MELTEM KARASAKAL

2018

PROMOTING PRIMARY SCHOOL TEACHERS' AWARENESS OF DYSCALCULIA

A MASTER'S THESIS

BY

MELTEM KARASAKAL

THE PROGRAM OF CURRICULUM AND INSTRUCTION
İHSAN DOĞRAMACI BILKENT UNIVERSITY
ANKARA

DECEMBER 2018

PROMOTING PRIMARY SCHOOL TEACHERS' AWARENESS OF DYSCALCULIA

The Graduate School of Education

of

İhsan Doğramacı Bilkent University

by

Meltem Karasakal

In Partial Fulfilment of the Requirements for the Degree of

Master of Arts

in

Curriculum and Instruction

Ankara

December 2018

İHSAN DOĞRAMACI BİLKENT UNIVERSITY

GRADUATE SCHOOL OF EDUCATION

Thesis Title: Promoting Primary School Teachers' Awareness of Dyscalculia

Meltem Karasakal

December 2018

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

Assoc. Prof. Dr. Erdat Çataloğlu (Supervisor)

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

Asst. Prof. Dr. İlker Kalender (Examining Committee Member)

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

Asst. Prof. Dr. Merve Koştur, Başkent University (Examining Committee Member)

Approval of the Graduate School of Education

Prof. Dr. Alipaşa Ayas (Director)

ABSTRACT

PROMOTING PRIMARY SCHOOL TEACHERS' AWARENESS OF DYSCALCULIA

Meltem Karasakal

M.A., Program of Curriculum and Instruction

Supervisor: Assoc. Prof. Dr. Erdat Çataloğlu

December 2018

The main aim of this study was to reveal the awareness of mathematics learning disorder (Dyscalculia) according to the opinions of the primary school teachers. Based on this aim, the general question was expressed as: "To what extent were Turkish primary school teachers aware of dyscalculia and dyscalculic children in their mathematics lessons?" Teachers' awareness about dyscalculia most likely might have a great importance in terms of communicating more effectively with those students in their classrooms and hence, implementing the mathematics education more efficiently. With that purpose, data from 16 different primary schools in the Çankaya district in Ankara from 113 primary school teachers were solicited through a questionnaire. The main result indicated that the majority of primary school teachers involved in the study were not aware of the concept of dyscalculia. Moreover, the majority of the primary teachers lacked the knowledge to deal effectively with dyscalculic children.

Keywords: Mathematics learning disability, dyscalculia, Turkish primary teachers

ÖZET

İLKÖĞRETİM MATEMATİK ÖĞRETMENLERİNİN DİSKALKULİ FARKINDALIĞI

Meltem Karasakal

Yüksek Lisans, Eğitim Programları ve Öğretim

Tez Yöneticisi: Doç. Dr. Erdat Çataloğlu

Aralık 2018

Bu çalışmanın temel amacı, ilköğretim sınıf öğretmenlerinin görüşlerine göre matematik öğrenme bozukluğu (Diskalkuli) farkındalığını ortaya koymaktır. Bu amaca dayanarak, çalışmanın genel sorusu şu şekilde ifade edilmiştir: "İlköğretim matematik öğretmenleri diskalkuli ve matematik derslerindeki diskalkulik öğrencilerin ne ölçüde farkındadır?" Öğretmenlerin diskalkuli hakkındaki farkındalığı, büyük olasılıkla sınıflarındaki bu öğrencilerle daha etkili iletişim kurması ve dolayısıyla matematik eğitimini daha verimli bir şekilde uygulaması açısından büyük bir öneme sahip olabilmektedir. Bu amaçla, çalışma Ankara'nın Çankaya ilçesinde bulunan 16 farklı ilköğretim okulunda gerçekleşmiştir. Çalışmaya 113 sınıf öğretmeni dahil olmuştur. Ana sonuç, araştırmaya katılan ilköğretim matematik öğretmenlerinin çoğunluğunun diskalkuli kavramının farkında olmadığını göstermektedir. Ayrıca, ilköğretim matematik öğretmenlerinin çoğunluğunun, diskalkulik çocuklarla etkin bir şekilde başa çıkacak bilgiden yoksun olduklarını da göstermektedir.

Anahtar Kelimeler: Matematik öğrenme bozukluğu, diskalkuli, ilköğretim matematik öğretmenleri

ACKNOWLEDGEMENTS

First of all, I would like to express my gratitude to my supervisor Dr. Erdat Çataloğlu. Without his guidance and persistent help this study would not have been possible. He always encouraged me during the study and never lacked his faith for me. I am so thankful to his farsightedness.

