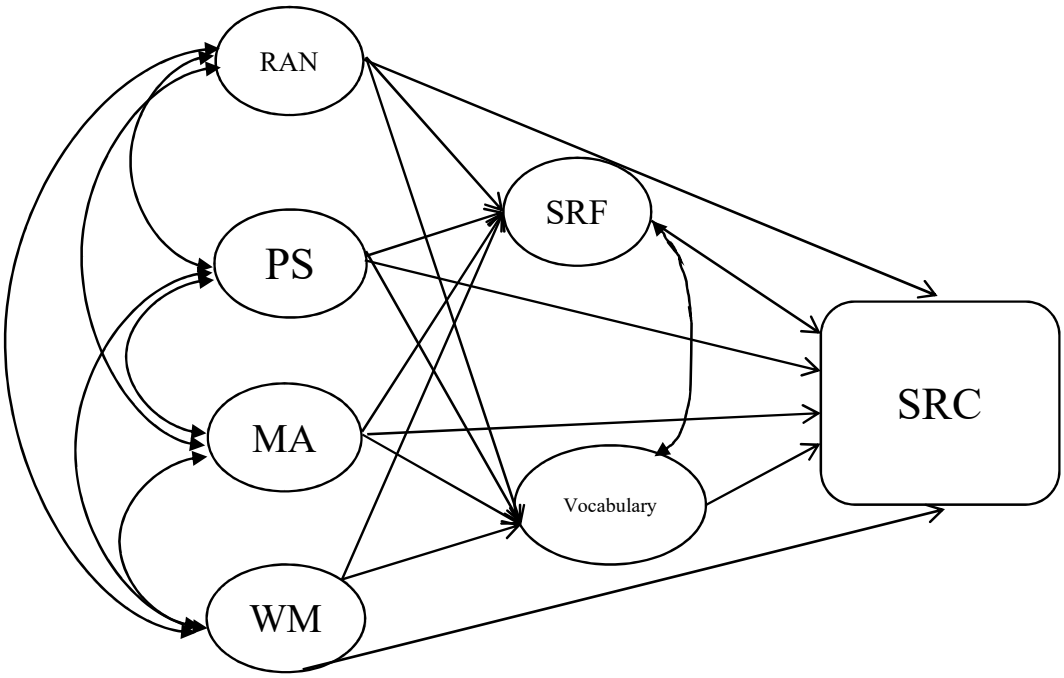


Fig. 1 Hypothesized / proposed model

According to the proposed model of the present study, SRF and Vocab were placed as the mediator variables which were hypothesized as two main predictors of SRC performances of 5th grade students with adequate and poor reading abilities. Different from previous path diagrams in some reading research which also explored the

contributions of variables to reading comprehension; this model not only gave emphasis on investigating the total effects of each variable but also attempted to show mediating roles of SRF and Vocab in Turkish science reading context. In the previous literature regarding the present study, one of the studies done with Hebrew-speaking participants in different reading profiles (with and without reading difficulty) provided a model for showing the relations between predictor variables (such as text accuracy, text speed, morphologic awareness, working memory, and RAN) and reading comprehension in expository texts however no mediator variable was set in their study (Primor, et al., 2011). In addition, another parallel study executed by Oslund, and his colleagues (2018) came up with a Structural Equational Model (SEM) in which they examined the direct and indirect effects of word-reading and vocabulary by means of the mediating effects of reading efficiency and inference-making skills of struggling and adequate English-speaking readers however they did not consider the effects of other cognitive variables such as RAN, PS, WM, and MA on reading comprehension in science content as different from the model used in the present study. Moreover, there is literally no model-based reading research regarding the investigation of the contribution of cognitive and linguistic skills to SRC performances for different reading groups in Turkish, at least according to the knowledge of the researcher of the present study. Therefore it can be noted that the proposed path model in the present study has different and unique aspects compared to the previous reading research studies in this sense.

CHAPTER 3

METHODOLOGY

The present chapter consists of five sections: research design and questions, participants, data collection instruments, procedure, and data analysis. In the first section, the research design is defined along with the research questions of the present study. The following section presents detailed information about the participants, instruments and data collection procedure. The last section explains the methods that were applied in order to analyze the data.

3.1 Research design

The present study employed a quantitative research design. The purpose of quantitative research is "to establish relationships between variables and look for and sometimes explain the causes of such relationships" (Fraenkel, Wallen, & Hyun, 2012, p.10). In the current study, reading competencies and science reading comprehension performances of the participants were quantitatively analyzed. The main aim of the present study is to compare the science reading comprehension performances of poor and adequate readers in 5th grade by examining their cognitive and linguistic abilities. The research questions of the present study are as follows:

1. Is there a significant difference between 5th grade adequate and poor readers in terms of their total science reading comprehension performances?
2. Is there a significant difference between 5th grade adequate and poor readers in terms of their science reading comprehension performances of

different expository texts including collection of descriptions, problem-solution, compare-contrast and cause-effect?

3. To what extent do cognitive and linguistic correlates of reading comprehension (RAN, PS, MA, WM, Vocabulary, and SRF) contribute to overall science reading comprehension performances of 5th grade adequate readers?
4. To what extent do cognitive and linguistic correlates of reading comprehension (RAN, PS, MA, WM, Vocabulary, and SRF) contribute to overall science reading comprehension performances of 5th grade poor readers?

3.2 Participants

This study was implemented with a total number of 80 5th grade students. One of the participants was excluded from the study due to her extremely poor performance on all tasks. There are two reading groups: 33 poor and 46 adequate readers. Participants were studying at a public middle school in Kağıthane, Istanbul. Convenience sampling was used to select the sample from the population. This sampling method is used when a group of individuals are more available and reachable than others for research (Fraenkel, Wallen, & Hyun, 2012). Participants who reveal or have potential to show the following characteristics were not included in the study according to the following criteria as recommended by Eason, Goldberg, Young, Geist, and Cutting, (2012): (1) former diagnosis of mental retardation; (2) known incurable visual and hearing as well as severe physical impairment; (3) history of a known neurological disorder (e.g. epilepsy, cerebral palsy, traumatic brain injury); (4) being a non-native Turkish speaker or having learned Turkish concurrently with other languages; (5)

treatment of severe psychiatric disorders, and (6) having IQ scores below 80 or above 130.

Reading groups (poor and adequate readers) of the participants were determined in two steps. Firstly, participants were assigned into groups by the directory and the counselor of the school. They provided the researcher a list that included a total of 80 5^{th} grade students belonging in the groups of either poor (n = 40) or good (n = 40) readers. Secondly, the researcher examined the accuracy of sample size by doing further analyses to divide reading groups into two in a correct manner (n = 33 for poor and n = 46 for adequate readers after certain analyses). These analyses were diffusively explained in the part of data analysis.

Turkish was the primary language for all students. All required procedures for permissions in order to engage participants into study were maintained prior to the implementation of the study. Demographic information of the participants is illustrated in Table 1.

Table 1. Participant Demographics

	Adequate (%)	Poor (%)
Sample size (*n*)	46 (58.2)	33 (41.8)
Gender		
Female	28 (60.9)	14 (42.4)
Male	18 (39.1)	19 (57.6)
Pre-school education	29 (63.0)	13 (39.4)
Mother education		
Illiterate	1 (2.2)	-
Primary school	13 (28.3)	11 (33.3)
Middle school	5 (10.9)	6 (18.2)
High school	15 (32.6)	13 (39.4)
College graduate	11 (23.9)	2 (6.1)
Father education		
İlliterate	-	-
Primary school	11 (23.9)	8 (24.2)
Middle school	7 (15.2)	7 (21.2)
High school	16 (34.8)	12 (36.3)
College graduate	11 (23.9)	2 (6.1)
Mother job		
White-collar worker	8 (17.4)	2 (6.1)
Blue-collar worker	7 (15.2)	2 (6.1)
Self-employer	2 (4.3)	3 (9.1)
Housewife	28 (60.9)	26 (78.8)
Father job		
White-collar worker	14 (30.4)	5 (15.2)
Blue-collar worker	13 (28.3)	6 (18.2)
Self-employer	15 (32.6)	22 (66.7)
Retired	2 (4.3)	-
Unemployed	1 (2.2)	-

According to Table 1, there were totally 79 fifth grade students (46 students with adequate reading, 33 students with poor reading performance) available for data collection. While most of the adequate readers in the sample were female, the number of males in the sample of poor readers was higher than those of females. As for the educational background of the parents, out of 79 children, most of the parents graduated from high school followed by primary school, college graduate, and middle school. In addition, it can be observed that both adequate and poor readers' mothers are usually housewives, and their fathers are often self-employed.

3.3 Instruments

Ten instruments including demographic information form, Turkish Rapid Automatized Naming Test (HOTIT), Processing Speed (PS) Test, three tests for Morphological Awareness (MA), Digit Span subset, test for vocabulary knowledge, measures for Science Reading Comprehension (SRC) and Science Reading Fluency (SRF) were used in this study.

3.3.1 Demographic information form

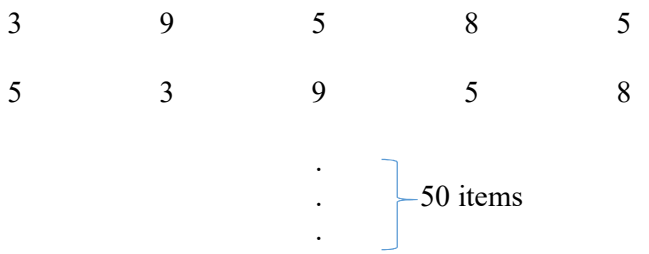
This form was completed with the support of psychology guidance and counseling teacher of the participants in the setting. It consisted of questions about participants' gender, birthday, status for preschool education and bilingualism, any impairment related to hearing loss, speech and language problems as well as any diagnosed situation like ADHD. There was also a part which asked for participants' parents' educational level and occupational status. Information related to the participants' last Turkish and Science course grades was also obtained. Participants' last grades taken on fall term in 2016-17 were recorded into the form.

3.3.2 Turkish rapid automatized naming test

This test measures how a test taker perceives a visual symbol as well as remembers its name accurately and rapidly. It is also called as rapid naming (RAN) or naming speed (Kirby et al., 2010). RAN test can be administered to the children between the ages of 5 years to 10 years 11 months (Denckla & Rudel, 1974). It has four subsets including pictures, numbers, colors and letters. In each subset, the test taker is asked to name each five item which is repeated ten times in a row. The test is individually

administered. Test takers are provided with instruction and asked for naming items accurately as quick as possible. It is kinds of speed test thus lower scores indicate better performances for test takers. Scoring is based on the time that the test taker uses for naming all items. The examiner needs to have specific cards for each subset, a stopwatch and a record sheet for each test taker.

In the current study, only the subset of numbers was used because it was previously suggested that letter naming task caused hesitation and frustration for test takers while naming or sounding letters (Sönmez, 2015). The subsets of pictures and colors were also excluded because these tasks were determined quite easy for 5th graders. RAN with numbers includes 50 items consisting randomly sequenced numbers. The following figure represents a sample of RAN-numbers test.



The original RAN was found to be internally consistent with a reliability value, ranged from .98 to .99 (Wolf & Denckla, 2005). The validity and reliability of the Turkish RAN (HOTIT) was assessed via a pilot study of Bakır and Babür (2009). The inter-rater reliability of HOTIT was found high and ranging from .99 to 1.00 and test-retest reliability coefficient ranges between .85 and .95 (Bakır & Babür, 2009).