I also owe my thanks to Özge Keskin, who is more than my beloved teacher and sister. She has never spared her moral and material support since the day I met her, and her work and logic have always been a role model for me.

Lastly, I would also like to thank all my dear fellow Serap Haktanır and other colleagues who have always believed and supported me in this process.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Introduction

Mathematical skills are fundamental to independent living in a societal order that is heavily based on numeracy. An individual's level of mathematical skills affects educational opportunities, later on having an impact on employment prospects and thus, affecting the person's socio - economic status. That is why it is crucial to understand how concepts of numeracy develop and take a closer look at how difficulties might arise in the acquisition of numeracy skills. For many children, mathematics seems to be an inherently difficult subject to learn. According to studies, between 5 and 8 percent of children aged 6-14 have a particular type of cognitive deficiency that restricts their ability to understand and learn fundamental ideas in numeracy (Geary, 2004). This deficiency has lately been categorized by researchers in cognitive sciences under the name "dyscalculia", as a disorder in which normally intelligent children demonstrate specific disabilities in learning mathematics (Ansari & Karmiloff-Smith, 2002). According to the Department for Education and Skills (DfES, 2001), dyscalculia is accepted as a condition that affects the ability to gain arithmetic skills. Dyscalculic learners show difficulty in using and understanding intuitions about numbers and quantities, and simple arithmetic operations in mathematics. It is very important for teachers to be informed about dyscalculia, in order for them to be able to develop strategies that will cater to the needs of student who have this disorder. Given the importance of numeracy skills

both in education and later stages of life, one could argue that providing educational support to students with dyscalculia would have very significant long-term effects.

Background

Even though research on dyscalculia is still rather limited compared to other areas of learning disabilities, such as dyslexia. Dyslexia is a specific language-related learning disability with difficulties ranging from single word decoding to spelling and writing (Fletcher, 2009; Lyon, Shaywitz, & Shaywitz, 2003) and is often characterized by deficits in decoding and phonological processing which impede comprehension. Under the dyscalculia concept, there are still a significant number of studies in the field, especially internationally. These studies on dyscalculia are mainly conducted in the field of neuropsychology and mathematics education. While the former focuses on the neurological understanding of the condition, the latter focuses on how the needs of dyscalculic children can be accommodated through special education. Based on the perspective, there are varying definitions of dyscalculia, some with a more cognitive neurological emphasis and some other with a more behavioral one. Many research in dyscalculia focus on methods of diagnosis and treatment (Butterworth, 2003; Cangöz, Altun, Olkun, and Kaçar, 2013; Francis, Smith, Wareham, & Wood, 2013). Lately, there have also been a number of studies that focus on specific advice for teacher to develop accommodating practices for students with dyscalculia. Even though research is developed internationally, Turkish literature on the area has been comparatively scarce. Despite a few studies in the area, wider research on understanding the scope of dyscalculia in Turkey is yet to be done.

Having provided background information on dyscalculia research, it is also important to provide an introduction to the Turkish education system and mathematics education. Turkey has a somewhat fragmented education system

in which public and private schools often provide different standards of education. Education in Turkey is often non-accommodating of the needs of students with learning disabilities, with most placement exams being knowledge-intensive multiple-choice tests. Turkey also has a low achievement level in mathematics among the 4th grade students. According to TIMSS 2015 results, Turkey ranked below the scale center point with 483 point, was significantly behind European countries that participated (Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M., 2016). In order to respond correctly to the TIMSS test questions, students need to be well aware of the content of the mathematics being evaluated, but also have a range of cognitive skills. According to the TIMSS framework, these skills can be summarized as knowing, implementing and reasoning. These three cognitive domains are used for the evaluation of the mathematical content of the fourth and eighth graders. Each field of mathematics content includes questions that were developed to address each of the three cognitive domains; For example, the issue of numbers includes questions to address knowledge of cognition, practice and reasoning. The proper understanding of numbers has importance since it is a prerequisite to the other mathematical contents including algebraic operations. One proof for this might be the observation of low achieving students on pre-algebra leads to reliable predicament of low achievement in the entrance exams for high school and university.

Problem

Dyscalculia is a mathematical learning disorder, which is generally characterized by mathematical ability that is significantly below the expected level for a students' age group. The existence of this disability has been widely supported by research. According to findings, dyscalculia needs to be addressed as an important issue in mathematics education. As explained above, in Turkey, most of the students have low achievement in mathematics. Despite this, there is no consensus on the cause of low achievement of math scores among the Turkish scientific community. Dyscalculia might be a cause of low achievement in math, especially at earlier stages of schooling. In order for teachers to be able to make use of suitable accommodation practices for low achievers in mathematics, they should first be aware of its root causes and hence dyscalculia. There are limited in numbers of empirical research on dyscalculia, its causes, and treatment methods. It is also necessary to know the level of awareness of teachers on dyscalculia, as their awareness is needed to employ better accommodation practices for dyscalculic students.

Purpose

The purpose of the study was to investigate the awareness level of primary school teachers of dyscalculia as a condition, and their level of knowledge and perhaps observed or suggested treatment of students with dyscalculia. This study obtain data in Çankaya district of Ankara from teachers in terms of their knowledge and perception of signs indicative of dyscalculia. The study made use of the method of survey to investigate the teachers' awareness of dyscalculia.

Research question

To this end, the study will focus on the research question which can be presented as: "To what extent were Turkish primary school teachers aware of dyscalculia and dyscalculic children in their mathematics lessons?"

Significance

As explained above, understanding dyscalculia and developing practices aimed at accommodating the needs of dyscalculic students ought to be a very important issue in mathematics education. This is especially the case in Turkey, where the field has not been thoroughly investigated yet, despite the perceived low achievement rates in mathematics. This thesis thus has the potential to be a significant study, both for the development of educational practices in Turkey and as a contribution to research in this field.

In Turkey, poor achievement of students in mathematics in various examinations is a serious issue. Dyscalculia might be a one of the causes of this problem, however, in many primary school teachers are not aware of dyscalculia even as a word. If this claim has merits, this study has the great opportunity to raise awareness among primary school teachers. Through interaction with primary school teachers, the study will provide them with a certain level of knowledge on dyscalculia. It will also help school administrators and teachers run support programs for dyscalculic students.
In addition to the low level of awareness among educators (Dias, M. deA. H., Pereira, M. M. deB., & vanBorsel, J., 2013; Sinem & Ayça, 2010), there were a few studies on learning disabilities in mathematics especially for dyscalculia in Turkey. Even though dyscalculia is perhaps as common as dyslexia, it is comparatively under studied. This study provides information on dyscalculia, its causes, methods of

diagnosis and treatment, which can become a landmark in the field of special education literature in Turkey. The study may also contribute to research in the field of mathematics learning disability education in Turkey. Therefore, studying with primary school teachers in terms of dyscalculia as a special learning disability is another crucial point of the thesis.

Limitations

There were a number of limitations to the scope of this study. Due to the limitations in resources, the study couldn't be conducted in a large area. That was why the study was limited to Çankaya district in Ankara. This means that the study was limited both geographically and socio-economically. It was limited to a highly developed urban area in Turkey and a school in a neighborhood with residents from predominantly middle-class backgrounds. Further research in rural areas and neighborhoods with a different composition would be needed to get a more complete picture of the situation in Turkey.

Another limitation was the decrease in the number of schools planned to be conducted. Initially, there were 33 schools in the list that received permission from the Ministry of Education. 16 schools of them were included in the study due to the fact that some schools did not allow the researcher to work, a school had been renovated and the questionnaires left in some schools could not be collected later.

In addition to this, the study was based on primary school teachers, especially those teaching mathematics lessons in the first and second grades. In order to get a wider grasp of the awareness around dyscalculia in Turkey, it is also necessary to

investigate how it is treated in later stages of education. That is why further studies could be conducted with teachers from middle and high school institutions.

Lastly, the study made use of survey and questionnaire methods among primary school teachers at Çankaya district, which limits the truthfulness of the data because data were driven from self-reports by the teachers.

Definition of key terms

Some definitions that are key to the understanding of the subject matter have been provided. Please note that the concept of dyscalculia will be discussed in detail in the second chapter of this study.

A **learning disability** is a condition that affects a person's ability to understand or use language, to do math calculations, to coordinate movements, or to direct attention. **Numeracy** is the ability to reason and to apply simple numerical concepts. Basic skills in numeracy include the ability to comprehend the relationship between numbers, as well as fundamental arithmetic operations such as addition, subtraction. **Developmental dyscalculia** is a learning disability that affects the processing of numerical and arithmetical information (Mussolin, C., De Volder A., Grandin C., Schlögel X. Nassogne M. C., & Noel M. P., 2010). **Dyscalculia**, in a wider sense, might also include acquired dyscalculia (as a result of brain lesions at a later stage in life). For the purposes of this study, the term dyscalculia will be used to refer to developmental dyscalculia, which is the commonly seen form of the condition.