3.3.3 Processing speed test

Processing speed test measures the ability of scanning and identifying two identical items in a given row. The test is non-verbal and cultural-free; that is why its original form was used in the current study. On the task sheet, there are rectangular boxes including different kinds of pictures showing different objects. Test takers were asked to circle two related items accurately and rapidly. On the task sheet, there are 40 rows. As the test taker goes down the rows, the difficulty level for matching the objects increases. The time limit of the test is 3 minutes. Total number of correctly selected items is recorded as the score for each participant.

3.3.4 Tests for morphological awareness

To measure morphological awareness of the participants, three tests: (1) Turkish correction and completion tasks for morphological awareness, (2) Turkish test of derivational morphology, and (3) Turkish test of morphological awareness were used in the current study. A composite score was calculated for participants' morphological awareness. The Cronbach's Alpha value of the composite score of morphological awareness ranges between .60 and .70.

3.3.4.1 Turkish correction and completion tasks for morphological awareness

This test was developed by Durgunoğlu (2003). This is a paper-pencil test which involves either correcting the suffixes (correction task) or generating the suffixes (completion task) in a short paragraph about a fictional animal with a pseudo-species name. It assesses the accuracy of individuals' morphological knowledge in

generating inflections for base words or correcting the inflection forms of the given words without time restriction (Durgunoğlu, 2003). Either in correction or completion tasks in the test, three paragraphs are used in the same context. For example, one of the paragraphs mentions about an imaginary animal called "mev" and it describes this animal's characteristics. This paragraph has five instances in which the the target word of "mev" was inflected in a wrong way.

In the correction task, test takers are expected to underline the words of "mev" in each sentence (except first sentence because it is correct for each paragraph) and then to convert the mistake of target words to the correct version. For example the correct form of the phrase "there is nothing scary in a mev" is *mevde korkutucu bir şey yoktur* with *mevde* meaning "in a mev". However, in the text, it is inflected as *mevden* ("from a mev"). In the completion task, the base form was given with a blank after the target word (*mev*__). In the completion task, the test takers are asked to generate the correct inflection after the target word in the given sentence context.

Both of the tasks have three paragraphs with three levels of difficulty. To illustrate the levels in each paragraph, it is possible to give the example of imaginary animal called *mev* again. For level 1; it was given as *mev* (nominal); as *mevler* (nominal + plural = mev + ler) for level 2; and the final level includes *mevlerimiz* (nominal + plural + possessive = mev + ler + imiz). Three different imaginary animals with different syllable structures and vowel harmony were created to form paragraphs (Durgunoğlu, 2003). These are *mev*, *kuna* and *peliz* which are non-sense words in Turkish. In both tasks, the sequence of the demonstration and the level of suffixation were counterbalanced across three names so that each test booklet includes each animal name with each level at each ordering of texts.

This test was administered to the participants as a group. In each testing group, the number of correction and completion tasks was counterbalanced. Each test taker individually worked and moved forward as they completed each paragraph. Duration of the test was 20 minutes. The data were scored by giving 1 for each correct suffix and 0 for each mistaken one. Total scores for each test taker were calculated based on assigned credits.

3.3.4.2 Turkish test of derivational morphology

This test measures the ability of adding appropriate derivations to Turkish non-sense words in a given sentence content and was developed by Kuzucu-Örge (2018). Non-sense words are especially used in the test. In Turkish, a new word with a new meaning can be created when a derivational suffix is added to that word. Therefore a measure for assessing derivational morphological awareness can also evaluate children's vocabulary capacity Kuzucu-Örge (2018). However the main focus should be on the derivations rather than the words or the meaning of the words for the aim of this test. Therefore non-sense words are used to prevent assessing vocabulary knowledge and morphological awareness at the same time.

The test consists of 15 items with multiple-choice questions. The test takers are asked to understand the meaning of a sentence and to select correct derivations among two choices given. For example, the sample question is: "If a person sells a pitak, who is this?" (Pitak satan kişiye ne denir?). The choices given are "pitakçı" or "pitaksız". "Pitak" is a non-sense word but phonologically similar to "kitap", means "book" in English. If the test taker is able to add the derivation of "çı" in Turkish, he / she may know the answer. The suffix of "çı" in Turkish accounts for a person who

does a job or an activity whereas the suffix of “sız” does not make any sense when it is added after the word of “pitak” in the context of the sample question. Therefore, the correct answer should be “pitakçı” that means “pitak seller” resembling “kitapçı” in Turkish which refers to “bookseller” in English.

3.3.4.3 Turkish test of morphological awareness

This a sentence-based judgmental morphology task that measures the ability of readers to determine the correct grammatical sentences by considering the morphological rules in the words which form accurate grammatical sentences. The test includes 30 statements with yes or no questions. The test takers are supposed to decide whether the grammar of the statements was correct or wrong. The ungrammaticality of the sentences depends on the violation of morphological structures of the words. Before the administration, two exemplary questions with four practice sentences are asked to the test takers. The test takers are asked to read these statements aloud to make sure that they do not have any decoding problems. While testing, the test takers read sentences silently in 3 minutes. The number of the correctly answered items was counted and reposted as the total score for the measurement.

3.3.5 Digit span test

It is one of the subsets of Wechsler Intelligence Scale for Children-Revised (WISC-R). It is also called as Memory for Digits/Numbers Test. It measures the ability of recalling and repeating a bunch of numbers in a correct order. Numbers range from 2 to 9 digits in the test. Forward and backward digit span are the two parts of the test.

As the test taker continues, the item difficulty increases in both parts. In the forward digit span task, the examiners read numbers aloud and ask the test taker for repeating numbers in the same order. In the backward span task, the test taker tries to repeat the numbers in the reverse order. Each task includes eight items. The examiner gives two trails for each item and repeats it eight times. If two consecutive errors occur per item, the test is discontinued. The total amount of full credits per row is 2 points. If the test takers only achieve to repeat half of the items in the same row, it is given partial one credit and the test continues.

3.3.6 Test for vocabulary knowledge

This test is a subset of WISC-R under the category of Verbal Intelligence. It measures the ability of expressing the meaning of real-words via using varied range of vocabulary. The test includes 34 different words and sequenced in an increased order of difficulty. The test takers are verbally asked for the meanings of the words. Each respond is written by the examiner in the corresponding box of the relevant word. There is no time limit for this test. If the test takers give five consecutive wrong answers, the test is discontinued. Scoring is applied based on the answer key. Answers were given 2, 1 or 0 points according to the richness of the meaning of the words that test takers provided.

3.3.7 Measure for science reading comprehension

Four reading passages and twenty comprehension questions in the content of 5^{th} grade science education were developed in order to assess science reading

comprehension performance of the participants of the study. The development procedure for reading passages and comprehension questions was as follows:

- The development of passages
    - The categorization of expository texts in 5th grade science course books
    - Determining the readability of passages
    - Taking expert opinions for the appropriateness of the passages
- The development of questions
    - Taking expert opinions for appropriateness of the questions

3.3.7.1 The development of passages

Prior to develop reading measures for the study, total of 89 reading passages in two 5th grade science course books of Ministry of Education (MoNE) was firstly read and then classified into four expository text structures (collection of descriptions, problem-solution, compare-contrast and cause-effect). The classification categories were adapted from Meyer & Freedle (1984). The aim of this categorization process was to observe the amount of different expository text structures that 5th graders generally read in their formal science courses. The categorization process was implemented by the researcher of the study, and then three experts provided their opinions in order to reach consensus about the accuracy of the categorization. It was found that the most frequent subgenres were collection of descriptions (45 %) followed by cause - effect (13, 4 %), compare - contrast (10, 9 %) and problem - solution (6, 1 %).

Four science reading passages for the study were developed: (a) The Journey of Food through Our Body (Besinin Vücumuzdaki Yolculuğu, see Appendix A), (b) Our Kidneys Are Very Important! (Böbreklerimiz Çok Önemlidir!, see Appendix B), (c) Two Different Natural Events: Erosion and Landslide (İki Farklı Doğa Olayı: Erozyon ve Heyelan, see Appendix C), and (d) Red-eyed Tree Frog (Kırmızı Gözlü Ağaç Kurbağası, see Appendix D), that represent the expository text structures of collection of descriptions, problem-solution, compare-contrast and cause-effect, respectively.

The readability of the passages was maintained by checking the validity of passages in the 5th grade science curriculum as well as equalizing the frequencies of words and sentences in each reading passage. The researcher carefully reviewed 5th grade science curriculum by looking at the learning objectives of all units in the science course book. The developed reading passages were matched with first- Livings and Life (Canlılar ve Hayat) - and seventh - Earth and Universe (Dünya ve Evren) units and determined as readable for having appropriate grade-level content for the participants. Additionally, each reading passage was examined in terms of the sentence frequencies by word count via a program called the Fatih Parser (Zafer, 2011). The aim of this procedure was to equalize the sentence and word amounts of the developed reading measures to the ones in the science course book for making them readable for the participants. The frequency analysis process took two days. It was found that the mean of the sentence frequencies was between 7 and 11 and the mean of word frequencies per passage was between 76 and 104 for a 5th grade reading passage. The frequencies of sentences and words located in the reading measures of this study were set according to these calculations. By this procedure, it was prevented to create too long passages for the participants.

Five expert opinions were taken concurrently during the development process (seven weeks) of the reading passages. The revisions were suggested at each meeting and then the next meeting was taken care of throughout the seven weeks. The researcher of the study took experts' opinions immediately after any revision for the passages and experts provided their opinions in terms of passage quality and science content. For the passage quality, each reading passage was examined by text organization, vocabulary choice, sentence structure, and grammar rules. Wording, concepts in the texts and conceptual density were also reviewed for the appropriateness of the science content.

Additionally, each reading passage was redesigned according to a special font called as "Dyslexie". It is a unique typeface or font that books are printed for children and adults with reading difficulty (especially dyslexics) to reduce the visual strain of reading. It is asserted by the developer of the font that also offers benefits for students without reading difficulties (Boer, 2008). Dyslexie has many unique characteristics such as adjusting the shapes, positions and sizes of the letters in order to prevent readers from turning, switching, mirroring, swapping errors. However, the unique effect on the readability performance on the participants was not aimed to be investigated in this study. The structure of the paragraphs was redesigned according to 12 point Dyslexie. In addition, Comic Sans as a sans-serif font with the size of 12 was preferred matching for Dyslexie due to its positive readability effects on students with reading difficulties as suggested in the field (British Dyslexia Association, 2012; Rello & Baeza-Yates, 2013).

3.3.7.2 The development of questions

A total of twenty factual/literal and inferential reading comprehension questions for each passage were developed by using the framework of The Barrett Taxonomy (Clymer, 1968). Two science education specialists and two experts in the field of reading acquisition participated in the revision process of passage development. All of them provided their opinions concurrently during 7 weeks. They looked at the clarity of questions, existence of leading questions, and assessment quality of either factual/literal or inferential comprehension questions.

While testing the participants, the texts were read silently without time limit and questions were answered loudly. The participants were allowed to see the reading passages while answering questions because it was not aimed to assess their working memory skills in this measurement. The time spent or both reading passages and comprehension questions per individual was separately recorded. There were two additional examiners apart from the researcher for this test however the scoring was only done by the researcher of the study for uniformity. Other examiners only helped during data collection process. Before the administration of the test, two day-long training sessions were provided to these examiners.

Scoring for the answers of reading comprehension questions varied across question types. There were two different question types (factual/literal and inferential) for each reading text in the study. Since factual questions are easier than inferential questions, their value was less. The assigned credits for answers per question were developed by the researcher. Then it was examined by five experts, revised three times and uniformity for answers was maintained.

3.3.8 Measure for science reading fluency

Voice recordings were taken while the participants were answering the reading questions of the passages used for assessing their reading comprehension performances. The amount of time spent in voice recordings was noted separately for each participant, and this period in seconds was set as the "reading fluency time in science/expository texts" by the researcher of the present study. Then, acquired reading durations were processed directly into the dataset. Higher scores represent lower science reading fluency performance for each participant data.

3.4 Data collection

Following three steps were taken during the data collection process:

- Getting information about the participants from Counseling and Research Center (Rehberlik ve Araştırma Merkezi [RAM] in Turkish)
- Meeting the directory and the counselor of the study school
- Implementing the assessments of the study

3.4.1 Getting information about the participants

RAM in the province of Istanbul was firstly visited in order to learn information about the distribution of 5th grade poor readers in middle schools. A middle school in Kağıthane district was suggested by RAM as a research school due to its accessibility and convenience for adequate sample of 5th grade students that was diagnosed by being poor readers.

3.4.2 Meeting the director and the counselor of the study school

A meeting was planned one week prior to the data collection process in order to meet and to get permission from the school director and the counselor. Since the study school was previously participated in a scientific research study about examining fluent and less fluent readers in the middle school, the school staff was highly willing to participate in the study. They recruited 40 poor and 40 adequate readers among 5th graders as eligible reading groups for studying, based on the findings from previous reading research that they executed. Then, permissions from the parents of the participating students were gathered. After student list was created, data collection process started. However the accuracy of the assigned reading groups was examined after data collection by certain analyses that are going to be described in the part of data analysis.

3.4.3 Implementation of data collection procedure

This study was conducted from April to May in 2017. An undergraduate student and a doctoral degree student were trained to help the researcher in the administration process. The selection of trained examiners was based on confidentiality. It was assured that all experiences during data collection were shared only with the researcher of the study.

Three examiners collected data from the participants in 11 sessions. The order of the tasks was counterbalanced and the tasks were administered individually in the library to maintain silence. Only Turkish correction and completion tasks for morphological awareness were administered to the groups. In one session, two participants were allowed to enter the library and they were examined in different

places distant from each other. During data collection, participants' voices were recorded according to the requirements of specific instruments within the knowledge and permission of the school staff. Participants' names were kept anonymous and ID numbers were assigned to each individual for confidentiality. Apart from the measures as described in the instruments part, no additional screenings or assessment were administered to the participants.

3.5 Data analysis

Data analysis was conducted in 3 steps as follows:

- Defining reading groups
- Preliminary analyses
- Statistical analyses

3.5.1 Defining reading groups

Before running statistical analyses in order to find answers for the research questions, the placement of poor and adequate readers was reviewed and examined in their previously assigned reading groups that were determined by the teachers. When it was closely looked at participants' scores on some measurements (science reading comprehension performance and depth of vocabulary knowledge), it was observed that some poor readers revealed good reading performances and also some adequate readers performed less than expected on specific conditions. Thus, in line with previous studies in the reading literature, two analyses were executed in the given order: cluster analysis and discriminant analysis in order to define whether a

participant belongs to any of the reading group or not (Brasseur-Hock, Hock, Kieffer, Biancarosa, & Deshler, 2011).

Firstly, a cluster analysis was run in order to identify the reading groups of the participants. Cluster analysis aims to categorize cases into groups that share similar characteristics. According to the results of the cluster analysis, 33 poor, 46 adequate readers were determined as different from their previous assignment (40 for poor, 40 for adequate readers). Secondly, a discriminant analysis was conducted to find out whether a participant was a poor / adequate reader or not. Discriminant analysis is used to predict which group the case belongs to. It is utilized in order to test theory where cases are classified as predicted. Therefore the researcher of the study used discriminant analysis immediately after clustering the groups of data. Discriminant analysis creates an equation as it is done in multiple regressions however it minimizes the possibility of misclassifying the cases into their relative groups by combining the variables scores into a new composite score, which is called as discriminant score. The degree of overlap between the discriminant scores of groups determines the success of the possible grouping. Since discrimination process is similar to regression, there are dependent and independent variables that is considered in grouping procedure. While predictor variables in the discriminant analysis were the depth of vocabulary knowledge, real-word and non-sense word reading, dependent variable (DV) was the science reading comprehension performance. According to the results of discriminant analysis, significant mean differences were obtained for all predictors on the DV. Log determinant were quite similar and Box's M was 6.95 with F=1.10 which is not significant (p = .355) as assumed. This result indicated that covariance matrices between groups do not differ and the assumption of equality of covariance matrices was not violated. In addition,

the discriminate function revealed a significant association between reading groups and all predictors, accounting for 65.44 % of between group variability. Finally, the cross validated classification showed that overall 93.7 % were correctly classified. In other words, the reading groups including thirty-three poor and forty-six adequate readers have 93.7 % of accuracy for this study.

Additionally, remained 6.3 % of sample, 4 cases out of seventy-nine participants, were closely examined in order to confirm their reading groups. One of the cases was belonging to the poor reader group however the discriminant analysis predicted it as having adequate reader characteristics. The mean scores of DV and predictor variables of this case were compared with both poor and adequate readers' mean scores and then this case was placed into poor readers' group since its mean scores was below the means of the poor reader group. The same procedure was implemented for other three cases. According to their higher mean values for the measures of DV and predictor variables, all these 3 cases were put into the group of adequate readers.

3.5.2 Preliminary analyses

Before conducting statistical analyses, data screening was implemented. Descriptive statistics (means, ranges, standard deviations, skewness, and kurtosis) and correlations were run for independent variables and the dependent variable. Additionally, assumptions relevant to each statistical analysis were checked as follows: (a) independency of data, (b) normality, (c) homogeneity of variance, (d) homoscedasticity, (e) linearity, (f) absence of any outliers (Huck, 2012; Fraenkel et al., 2012; Santoro, 2012).

3.5.3 Statistical analyses

All the data were analyzed quantitatively and IBM Statistical Package for Social Sciences (SPSS) 22.0 was used in order to run statistical analyses. All analyses in this study are categorized into two: comparative and predictive analyses. Each analysis procedure regarding specific research questions is presented as follows:

3.5.3.1 Comparative analyses

In order to investigate first and second research questions, comparative analyses were conducted. In the first research question, difference between 5th grade poor and adequate readers in terms of their total science reading comprehension performances was investigated. To provide a general science reading comprehension performance measure for participants, the composite score of science reading comprehension was firstly generated by combining all scores taken from four separate science reading measures: (1) collection of descriptions, (2) compare-contrast, (3) problem-solution, and (4) cause-effect. Then, an independent samples *t*-test was conducted in order to see the difference between 5th grade poor and adequate readers in terms of their general science reading comprehension performances. Through this analysis, the alpha level was set at .05 and assumptions for the test were met.

In the second research question, difference between 5th grade poor and adequate readers in terms of their total science reading comprehension performances of different expository texts including Collection of Descriptions, Problem-Solution, Compare-Contrast and Cause-Effect was investigated. The Mann-Whitney U test was performed in order to find the difference between 5th grade poor and adequate

readers' science reading comprehension performances across different expository text reading measures. This test is an alternative test for independent samples *t*-test when the assumption for normality is not met for the data (Huck, 2012). Additionally, it was explored whether the potential difference between reading groups changes across different expository text structures. For this aim, four independent samples t-tests were run to find the significance between text structures for reading groups. A Bonferroni adjusted significance criterion of .0125 (.05/4) was used for applied multiple tests at the same time. It is one of the most common techniques to adjust alpha level and Type I error risk was simply reduced by the number of times that the procedure of the hypothesis testing is going to be used (Huck, 2012).

3.5.3.2 Predictive analyses

For third and fourth research questions, predictive analyses were conducted. For third research question of the present study, the contributions of cognitive variables (RAN, PS, MA, WM, Vocab, and SRF) to science reading comprehension performances of adequate were investigated. Firstly, inter-correlations between independent variables and the dependent variable (science reading comprehension) were explored by Pearson product-moment correlational analysis. An alpha level of .10 was used in order to run all analyses, because it was intended to include all potentially useful relationships. Therefore a more liberal and inclusive value of alpha was selected as suggested by Babür (2003). Then, path analysis was employed in order to reveal the relative importance of measured variables (RAN, PS, MA, WM, Vocab, and SRF) onto the dependent variable (science reading comprehension) for each reading group data. All assumptions were separately met to conduct path analysis for each reading

group. For the fourth research question of the present study, all process executed for the third research question was repeated for the data of the poor reader group.

3.5.3.3 Path analysis

Path analysis is a flexible and comprehensive method in order to (a) understand the patterns of correlation/covariance among a set of variables, and (b) explain as much of their variance as possible with the specified model (Suhr, 2008, p.1). For this aim, models and relationships among measured variables are tested in a pattern which is defined as the proposed path model (Pedhazur, 1997). It is generally defined as a causal modelling and allows examination of hypotheses of small samples in the direction of causality estimation. In addition, it is regarded as an extension of multiple regressions (Babür, 2003) and presented as a beneficial analysis method for investigating achievement and other phenomenon such as health issues, self-efficacy, and depression (Suhr, 2008).

In a path analysis, all studied variables are depicted in a path diagram that is required to be hypothesized under the control of a theory-driven model. In other words, all hypothesized correlational and causal constructs in the developing path diagram must be built regarding the theoretical rationale of the related study (Pedhazur, 1997). There are three important steps of path analysis while setting decisions according to this requirement: (1) to determine which variables to include in the model, (2) to specify how to order the causal chain of those variables, and (3) to indicate which paths are not necessary for the model. It is important to know that the third step is the only one that is statistically tested in the path analysis procedure.

A path diagram is an illustration showing direct and indirect effects of the independent variables (IVs) on the dependent variables (DVs). Variables in a path diagram are either *exogenous*, whose variance is not dependent on any other variable in the model, or *endogenous*, whose variance is based on other variables in the model. Straight arrows between two variables indicate the directions of causal relationships and only point in one direction. On the other hand, curved or double-headed arrows show correlations between exogenous variables in a path model. While exogenous variables are depicted by ovals or circles, endogenous variables are illustrated by rectangular or quadratic shapes.

By means of path analysis procedure, one can illustrate and find direct and indirect paths through DVs using standardized path coefficients, which are beta weights obtained from linear regression analysis. The standardized regression/path coefficients (β) are the estimated changes in a DV and related with a one standard deviation (SD) change in each IV, holding the other IVs constant. Therefore, they express the effect of a specific IV on a DV in standard deviation units. While a beta coefficient can be calculated to reveal the direct effect of one exogenous variable on an endogenous variable, two or more beta coefficients can be combined together to produce total effect estimates which give information about indirect effects.

The direct effect illustrates the effect of a variable on another one without the mediating factors of other variables. On the other hand, indirect effect refers to the effect of a variable which is mediated by one or more variables (Pedhazur, 1997). The following figure represents a simple example of how direct and indirect effects of variables are shown in a path model/diagram with path coefficients.