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

The purpose of this literature review is to provide a context for understanding dyscalculia. Dyscalculia is a learning disability that affects a student's comprehension of mathematics and number concepts, which has begun to be studied and examined more closely over the 20th century. In this literature review, ways to identify and accommodate students who struggle with dyscalculia are investigated. As with other learning disabilities, if dyscalculia is not addressed in early childhood, one may struggle with mathematical calculations throughout life.

In addition to that, this chapter includes a review of recent studies on dyscalculia and appropriate teaching procedures to address this disability; with a focus on some of the more effective techniques which may lead primary school teachers in terms of exploring procedures to identify and treat dyscalculia in their mathematics lessons.

Dyscalculia

Research studies were conducted about dyscalculia across two main fields. One is neuropsychology and the other one is mathematics education. When reading the literature, one quickly realizes that different definitions of dyscalculia exist. Considering the cognitive neuroscience and behavioral theories of dyscalculia or developmental dyscalculia, this section will present and discuss its different definitions, features, and root causes based on scientific literature.

What is dyscalculia?

Numerical processing is a high-level cognitive process which has to be further explored by neuroscience. Because of the complexity involved in numerical processing; it is difficult to define what it means to have a specific mathematical learning disability, such as dyscalculia. Despite these difficulties, efforts have been made to identify and define what dyscalculia is.

Researcher Kosc was among the pioneers in his field to come up with a neuropsychological definition of developmental dyscalculia. According to his understanding, dyscalculia is "a difficulty in mathematical performance resulting from the impairments to those parts of the brain that are involved in mathematical processing without a concurrent impairment in general mental function" (Kosc, 1974). This definition is still used by researchers in cognitive neuroscience when defining dyscalculia.

Developmental Dyscalculia (DD) is defined as a specific learning disorder that is characterized by a persistent impairment in processing numerical information and learning arithmetic facts (Diagnostic and Statistical Manual of Mental Disorders-V; APA, 2013). According to Cowan and Powell (2014), mathematical learning disability is acknowledged to be the same construct as mathematics disorder (Diagnostic and Statistical Manual of Mental Disorders-IV; APA, 1994). More recently, Kucian and von Aster (2015) defined developmental dyscalculia as a "specific learning disability affecting the development of arithmetical skills" (p.2) and "a heterogeneous disorder resulting from individual deficits in numerical or arithmetical functioning at behavioral, cognitive/neuropsychological and neuronal levels" (p.4).

Consequently, all researchers stress that the child who has developmental dyscalculia or dyscalculia must substantially underachieve on a standardized test relative to the level expected by that given age, education and intelligence, and must experience disruption to academic achievement or daily living. Standardized tests generally test a range of skills, which may include spatial and verbal activities, before collapsing the total into one global score of 'math achievement' (Landerl, Bevan, & Butterworth, 2004).

Features of dyscalculia

The most generally agreed upon feature of a student with dyscalculia is difficulty in learning and remembering arithmetic facts (Geary, 1993; Geary & Hoard, 2001, Ginsburg, 1997; Jordan, Hanich, & Kaplan, 2003b; Jordan & Montani, 1997; Kirby & Becker, 1988; Russell & Ginsburg, 1984; Shalev & Gross-Tsur, 2001). Eventually, all of the researchers found that students with mathematics difficulties struggled with both calculation and retrieval of the arithmetic facts.

On the other hand, a second feature of the students with dyscalculia is difficulty in executing calculation process procedures, with immature problem-solving strategies, long situation or long times and accompanied with high error rates (Geary, 1993). Geary suggests that retrieval difficulties are unlikely to improve with experience in comparison to procedural problems. According to Geary, this difference between the two types of difficulties arise because procedural problems stem from a lack of conceptual understanding, while retrieval difficulties are due to general semantic memory dysfunction (Geary, 1993).

As a semantic approach of dyscalculia, “developmental dyscalculia” (Kosc, 1974) or “acquired dyscalculia” (Munro, 2003) could be exemplified. These terms are used to classify situations where students have low achievement in standardized tests. The term “acquired dyscalculia” is used for students with brain trauma, while the term “developmental dyscalculia” is used for students without evidence of brain injury.