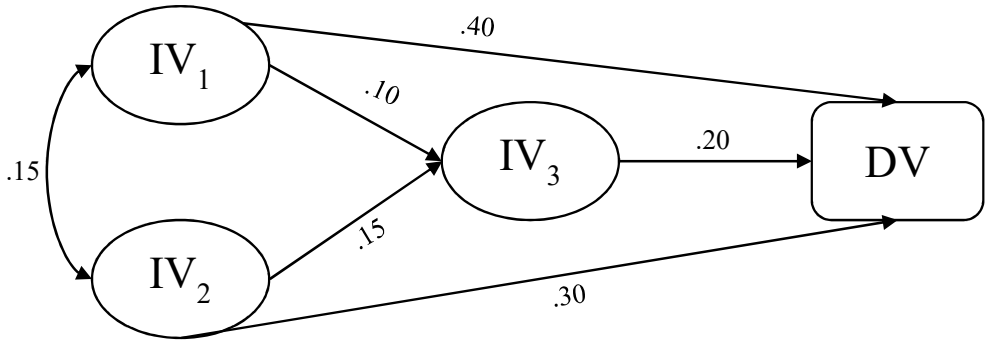


Fig. 2 Direct and indirect effects in an exemplary path model

Example:

$IV_1 \longrightarrow DV = .40$ (direct effect of IV_1 on DV)

$IV_3 \longrightarrow DV = .20$ (direct effect of IV_3 on DV)

$IV_1 \longrightarrow IV_3 = .10$ (direct effect of IV_1 on IV_3)

$IV_1 \longrightarrow IV_3 \longrightarrow DV$ is (.10) (.20) = .02 (indirect effect of IV_1 on DV through IV_3)

Table 2. Calculations Regarding Direct and Indirect Effects in The Path Model

	Direct effect	Indirect effect	Total effect
IV_1	.40	(.10) (.20) = .02	.40 + .02 = .42

In Figure 2 illustrated above, IV_1, IV_2 and IV_3 have direct effects on the dependent or endogenous variable, DV. However, the direct effects of IV_1 and IV_2 are facilitated or mediated by IV_3 therefore IV_3 can be illustrated as a mediator variable different from IV_1 and IV_2 which can be stated as exogenous variables. In Table 2, the direct, indirect and total effects of IV_1 on DV were illustrated in a very brief way. It can be seen that adding all path coefficients regarding the path of IV_1 through DV reflects the total weight of the particular path (see Table 2).

In the framework of the present study, the relationships among measured variables (RAN, PS, MA, WM, Vocabulary, and SRF) were examined through a classical path analysis and linear regressions. The direct and indirect effects of the constructs on one another and on DVs of science reading comprehension and science

reading fluency were examined for each reading group (adequate and poor readers). The proposed path model, which represented in the page of 56, was developed. Then absolute magnitudes of path coefficients were examined. Standardized path coefficients with absolute values less than .10 were regarded as “small” effect estimations as suggested by (Suhr, 2008). In addition, specific paths with beta coefficients which reach “.10” significance level as well as with absolute values between .10 and .90 were illustrated by bold lines. Any value that contradicts this information was shown by dashed lines. Based on this procedure, the model of the present study was modified, reduced, and novel path diagrams were developed for each reading group data.

CHAPTER 4

RESULTS

In this chapter, the findings of the quantitative data analysis are presented. This chapter has three sections. The first section presents descriptive statistics for all measures (independent and dependent variables). The second section shows the findings obtained from each research question with their relevant preliminary analysis results, and the last section evaluates all proposed path models created from research questions of 3 and 4 and describes the reduced models based on modifications applied to the path models of each reading group.

4.1 Descriptive statistics

Descriptive statistics based on the mean scores and standard deviations of adequate and poor readers were illustrated in Table 3.

Table 3. Means and Standard Deviations for All Measures by Reading Group

Variables	Reading groups					
	Poor readers			Adequate readers		
	M	*SD*	*N*	*M*	*SD*	*N*
Linguistic skills						
SRF	234.29	92.63	33	142.22	48.29	46
Vocabulary	33.93	12.92	33	49.71	8.63	46
Cognitive skills						
RAN	27.85	6.78	33	21.87	3.45	46
PS	26.66	5.59	33	31.76	11.09	46
MA	42.36	6.75	33	50.23	6.36	46
WM	12.18	3.96	33	15.36	4.65	46
SRC						
Text 1	16.78	12.35	33	25.89	12.97	46
Text 2	25.15	9.95	33	31.63	9.14	46
Text 3	14.78	6.83	33	19.28	6.12	46
Text 4	22.03	9.23	33	26.32	6.95	46

Total score	78.75	29.00	33	103.13	20.97	46

Note. SRF = Science Reading Fluency (in seconds); Vocabulary = Depth of Vocabulary Knowledge; MA = Morphological Awareness; RAN = Rapid Automatized Naming (in seconds); PS = Processing Speed; WM = Working Memory; Text 1 = Collection of Descriptions; Text 2 = Problem-Solution; Text 3 = Compare-Contrast; Text 4 = Cause-Effect.

Table 3 shows that poor readers had lower mean scores compared to their adequate reader peers at both independent (reading-related / linguistic and cognitive skills) and outcome (science reading comprehension) variable of the present study.

4.2 Findings

4.2.1 Findings of the first research question

In order to investigate whether the performances in total science reading comprehension differ in reading groups of the present study, independent samples *t*-test was conducted. Firstly, following assumptions were met before executing the test: (1) the independent variables were including two independent groups or categories as poor and adequate readers, (2) the dependent variable (science reading comprehension) was measured on a continuous scale, (3) there were no outliers in each reading group, (4) normality of the data was tested by using Kolmogorov-Simirnov on the dependent variable. The test statistics was .200 ($p > .05$) and distribution of the data was normal, (5) Levene's Test for Equality of Variances was executed prior to interpret the results of *t*-testing. Since the significance value was greater than .05 in Levene's Test (.185), equal variances were assumed (Huck, 2012).

The results of independent samples *t*-test showed that 5th grade poor readers in the present study had significantly lower science reading comprehension performance ($n = 33$, $M = 78.75$, $SD = 29.00$) than adequate readers ($n = 46$, $M =$

103.13, SD = 20.97), $t(77) = 4.33$, $p < .05$, d =.95. This finding suggested that poor readers have more struggles than their adequate reader peers in reading 5th grade science texts.

4.2.2 Findings of the second research question

In order to investigate whether the performances in science reading comprehension across different expository test structures (collection of descriptions, problem-solution, compare-contrast and cause-effect) differ between the same groups, Mann-Whitney U test was conducted. Firstly, following assumptions were met before executing the test: (1) the independent variables were including two independent groups or categories as poor and adequate readers, (2) the dependent variable (science reading comprehension) was measured on a continuous scale, (3) there were no outliers in each reading group, (4) normality of the data was checked by running Kolmogorov-Simirnov test. Since the test statistics for each data was not significant at $p = .05$, the Mann-Whitney U test (a nonparametric equivalent of the t-test) was performed as appropriate.

The findings of Mann-Whitney U test indicated that the science reading comprehension performances in the poor reader group was significantly lower than the adequate reader group for all expository text structures including collection of descriptions ($U = 458$, $p = .003$), problem-solution ($U = 466$, $p = .003$), compare-contrast ($U = 421$, $p = .001$) and cause-effect ($U = 559$, $p = .045$). This finding shows that the lower science reading comprehension performances of poor readers do not change based on expository text structure type that they read. Adequate readers were well-achieved compared to their poor reader peers in reading each expository text structure.

Since significance differences were obtained for each science reading measure across different text structures, multiple *t*-tests were executed at the same time in order to investigate whether obtained significance levels differ across different text structures or not. Using a Bonferroni-adjusted alpha of .0125 (.05/4), 3 of the 4 reading scores were found significantly lower in poor readers for the texts of collection of descriptions ($t(77) = 3.13$, $p = .002$, $d = .68$), problem-solution ($t(77) = 2.99$, $p = .004$, $d = .65$), and compare-contrast ($t(77) = 3.06$, $p = .003$, $d = .80$). However, science reading comprehension performances do not differ for the text structure of cause-effect between the two reading groups ($p = .021$, $d = .51$). The results indicated that there exist group differences while reading the text structures of collection of descriptions, problem-solution, and compare-contrast however this result is not valid for Cause-Effect text structure. This finding may reveal that both poor and adequate readers have comparable struggles while reading cause & effect text structure therefore their performance on this task did not differ from each other.

4.2.3 Findings of the third and the fourth research questions

In this section, findings based on preliminary analysis are firstly reported. Then, results obtained from inter-correlational analysis between all variables and path analysis is shown in terms of each reading group. Preliminary analysis was executed in order to get accurate results from path analysis. Each preliminary analysis based on the data of reading groups is described in detail as follows:

4.2.3.1 Preliminary analysis results for the adequate readers

Data were first screened by missing data and outliers in adequate readers and then examined for assumptions. No missing data existed for the group of adequate

readers. Outliers were identified by doing preliminary regression analysis and calculating Mahalanobis distance. It was determined that chi-square critical value was 15.1 at $p < .001$ with $df = 6$. One case exceeded this critical value that is why it was excluded from adequate reader group ($n = 45$). Secondly, linearity was analyzed by creating scatterplot matrix of all independent variables and the dependent variable. All scatterplots displayed elliptical shapes which is a representative of linearity and normality for the data set. Univariate normality was thirdly assessed for each variable. Data sets of the variables including morphological awareness, working memory and processing speed showed abnormal distribution for adequate reader group. Thus, data of these variables were transformed by using transformation types of reflect & logarithm for MA, inverse for WM, and logarithm for PS. These transformed data were used in all subsequent analyses for adequate reader group. Finally, multivariate normality and homoscedasticity were examined through generation of a residuals plot within another preliminary regression. Residuals plot was not scattered thus multivariate normality and homoscedasticity was assumed.

4.2.3.2 Preliminary analysis results for the poor readers

Data were first screened by missing data and outliers in poor readers and then examined for assumptions. Since one of the poor readers showed extremely poor performance in almost each tests, she was directly excluded from the analyses. Outliers were identified by doing preliminary regression analysis and calculating Mahalanobis distance. It was determined that chi-square critical value was 18.00 at $p < .001$ with $df = 6$. Three cases exceeded this critical value that is why they were excluded from the poor reader group ($n = 30$). Secondly, linearity was analyzed by creating scatterplot matrix of all independent variables and the dependent variable.

All scatterplots displayed elliptical shapes which is a representative of linearity and normality for the data set. Univariate normality was thirdly assessed by Kolmogorov-Simirnov tests for each variable, indicating normal distribution at $p > .05$. Multivariate normality and homoscedasticity were finally examined through generation of a residuals plot within another preliminary regression. Residuals plot was not scattered thus multivariate normality and homoscedasticity was assumed.

4.2.3.3 Inter-correlational analysis results among the variables for reading groups

After all assumptions were separately met for both adequate and poor readers, inter-correlational analysis results were calculated among all measured variables for each reading group. The results of correlational analysis were illustrated in Table 4.

Table 4. Inter-correlations Among All Variables for Poor (n = 30) and Adequate Readers (n = 45)

Variables	SRC	SRF	Vocabulary	RAN	PS	MA	WM
SRC		-.319*	.279	-.091	.073	.065	.033
SRF	-.011		-.210	.094	-.279	-.027	-.094
Vocabulary	.539**	-.096		-.141	.125	.339*	.036
RAN	.137	.382*	.021		-.311*	-.244	-.144
PS	.265	-.192	.333	-.485**		.398**	-.083
MA	.511**	.182	.592**	.069	.449*		.020
WM	-.052	.541**	.101	-.121	-.015	.247	

Note. SRC = Science Reading Comprehension, SRF = Science Reading Fluency, Vocabulary = Depth of Vocabulary Knowledge, RAN = Rapid Automatized Naming, PS = Processing Speed, MA = Morphological Awareness, WM = Working Memory.
*$p < .05$, **$p < .001$. Poor reader group below diagonal and adequate reader group above diagonal.

Table 4 illustrates that there is a significant and moderate correlation between SRC and SRF in the adequate reader group ($r = -.319$, $p < .05$). In addition, other significant relations exist between the variable pairs of MA-Vocabulary (.339),

RAN-PS (-.311), and PS-MA (.398). On the other hand, in the poor reader group, SRC had significant as well as high correlation with Vocabulary (r = .539, p < .001) and MA (r = .511, p < .001) in a descending order. In addition, SRF significantly correlated with RAN (r = .382, p < .05) and WM (r = .541, p < .001) for poor reader group. Other significant relationship between independent variable pairs were between MA-Vocabulary (.592), RAN-PS (-.485), and PS-MA (.449).

4.2.3.1 Findings from the third research question

Path analysis results for science reading comprehension of adequate readers

The results in this section is reported based on the effects of independent (RAN, PS, MA, WM) and mediator variables (SRF and Vocabulary) on Science Reading Comprehension (SRC) for adequate reader group. Since SRF and Vocabulary are two main reading-related components which directly explain SRC, they were determined as mediator variables in the path model of the present study (See Figure 1, p. 56).

In the first layer of the path analysis, the contribution of independent variables (RAN, PS, MA, WM) on SRF and Vocabulary were calculated by simultaneous multiple regression. In the second layer, SRF and Vocabulary were regressed onto the dependent variable (SRC), and in the third step, all variables including independent and mediator ones were finally regressed onto SRC to find their unique contribution to SRC performances of adequate readers. The following paragraphs report overall result of the multiple regression analyses for the first path explaining adequate reader group. Path diagram of variables predicting SRC performances of adequate readers were illustrated in Figure 3 below. In addition, all

statistical analysis results based on the path diagram of adequate readers were shown in Tables of 5, 6, and 7.

Table 5. Direct Effects of PS, MA, And WM on SRF for Adequate Readers (n = 45)

Dependent variable	Independent variable	β	Squared semi-partial correlation	t-value	$p(t)$
Final step		Significantly effecting variables			
SRF	PS	-.332	.093	-2.04	< .10
	MA	.108	.010	.665	.510
	WM	-.124	.016	-.830	.411

Note: R^2 = .102, (p = .10), R^2_{adj} = .036, $F(3, 41) = 1.54$, p = .218, $p > .05$

Table 5 shows the multiple regression analysis results for the path between independent variables and the mediator variable, SRF, of the present study for adequate readers. After all independent variables (RAN, PS, MA, and WM) were regressed onto SRF, it was found that only PS (β = -.332, $p < .10$) had significantly explained 9.3 % of variance in SRF performances in the model (R^2 = .102, $p < .10$, $F(3, 41) = 1.54$, p = .218, $p > .05$). Although MA and WM did not significantly predict SRF performances, they were not excluded from the model because the beta weigh values of these cognitive correlates (β = .108, β = -.124, respectively) had small but considerable effect on SRF of adequate readers.

Table 6. Direct Effect of MA on Vocabulary for Adequate Readers (n = 45)

Dependent variable	Independent variable	β	Squared semi-partial correlation	t-value	$p(t)$
Final step		Significantly effecting variables			
Vocabulary	MA	.339	.114	2.36	< .10

Note: R^2 = .115, (p = .10), R^2_{adj} = .094, $F(1, 43) = 5.57$, p = .023, $p < .05$

Table 6 illustrates the multiple regression analysis results for the path between the independent variables and the mediator variable, Vocabulary, of the present study.

After all independent variables (RAN, PS, MA, and WM) were regressed onto Vocabulary, it was found that only MA (β = .339, $p < .10$) significantly explained 11.5 % of variance in Vocabulary in the model ($R^2 = .115$, $p = .10$, $F(1, 43) = 5.57$, $p = .023$, $p < .05$).

Table 7. Direct Effect of SRF, and Vocabulary on SRC for Adequate Readers (n = 45)

Dependent variable	Independent variable	β	Squared semi-partial correlation	t-value	$p(t)$
Final step		Significantly effecting variables			
SRC	SRF	-.272	.076	-1.86	< .10
	Vocabulary	.222	.052	1.52	.136

Note: $R^2 = .148$, ($p = .10$), $R^2_{adj} = .108$, $F(2, 42) = 3.66$, $p = .034$, $p < .05$

Table 7 displays the multiple regression results for the path between independent variables and the dependent variable, SRC, of the present study for adequate readers. After all independent variables as well as the mediator variables were regressed onto SRC, it was found that SRF (β = -.272, $p < .10$) significantly predicted SRC comprehension scores of adequate readers and explained 7.6 % of variance in SRC in the model ($R^2 = .148$, $p = .10$, $F(2, 42) = 3.66$, $p = .034$, $p < .05$). The negative beta weight of SRF indicated that the lower SRF means higher fluency performance for adequate readers in the present study. Although Vocabulary did not significantly predict SRC performances, it was not excluded from the model because the beta weigh value (β = .222) had small but considerable effect on SRC of adequate readers.

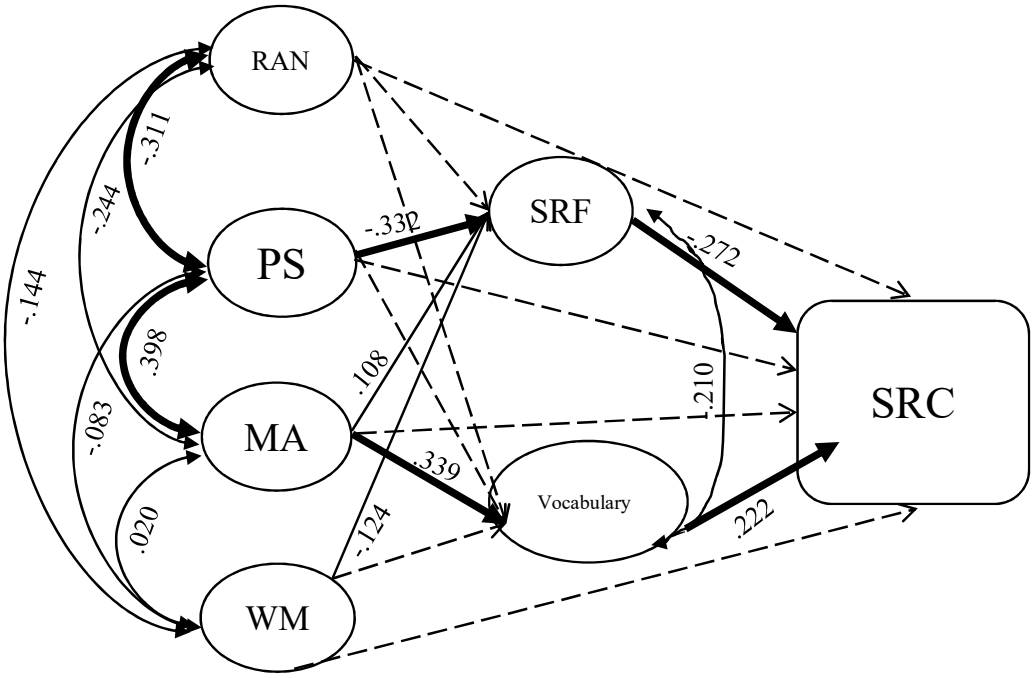


Fig. 3 Path diagram of variables predicting SRC for adequate readers

As Figure 3 illustrates, there is a significant indirect path from PS through SRC performances of adequate readers and this path is mediated by their SRF skills. In addition, there is a second significant indirect path from MA through SRC, which is moderated by Vocabulary capacity of these readers.

Results of total effects on Science Reading Comprehension (SRC) of adequate readers

In this section, total effects were calculated and illustrated in terms of each reading group. As described in Chapter 3, a path diagram consisting of indirect and direct path lines from IVs through DVs. The total effect of variables on a DV is calculated by summing direct and indirect effects of that related variable. The total effects of

each variable on the dependent variable, SRC, for adequate readers were illustrated at Table 8 below.

Table 8. Total Effects on SRC for Adequate Readers (n = 45)

Outcome	Determinant	Direct Effect	Indirect Effect	Total Effect
SRC	SRF	-.272	-	-.272
	Vocabulary	.222	-	.222
	PS	-	.090	.090
	MA	-	.046	.046
	WM	-	.033	.033
	RAN	-	-	-

According to the Table 8, mediator variables, SRF (-.272) and Vocabulary (.222), are the two cognitive correlates that have significant and direct effects on SRC performances of adequate readers in the present study. The negative effect of SRF on SRC indicates that how well participants comprehend the expository texts is related with how fast they read the textual materials used in the study. In addition, the effect of Vocabulary on SRC shows that an increase in participants' vocabulary knowledge has a positive influence on their performance of understanding and comprehension of expository text structures.

4.2.3.2 Findings from the fourth research question

4.2.3.2.1 Path analysis results for science reading comprehension of poor readers

The results in this section is reported based on the effects of independent (RAN, PS, MA, WM) and mediator variables (SRF and Vocabulary) on Science Reading Comprehension (SRC) for poor reader group. All the steps (each layer in the path diagram) of statistical analyses performed in adequate readers' data were carried out in the same way for poor readers as well. Path diagram of the variables predicting SRC performances of poor readers were illustrated in Figure 4 below. In addition, all

statistical analysis results based on the path diagram of poor readers were shown in Tables of 9, 10, and 11.

Table 9. Direct Effects of RAN, and WM on SRF for Poor Readers (n = 30)

Dependent variable	Independent variable	β	Squared semi-partial correlation	t-value	$p(t)$
Final step		Significantly effecting variables			
SRF	RAN	.454	.287	3.30	< .10
	WM	.596	.410	4.33	< .10

Note: R^2 = .496, (p = .10), R^2_{adj} = .459, $F(2, 27)$ = 13.30, p = .000, p < .05

Table 9 shows the multiple regression analysis results for the path between independent variables and the mediator variable, SRF, of the present study for poor readers. After all independent variables (RAN, PS, MA, and WM) were regressed onto SRF, it was found that only RAN (β = .454, p < .10) and WM (β = .596, p < .10) had significantly explained 49.6 % of variance in SRF performances in the model (R^2 = .496, (p = .10), $F(2, 27)$ = 13.30, p = .000, p < .05).

Table 10. Direct Effect of MA on Vocabulary for Poor Readers (n = 30)

Dependent variable	Independent variable	β	Squared semi-partial correlation	t-value	$p(t)$
Final step		Significantly effecting variables			
Vocabulary	MA	.592	.350	3.88	< .10

Note: R^2 = .351, (p = .10), R^2_{adj} = .327, $F(1, 28)$ = 15.11, p = .001, p < .05

Similar to the adequate reader group data, Table 6 illustrates that the only significantly effective variable on Vocabulary was MA for poor readers as well. In other words, MA (β = .592, p < .10) explained 35 % of variance in Vocabulary for poor readers (R^2 = .351, $F(1, 28)$ = 15.11, p = .001, p < .05).

Table 11. Direct Effect of Vocabulary, MA, RAN, and SRF on SRC for Poor Readers
(n = 30)

Dependent variable	Independent variable	β	Squared semi-partial correlation	t-value	$p(t)$
Final step		Significantly effecting variables			
SRC	Vocabulary	.366	.123	1.87	< .10
	MA	.313	.091	1.58	.125
	RAN	.172	.039	1.01	.322
	SRF	-.169	.037	-.98	.336

Note: R^2 = .383, (p = .10), R^2_{adj} = .284, $F(4, 25) = 3.87$, p = .014, $p < .05$

Table 11 shows the multiple regression results for the path between independent variables and the dependent variable, SRC, of the present study for poor readers. After all independent variables as well as the mediator variables were regressed onto SRC, it was found that Vocabulary (β = .366, $p < .10$) significantly predicted SRC comprehension scores of poor readers and explained 12.3 % of variance in SRC in the model (R^2 = .383, p = .10, $F(4, 25) = 3.87$, p = .014, $p < .05$).