In summary, it can be said that both researchers approach the dyscalculia or developmental dyscalculia as a structural defect of the mathematical abilities. Researchers assume that the origin of dyscalculia is either a congenital disorder or an anatomical-physiological disorder of the brain.

Deficits of dyscalculia

Butterworth, a professor at the Institute of Cognitive Neuroscience and Psychology at the University College London, argues that dyscalculic students suffer from a lack of *numerosity* or *numerical magnitude* understanding. Since numerosity, that is the basic understanding of numbers, plays an integral role in understanding mathematics, the lack thereof has a serious impact on the students’ ability to learn mathematics. “The capacity to represent and mentally manipulate numerosities is the key to learning arithmetic.” (Iuvulano, Tang, & Butterworth, 2008, p. 669). According to Butterworth, dyscalculics are poor in performance, either in accuracy or in time, on very simple numerosity tasks, such as number comparison or the enumeration of small arrays of subjects.

Sub-types of dyscalculia

Wadlington and Wadlington (2008) describe three subtypes of dyscalculia; semantic, procedural, and visuo-spatial. The semantic subtype makes a reference to having difficulty with memorization. Neuropsychological studies showed that semantic memory systems for numerical and non-numerical information are localized in different areas of the brain (Thioux, Seron, & Pesenti, 1999). That is why number knowledge can be separated from verbal semantic memory. For a dyscalculic who suffers from semantic dyscalculia, suggested teaching strategy is to provide visual aids. A dyscalculic with procedural difficulty has trouble with procedures as well as following steps when solving a problem. Lastly, visuo-spatial dyscalculics often have difficulty in representing spatial concepts as placing a value on a number line. More recently, according to Karagiannakis, Baccaglini-Frank, and Papadatos (2014), four subtypes can be proposed as: core number, memory, reasoning and visual spatial. Researchers proposed a table of mathematical learning difficulties (MLD) subtypes classification with possible specific systems involved, and typical mathematical difficulties encountered.

To sum up, it could be said that researchers continue to look for the causes of the problem; however, exploring the exact concept of sub-types of the dyscalculia might take longer. Although, subtype classifications certainly do not identify the dyscalculic tendencies but do indicate the discrepancy between students' general cognitive abilities and their mathematics scores.

The role of dyscalculia in primary mathematics education

Mathematical knowledge plays an integral role in an individual's cognitive and creative development. Starting from daily activities in childhood, mathematical knowledge and associated skills play an ever-increasing role in one's daily life. Difficulty in acquiring and making use of these skills poses great challenges to the individual, both in their education and daily lives. This is true for Turkish students, and often the teacher may be the only one to discover and help dyscalculics. By looking at mathematics and dyscalculia in this respect, this section will provide detailed information on dyscalculia so as to be useful for primary school teachers.

The biological basis of numeracy and dyscalculia

Studies have shown that *numerical magnitude* is processed in the intra parietal sulcus, or the IPS (see Figure 1), located in the parietal lobe of brain.

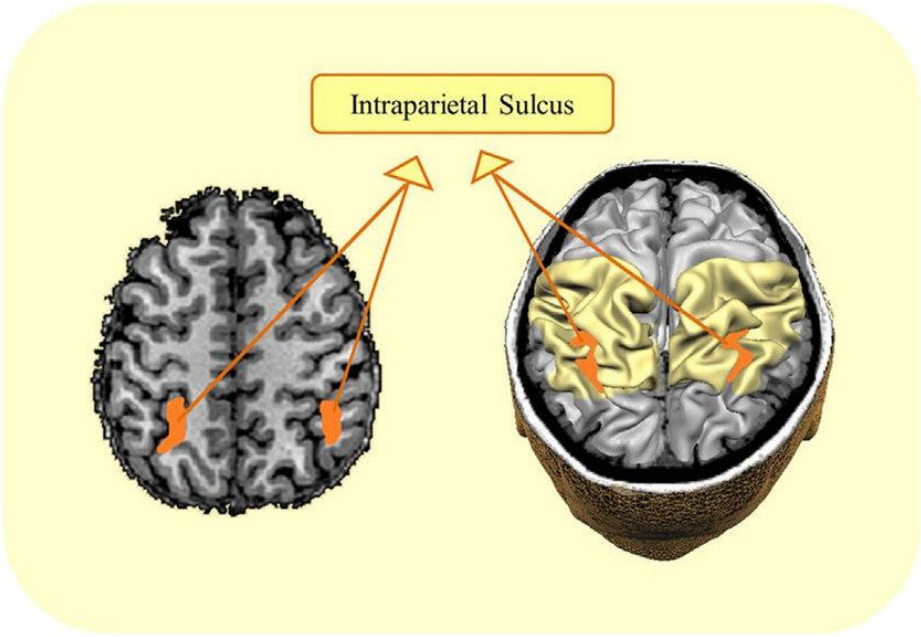

Figure 1. Location of IPS

The intraparietal sulcus (IPS) helps children understand the meaning of numbers. It is located at the back of the brain, in an area called the parietal lobe, which is the area