Although MA (β = .313), RAN (β = .172), and SRF (β = -.169) did not significantly predict SRC performances, they were not excluded from the model because their weighs on effecting the dependent variable had considerable effect in the model. Especially, the unique effect of MA explained 9.1 % of variance in SRC for readers with poor expository text reading comprehension performance (β = .366, p = .125, $p > .10$).

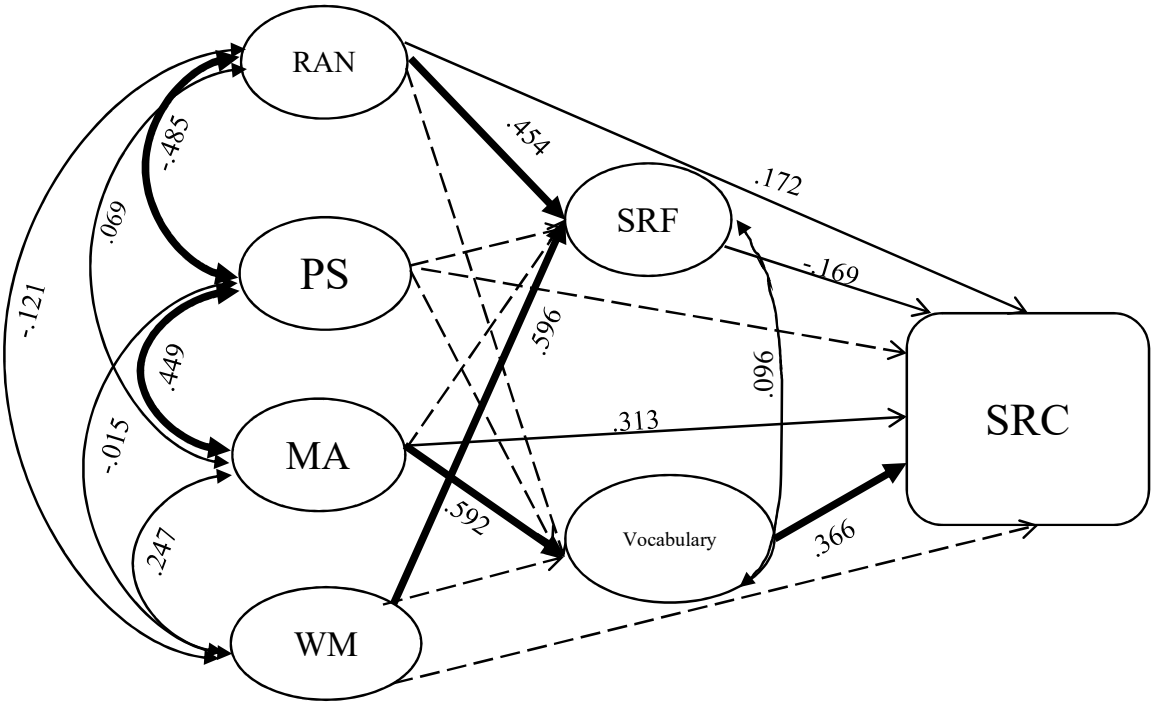


Fig. 4 Path diagram of variables predicting SRC for poor readers

As Figure 4 illustrates, there is only one a significant indirect path from MA through SRC which is mediated by Vocabulary in the path model of poor readers. In addition, significant direct path from RAN and MA through SRF are noted. However there is less number of significant paths, some insignificant but considerable amount of effects can be highlighted. For instance, the direct path from MA through SRC is worthwhile to examine. Moreover, the direct relationships between RAN-SRC and SRF-SRC are important to consider in the path modelling of poor reader data of the present study.

4.2.3.2.2 Results of total effects on Science Reading Comprehension (SRC) of poor readers

The total effects of each variable on the dependent variable, SRC, for poor readers were illustrated at Table 12 below.

Table 12. Total Effects on SRC for Poor Readers (n = 30)

Outcome	Determinant	Direct Effect	Indirect Effect	Total Effect
SRC	MA	.313	.216	.529
	Vocabulary	.366	-	.366
	SRF	-.169	-	-.169
	WM	-	.100	.100
	RAN	.172	-.076	.096
	PS	-	-	-

According to the Table 12, MA had the highest effect (.529) on SRC performances of poor readers. In addition, Vocabulary can be illustrated as having moderate effect on reading comprehension performances of poor readers in reading expository text structures. Different from adequate reader group, SRF had small effect on SRC for poor readers.

CHAPTER 5

DISCUSSION AND CONCLUSION

This chapter includes the discussion of the results obtained from the data analysis. Based on the findings, it presents some implications for reading comprehension instruction at Turkish educational settings, especially for science text reading. In addition, it provides limitations of the current study, and some suggestions which are given for further research in the field of reading comprehension and reading difficulties.

5.1 Discussion

The primary goal of this study was comparing the science reading comprehension performances of 5th grade students with and without reading difficulty. It aimed to compare the participants' expository text reading comprehension performances in terms of both overall and separate achievement scores from different text structures (Collection of Descriptions, Compare-Contrast, Cause-Effect, and Problem-Solution). In addition, a newly developed multicomponent model of the cross-sectional data was examined to determine the cognitive and linguistic correlates of science reading comprehension for 5th grade students with different reading competencies.

5.1.1 Comparing expository text reading performances of adequate and poor readers

It was hypothesized in the current study that participants with poor reading comprehension performance in 5th grade level had significantly inferior scores compared to their adequate reader peers on each measure which effects reading

comprehension. As predicted, the results of the independent samples *t*-test showed that students who were classified as poor readers in the current study performed significantly lower performance on both overall and separate measures of science text reading. The result showing the lower performance of poor readers in overall science reading was in congruence with previous studies, which stated that skilled readers have superior reading performance in terms of recalling information in science texts than those of which indicate poor performance in reading these kinds of texts (McNamara & Wong, 2003; Taylor, 1979). On the other hand, when the differences were investigated within text structures, series of *t*-test results showed that reading groups revealed significant and comparable performances for three text structures including Collection of Description, Compare-Contrast, and Problem-Solution whereas their comprehension level did not significantly differ when reading Cause-Effect text structure ($p = .021$, $p > .0125$). This result is consistent with the findings of Richgels and colleagues (1987), which found that middle school students had the awareness of some scientific texts including description, compare-contrast, and problem-solution however they have difficulty while recognizing the causation signals in a science text. The result of the second research question has similar interpretations with the aforementioned study because it can be assumed that the Cause-Effect version of expository texts can be challenging for both poor and adequate readers (Meyer & Freedle, 1984) due to the language demands or complexity of these types of text structures (Fang, 2006). Therefore it may result in deficiencies of recognizing, understanding and interpreting the meaning located in those texts regardless of reading competencies beyond primary grades. Moreover, achievement scores of poor readers obtained from the cognitive and linguistic correlates of reading comprehension (RAN, PS, MA, WM, SRF, and Vocab) were

determined as lower than those of adequate readers. This finding might indicate the existence of some cognitive components that explains the difficulty of science reading comprehension in the context of Turkish.

5.1.2 The interplay between cognitive, linguistic skills and science reading comprehension

In order to reveal the inter-relationships between all variables, correlational analyses were executed for each reading group data. The correlational analysis results of adequate and poor readers showed different patterns from each other in terms of the associations between independent variables (RAN, PS, MA, WM, SRF, and Vocab) and the outcome variable (SRC).

5.1.2.1 Adequate readers

According to the Automaticity Theory of Reading (Samuels, 1976) and Componential Model of Reading (Joshi & Aaron, 2000), reading fluency in any context has a strong correlation with reading comprehension performances of skilled readers. Since speeded reading frees the attention devoted for decoding individual words while reading, it facilitates better the meaning making process for readers. In the present study, it is possible to see that adequate readers can fluently read expository texts and therefore their better SRC performance compared to poor readers can be associated with their fluent reading activity.

5.1.2.2 Poor readers

The results demonstrated that SRC correlated more strongly with MA (.511) and Vocab (.539) for poor readers ($p < .01$). This means that deficiencies in the

knowledge of structures of derivatives, inflections and grammatical features of words, and having less word meaning capacity of disadvantaged readers are crucial for understanding the poor performance of these students. More specifically, failing to recognize the correct form of suffixes in proper sentence content, and also having less knowledge of content familiar words could impair their reading comprehension performances. This relational finding is consistent with the study results of Primor et al. (2011) and Oslund et al. (2018), both of which examined the relationship between SRC and its correlates and found significant relationship between variable pairs of SRC-MA (Primor et al., 2011), and SRC-Vocab (Oslund et al., 2018) especially for poor readers who study beyond primary years.

5.1.3 Contributions of PS, MA, SRF, and Vocabulary to SRC for adequate readers

Path analysis results based on the proposed model of readers with adequate performances revealed that SRF and Vocabulary did not only have a direct influence on SRC but also took a scaffolder role for building the relationship between the variable pairs of PS-SRC and MA-SRC. Firstly, this result is in congruence with the theoretical accounts based on the role of reading fluency because SRF is stated as a reading-related skill which indicates the overall reading competency of individuals (e.g., Fuchs et al., 2001; Laberge & Samuels, 1974) and the considerable amount of total effect of SRF on SRC for adequate readers can confirm the view of these theoretical perspectives. Especially beyond Grade 4, text reading fluency starts taking a mediating role for explaining the relationship between sub-lexical and text-level skills of readers. In other words, in the beginning years of reading comprehension development students' reading comprehension skills can easily be explained by their word-reading skills however as they pass Grade 3, the contribution

based on SRF and listening comprehension (e.g. oral vocabulary knowledge) skills of adequate readers increases (Kim & Wagner, 2015). However, the accounts of Kim and Wagner (2015) approach the role of text reading fluency on reading comprehension in the context of English reading, some Turkish studies examining the relationship between reading fluency and comprehension in 5th grade students provided consistent results for the present study (e.g., Baştuğ & Keskin, 2012; Yıldırım et al., 2017; Yıldız & Çetinkaya, 2017; Yılmaz & Baydık, 2017). Common findings of all of these studies revealed and supported the hypothesis of the present study in the sense that reading comprehension performances of students beyond primary years are related with how fast or fluent they can process the information in expository texts. However, these studies remain insufficient for giving evidence which would explain the causal relationship between SRC and SRF in Turkish reading context. Different from prior research, the present study found how well text reading fluency of adequate readers explained the significant variance in their reading comprehension performances for science text reading.

The second variable which directly affected the SRC performances of adequate readers in the model of the present study were found as Vocabulary, which was operationalized as the depth of vocabulary knowledge accounting for the quality of semantic, meaning making, skills of the readers (Perfetti, 2007). This result is consistent with the other study findings which examined the role of oral vocabulary knowledge in explaining reading comprehension (e.g., Oslund, et al., 2018; Ouellette, 2006; Protopapas, et al., 2013; Swart, et al., 2017) however the present study results can be mostly resembled to the findings of Oslund and his colleagues (2018), which found the unique effect of the ability of explaining word meaning on science reading comprehension performances of adequate readers in the middle

school level. In the lights of the consistent findings, the importance of expressing word meanings in expository discourse can be linked to the ability of adequate readers' comprehending performance where they can immediately use the word meanings in the information integration process in science content. Additionally, this strong causal relation between depth of vocabulary knowledge and reading comprehension may indicate the bigger semantic capacity of adequate readers' lexical knowledge in the content of middle school science (Perfetti & Stafura, 2014). Since vocabulary and reading comprehension have a reciprocal relationship, this finding may also validate the view that greater vocabulary size leads to better comprehension which helps school-aged individuals learn more content-area vocabulary (Kieffer & Lesaux, 2007).

Regarding the causal relation between adequate readers' skills of speed of processing and morphological awareness with their SRC performances, it was found that SRF and Vocabulary had mediating effects. In other words while PS skills of these students were mediated by SRF performances, MA skills were moderated by their Vocabulary skills in order to explain their overall SRC performance. Firstly, the indirect effect of PS skills on SRC performances of adequate readers through SRF measure can be explained by the view of Joshi & Aaron (2000) because they found that the speed of processing skills of typical students beyond primary years (Grade 4) added significant amount of variance (10 %) in explaining their reading comprehension performance. However the study of Joshi & Aaron (2000) solely examined PS-reading comprehension relation in a direct manner and there is no study which found an indirect relationship through SRF according to the researcher's knowledge of the present study. On the other hand, MA-SRC relation through Vocabulary can be shown as a consistent finding with previous reading research

because this relationship demonstrates the facilitating role of morphemes through the capability of explaining meaning of words in order to support skilled reading comprehension performance of adequate readers (e.g., Kuo & Anderson, 2006; Nagy, et al., 2006). In other words, as students become abled to understand the morphemic structure of the words located in the texts, they can also increase their vocabulary capacity which gradually leads them to have better reading comprehension development. Contrary to the present study results, Levesque and his colleagues (2017) found no mediating effect of vocabulary on MA-SRC relationship for 3rd grade students and they discussed that the role of vocabulary in this grade level may be not sufficient to build this relation because these students are still in the process of novel vocabulary learning for facilitating their reading comprehension development (Levesque, et al., 2017). Although these studies provide either consistent or inconsistent findings with the present study results in terms of MA-SRC relationship, it is required to know that there is almost no research in Turkish examining the relation between MA-Vocabulary to reveal the word-level effects in comprehending different kinds of text structures (Durgunoğlu, 2017).

5.1.4 Contributions of RAN, MA, WM, SRF, and Vocabulary to SRC for poor readers

Path analysis results based on the proposed multicomponent model of poor readers in the present study showed that the skills of MA, SRF, and Vocabulary had stronger total effects on their SRC performances compared to the other variables including RAN, PS, and WM. In terms of the indirect path results, SRF moderated the relations between RAN-SRC and WM-SRC, while Vocabulary only mediated MA-SRC relationship. Firstly it was found that MA had the highest total effect (.529) on SRC

for poor readers in the present study. This finding is congruence with the study result of Burani, et al. (2008) because they attributed this relation to the poor readers' ability to use morphological awareness or morphemic constituency (roots and suffixes) primarily as a strategy for rapid reading to compensate for their struggling reading comprehension performance. More specifically, since poor readers cannot achieve to develop their sight-word reading as their adequate reader peers, they try to reach reading comprehension by relying on their abilities to decompose words into meaningful units such as roots and suffixes which also indicates their word-level skills in reading comprehension (Burani, et al., 2008). There are also other studies which found inconsistent results showing no effect of MA on explaining SRC performances of poor readers (Mokhtari, et al., 2016; Primor, et al., 2011) however it should be noted that these studies were executed with participants whose native languages were different from Turkish therefore it is important to state that border-lines of the relationships between reading comprehension and its cognitive and linguistic correlates regarding each specific language system may be different from each other and these relations may not always show the same pattern for explaining the nature of reading comprehension.

Regarding the total effects of SRF and Vocabulary for poor readers in the present study, it was found that depth of vocabulary knowledge had a significant direct effect on SRC. This finding might indicate that low semantic skills of poor readers may result in poor performance in comprehending expository texts because it was theoretically proved that the ability of comprehending any kind of texts mainly requires the ability of comprehending words (Perfetti & Stafura, 2014). Additionally, this finding corporates those of Oslund, et al. (2018) and Torgesen, et al. (2007) who found that vocabulary was a statistically significant predictor of reading

comprehension performances of middle school students. Thus it can be stated that the facilitating role of vocabulary in explaining reading comprehension for adequate and struggling readers are alike.

Different from the results obtained from adequate readers' data, RAN and WM had statistically significant direct effects on SRF in explaining SRC for poor readers. With respect to the RAN-SRF relation, the present study provides consistent results with previous theoretical considerations because naming speed is regarded as a good predictor of less fluent performance of struggling readers (Wolf, et al., 1986; 2000). On the other hand, the direct relationship between RAN-SRF in explaining SRC performances of middle school students in the present study are in line with previous empirical study results executed with English (Barth, Catts, & Anthony, 2009) and Turkish (Babayiğit & Stainthorp, 2011) speaking children. These studies commonly found that RAN was the factor most uniquely related to reading fluency performance as similar to the present study results. Moreover, it is crucial to stress the importance of determining which RAN task is supposed to be used in examining its relation with reading fluency and comprehension because difficulties of poor readers are reasoned by several processes including inaccurate retrieval of phonological codes (Wagner, et al., 1994), poor controlling of cognitive processes to have phonological retrieval (Wolf, et al., 2000), and problems generally related to speed of processing (Kail & Hall, 1994). Therefore, considering the need of further studies which may look at the factors related to RAN, rather than RAN itself, is important especially for understanding the reading competencies of poor readers (Barth, et al., 2009).

On the other hand, another significant association was found between SRF and WM for poor readers. Although lack of relevant empirical studies limits the

discussion about WM-SRF relation especially for the language systems with shallow orthographies like Turkish, it could be noted that this finding may indicate the integral role of WM in explaining some linguistic processing skills in a general manner. In other words, this finding may provide evidence that linguistic skills of readers are constrained by their general memory capacity and its effective utilization regardless from language specificity. The direct relation of WM with SRF performances of poor readers may reveal the fact that WM is a kind of language subsystem specifically designed for language comprehension skills of individuals with different competencies (Dehn, 2008). Thus it can be derived from this interpretation that lower WM capacity of poor readers in the present study may compromise their automatic reading skills and therefore it resulted in poor reading comprehension. However one of the studies done with Greek-speaking middle school children provided inconsistent results with the present study (Chrysochoou, Bablekou, & Tsigilis, 2011). While the study found no mediating effect of reading fluency for WM-reading comprehension relation, they similarly touched upon the lack of relevant studies regarding this relation in transparent language systems as it was did in this section of the present study. In other words, it can be stated that WM could be a language-specific cognitive correlate of reading comprehension.

The last pattern obtained from the path analysis results of poor readers in the present study revealed that depth of vocabulary knowledge of these students mediates the relationship between their MA and SRC skills. There are plausible explanations from some previous study findings regarding this pattern for struggling readers (e.g., Cain, et al., 2004; Nagy, et al., 2003; Tong, et al., 2011). One of the explanations can be obtained from the consistent study findings of Tong, et al. (2011), who found that poor MA skills of students contribute to reading

comprehension difficulties especially in the late elementary school years like Grade 5 and this relation can be reasoned by poor skills of these students at inferring the meaning of novel words from the content (Cain, et al., 2004; Tong, et al., 2011). With respect to skilled readers, children who understand the morphemic structure of words might be able to transfer this ability into their understanding and expressing the meaning of the words in a content-area reading task and ultimately it may result in successful reading comprehension. However, for struggling readers, since they might be less able to acquire the meanings of new morphologically complex words that they come across in texts, they cannot comprehend better (Nagy, et al., 2003; Tong, et al., 2011) as it was observed in the poor reader group of the present study.

5.2 Conclusion

The present study results showed that reading comprehension of science texts have both similar and different patterns for Turkish middle school students with different reading profiles. For similarities, it could be noted that depth of vocabulary knowledge or ability to express word-meanings were found to be the second important determinant for science reading comprehension in both groups. This finding may reveal the importance of the word-knowledge and capacity for all in science learning. In addition, the moderate effect of vocabulary knowledge in SRC may put forward the perspective of SVR in which the language comprehension skills of upper grade students are emphasized as becoming significant in predicting reading comprehension in those years rather than focusing on decoding (Gough & Tunmer, 1986). As a result, given the strength of Vocab-SRC relation, it can be stated that word-meaning development could be a logical pressure point for science reading instruction.

For the differences between adequate and poor readers, while SRF seems to be the most important variable affecting comprehension performances for adequate readers, morphological awareness was found as the first and significant contributor for struggling readers' SRC performance. This finding may imply that adequate readers who participated in the present study have a better understanding of the informational or expository texts they read, depending on their fluent reading. On the other hand, since fluency performance is deficient in poor readers, it may come to the forefront as a variable that better predicts comprehension performance in poor readers with the ability to break words into their roots and suffixes which accounts for the awareness of morphology in reading. In addition, one can also speculate that two important linguistic comprehension skills, SRF and MA, were found as the key factors to consider reading comprehension in Turkish. This finding can be regarded as a first step in the need for correct assessment and evaluation of fluency and morphological awareness skills in terms of understanding how fifth graders deal with reading comprehension while reading complex structured texts such as expository discourse in science.

5.3 Implications

The results of the present study suggest that reading comprehension performances of 5th grade students with and without reading difficulties have distinctive patterns in terms of their SRC performances as well as cognitive, linguistic, and affective predictors that determine their unique SRC performance. First of all, it was revealed that poor readers showed inferior performance than adequate reader peers in both overall reading performance and reading different kinds of expository text structures such as collection of descriptions, compare-contrast, and problem-solution. Thus,

educators should also assess the possible weaknesses of students at this level as they use such kind of expository texts in their instructional settings. In addition, it was found that the reading comprehension performances of reading groups in the present study did not significantly differ when they read cause-effect structure. When this finding is evaluated, it can be suggested that educators should closely follow the reading performance of all readers, particularly when they especially read Cause-Effect texts.

On the other hand, when SRC performances of struggling and good readers were compared by means of cognitive and linguistic correlates of reading comprehension, it was seen that the predictive path of the variables that differed from each other. For the adequate readers, fluency in reading expository text reading affected their SRC performances the most. How to instruct fluent readers in a content-area course to make them better in comprehending is important to consider. In other words, it can be stated that fluency-based instruction should be founded in meaning-based, whole language instruction (Altwerger, Jordan, & Shelton, 2007). If the only purpose of reading is to increase the rate of reading of these readers, they may lose what they are supposed to focus on, comprehension. Thus creating fluent readers without taking meaningful comprehension into account will be an irresponsible practice for these readers. Thus, a meaning-centered approach regarding the specific contents can be suggested to educators in this sense. In addition, the adequate readers' path revealed that their SRC performance was also significantly predicted by their MA skill by means of the mediation of their vocabulary skills. This finding may suggest that the strong lexical representations of words of adequate readers also facilitate their MA skills which in turn enhance their SRC skills in reading expository texts. To keep this efficiency, specific instructions

can be maintained by educators by teaching morphological structures of content-area vocabulary in science texts. It may also prevent these readers encounter any surprise in reading (like influent reading performance due to the morphologically complex nature of a word) such complicated texts and may increase their reading comprehension performance more.

For poor readers, MA, Vocab, and SRF emerged as three important correlates of struggling SRC performance. While the pattern of MA through SRC was the same as adequate readers, the role of RAN and WM in explaining SRC through fluency emerged differently. This finding may indicate that explicit teaching of reading by sight will be important for these students. It was also found that WM had an influence on their fluency. Since automated reading makes WM capacity of individuals available for better comprehension, lower WM capacity of the poor readers in the present study would prevent them to devote their resources necessary for fluent reading and it therefore may result in lower SRC performance. Thus the development of automaticity in reading science texts for poor readers may be the great equalizer for WM-comprehension relation because it is stated that WM skills of the reader may better focus on higher-order processing skills when automatic reading is adequately achieved (Swanson, et al., 2007). In addition, some specific techniques such as scaffolding struggling reading while reading content-area texts, using advance organizers to activate their relevant schema about the topic read, using verbal rehearsal strategy or visual mnemonics can be used to increase these students' retention and retrieval of information (Dehn, 2008).

5.4 Limitations of the present study

The present study has a number of limitations including:

- This study included only fifth grade students in a limited amount of sample size. With a larger sample from randomly selected students in each reading group would provide more credible results in terms of generalizability.
- The measure of Science Reading Fluency (SRF) was applied to students via recording their response time in answering each reading comprehension questions. A standardized text reading fluency instrument would be used in order to obtain more reliable and valid results about the SRF skills of the participants.
- The expository texts used in the present study were developed by the researcher of the current study. In the process of developing the texts, additional expert opinions could be obtained from cognitive psychologists and special education specialists besides experts in the department of education.
- The current study embodied a quantitative research design. A longitudinal study would also be beneficial in order to have a deeper understanding of the cognitive development of adequate and poor readers in reading activity.
- This study is the first reading research study which aimed to differentiate adequate and poor readers not only for comparing their science reading comprehension performances but also for examining their differences in the cognitive, linguistic, and affective domain in reading comprehension in Turkish. That is why, the researcher of the present study has struggles in finding related literature specific to the language system of Turkish.

5.5 Recommendations for further research

Further research can be implemented with a larger sample size to see the correct effects of the independent correlates of reading comprehension. Additionally, more comprehensive reading comprehension measure would be used to assess science reading efficiency, accuracy as well as comprehension performances of different reading groups. Another suggestion may be about executing additional longitudinal and cross-sectional further research in Turkish reading in terms of the variety of factors related to the socio-cultural context of reading.

APPENDIX A

TEXT 1: COLLECTION OF DESCRIPTIONS

The Journey of Food through Our Body
(*Besinin Vücuttaki Yolculuğu*)

When we start to eat food, large first broken down by our teeth. Saliva in our mouth starts breaking down the food. While chewing, we taste that food with the taste buds on our tongue. When we swallow the food, it travels down the esophagus, or food tube, to the stomach. The stomach breaks up the food, mixes the food with chemicals in our stomach which helps to remove the nutrients from the food. The stomach muscles mix and move the food by repeatedly stiffening and relaxing.

Bir şeyler yemeye başladığımız zaman ilk olarak besini dişlerimiz ile parçalarız. Ardından dilimiz ile o besini tadarız. Daha sonra besin, yutaktan mideye doğru yolculuk yapmaya başlar. Mide, kasılıp gevşeme özelliği ile besini sırasıyla parçalar, karıştırır, bulamaç haline getirir ve burada sindirir.

Next, the digestible food moves to the small intestine. It is curved in shape and about 8 meters long. In the small intestine, the digestible food is separated and mixed with blood. Once broken down, the digestible food travels to the large intestine where absorption of water, vitamins, and minerals from the food takes place. Eventually, food wastes eliminated from the body through the colon and anus.

Sindirilen besin, yaklaşık 8 metre uzunluğundaki kıvrımlı şekle sahip ince bağırsağımıza ulaştırılır ve burada ufak parçalara ayrılarak kana karışır. Daha sonra, besinin yolculuğu su ve minerallerin emiliminin sağlandığı kalın bağırsakta devam eder. En sonunda, oluşmuş olan besin artıkları anüs yardımı ile vücut dışına atılır.

Reading Comprehension Questions
(Okuduğunu Anlama Soruları)

1. What is the first place that food digestion starts in the journey through our body?
   (Besinin vücudumuzda yolculuğu sırasında ilk uğradığı yer neresidir?)

2. Once we swallow food, name the organs of the body that the food travels through.
   (Besinin vücutta uğradığı organların adını sırasıyla söyle.)

3. Describe what happens when the food is between the stomach and the small intestine.
(Besinin mide ile ince bağırsak arasındaki geçirdiği aşamaları sırasıyla söyle.)

4. Which organ of your body absorbs vitamins and minerals from food?
(Vücudumuzun hangi organında besin artıkları oluşur?)

5. Suat has rapidly eaten his dinner without chewing carefully. Two hours later he went to doctor with a stomachache. What could be the reason for Suat's stomachache?
(Suat, annesinin hazırladığı poğaçaları çok fazla çiğnemeden yemiştir. İki saat sonra mide ağrısı ile doktora gitmiştir. Sence, Suat'ın mide ağrısının sebebi ne olabilir?)

6. What is this text about?
(Bu metnin konusu nedir?)

APPENDIX B

TEXT 2: PROBLEM – SOLUTION

Our kidneys are very important!

(Böbreklerimiz Çok Önemlidir!)

Our kidneys are important for the excretory system. If we do not maintain the health of our kidneys, kidney failure and kidney stone problems occur. Kidney failure occurs when blood cannot be adequately filtered from waste products.

Böbreklerimiz, boşaltım sisteminde görev alan önemli bir organımızdır. Böbreklerimizin sağlığını korumazsak, böbrek yetmezliği ve böbrek taşı problemleri oluşur. Böbrek yetmezliği, kanın atık maddelerden yeterince temizlenememesi sonucunda ortaya çıkar.

Renal transplantation is necessary for individuals with this disease to return back their former healthy state. On the other hand, kidney stones occur as a result of mineral deposits in the kidneys. Drinking at least 2 liters of water a day, having a balanced diet and avoiding foods that are over salty and spicy are required to protect our kidneys from these problems.

Bu hastalığa sahip olan bireylerin eski sağlıklı hallerine geri dönebilmeleri için böbrek nakli gerekir. Böbrek taşı ise, böbreklerde mineral birikmesi sonucunda oluşur. Böbreklerimizi belirtilen bu problemlerden korumak için; günde en az 2 litre su içmek, dengeli beslenmek, aşırı tuzlu ve baharatlı yiyeceklerden kaçınmak gerekmektedir.

Reading Comprehension Questions

(Okuduğunu Anlama Soruları)

1. According to the text, which kind of problems do we face unless taking care of our kidneys well?

   (Metne göre, böbreklerimize iyi bakmazsak nasıl problemlerle karşılaşırız?)

2. Irem's mother generally puts a lot of salt into the dishes. Do you think that consuming too much salt in the meals results in any harm? Why?

   (İrem'in annesi yemeklere düzenli olarak çok tuz atmaktadır. Sence, yemeklerde fazla tuz tüketmenin herhangi bir zararı var mıdır? Neden?)

3. What types of health problems do people in Africa have, in which water resources are very limited? Why?
(Su kaynakları oldukça kısıtlı olan Afrika kıtasında yaşayan insanlar, sence hangi tür sağlık problemleri yaşayabilirler? Neden?)

4. What kind of a photo would you take if you participated in a photography exhibition of the kidney foundation about kidney health?
(Böbrek vakfının böbrek sağlığı ile ilgili yaptığı fotoğraf yarışmasına katılsaydın nasıl bir fotoğraf çekerdin?)

5. What is this text about?
(Bu metnin konusu nedir?)

APPENDIX C

TEXT 3: COMPARE – CONTRAST

Two Different Natural Events: Erosion and Landslide

(İki Farklı Doğa Olayı: Erozyon ve Heyelan)

Erosion and landslide are two natural phenomena with similar and different characteristics. The common feature of these two natural phenomena is that they come into play as a result of the movement of the earth. Erosion occurs by eroding of fertile parts of the soil.

Erozyon ve heyelan, birbirine benzer ve farklı özelliklere sahip iki doğa olayıdır. Bu iki doğa olayının ortak özelliği toprağın hareketi sonucunda meydana gelmeleridir. Erozyon, toprağın verimli kısımlarının aşınması ile oluşur.

Landslide means, in contrast to erosion, that the soil slides off the whole area. Also, when the landslide is in very rainy conditions, it comes down to a hole. Erosion is more effective in long time intervals, in areas where rainfall is not very visible.

Heyelan ise erozyonun tersine toprağın bütün halde zeminden kayması anlamına gelir. Ayrıca, heyelan çok yağış alan ortamlarda, bir anda meydana gelir. Erozyon ise uzun zaman aralıklarında, yağışın çok görülmediği bölgelerde daha çok etkilidir.

Reading Comprehension Questions

(Okuduğunu Anlama Soruları)

1. What is landslide?
   (Heyelan nedir?)

2. According to the text, what is the common feature of erosion and landslide?
   (Metne göre, erozyon ve heyelanın ortak özelliği nedir?)

3. In your opinion, which natural phenomenon can be expected to be more visible in rain forests?
   (Sence, yağmur ormanlarında hangi doğa olayının daha fazla görülmesi beklenebilir?)

4. Why does tree-planting prevent landslides and erosion?
   (Ağaç dikmek neden heyelan ve erozyonun önüne geçer?)

APPENDIX D

TEXT 4: CAUSE – EFFECT

Red-eyed Tree Frog (Hylidae)

(Kırmızı Gözlü Ağaç Kurbağası)

There are 417 species of frogs that live in South America. One of these frogs is a red-eyed tree frog (Hylidae). These animals live by hiding in the flowers of the trees. They eat locusts.

Güney Amerika'nın Ekvator ülkesinde 417 çeşit kurbağa yaşamaktadır. Bu kurbağalardan bir tanesi de kırmızı gözlü ağaç kurbağasıdır. Bu hayvanlar, ağaçlardaki çiçeklerin içinde saklanarak yaşar ve çekirge ile beslenir.

The trees where the frogs live are often cut down by loggers harvesting the wood from the trees. When the trees are cut down, the frogs lose their homes. Therefore, the numbers of these frogs have currently begun to decrease. Other factors causing the decrease in the red-eyed tree frogs are seasonal weather changes and pollution. Due to these situations, the red-eyed tree frogs are at risk of extinction.

Oduncular bu hayvanların yaşadığı ağaçları kestikleri için, günümüzde sayıları azalmaya başlamıştır. Bu durumdan dolayı, kırmızı gözlü ağaç kurbağalarının nesilleri tükenme tehlikesi ile karşı karşıyadır. Bu kurbağaların sayısının azalmasına neden olan diğer etkenler ise mevsimsel hava değişikleri ve kirliliktir.

Reading Comprehension Questions

(Okuduğunu Anlama Soruları)

1. Where does red-eyed tree frog (Hylidae) live?
   (Kırmızı gözlü ağaç kurbağası nerede yaşar?)

2. Why is the population of red-eyed tree frogs decreasing?
   (Kırmızı gözlü ağaç kurbağalarının sayısı neden azalmaktadır?)

3. Recently, the number of locusts in Ecuador, a country in South America where red-eyed tree frogs live, has increased considerably. What could be the reason for this situation?
   (Ekvator'da çekirge sayısı oldukça artmıştır. Bu durumun sebebi, sence ne olabilir?)

4. If a factory is built in the forest where the red-eyed tree frogs live, what do you think might happen to the frog population?
(Metinde bahsedilen kurbağaların yaşadığı ormana fabrika kurulursa, sence neler meydana gelebilir?)

5. What is this text about?
(Bu metinde neler anlatılıyor?)

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