colored in light yellow. The IPS is highlighted in orange in the picture. The brain picture on the left is a picture of a brain taken using a magnetic resonance imaging scanner. The brain picture on the right is a cartoon brain. (Bugden & Ansari, 2014). Retrieved from ResearchGate database.

Related data suggests that there is a disruption between the activity of the IPS and the numerical distance in dyscalculic children (Ansari, 2008). In details, the term "acalculia", originally proposed by Henschen (1920), has been used to address a wide range of disorders, from the inadequacy to the inability to calculate arithmetic. A case series study by Henschen (1920) showed that left parietal brain damage led to problems with numbers, often with no other cognitive symptoms. Later, detailed case studies have shown that damage to the left parietal lob can lead to severe acalculia with other cognitive functions intact (Cipolotti, Butterwoth, & Denes, 1991). As an evidence of in their case studies, the patient C.G., who has passed a dense stroke, was shown. The most striking feature of her was a distortion in number information. This was not just a deficiency specific to one category, but a solid subtype of acalculia that had never been documented before.

Screening methods –tasks

Currently, there are several screening methods for both identifying and assessing dyscalculics. One specific screening method for identification is dyscalculia screening quiz named as *dyscalc*. It is a free, on-line quiz that asks questions regarding mathematical concepts. When the test taker has difficulty with these concepts, the test concludes that the test-taker may show signs of dyscalculia or another learning disability (Francis et al., 2013). In details, that free dyscalculia

screener has been designed for students over 14 years old who have average academic skills. This screen consists of 20 items to remember the facts about number sense (an intuitive feeling for numbers), arithmetic and calculation. Moreover, in the test, there are items requiring to solve real life problems presented in written form and money-time calculations. During the test, answering time is taken by the screener and there are some questions from the test given at Figure 2 and Figure 3.

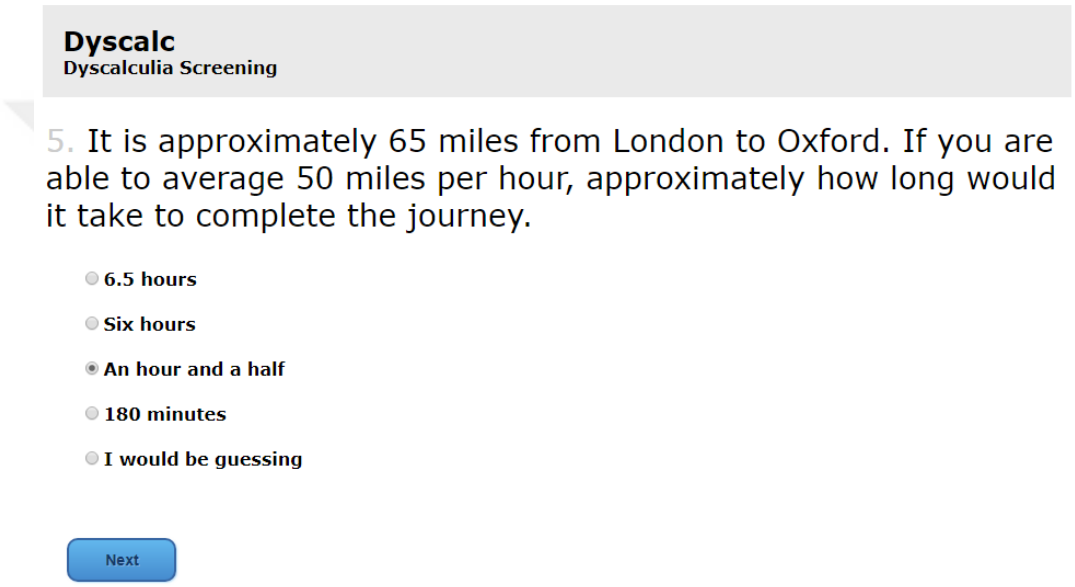

Figure 2. Question 5

It is the 5th question on the screen which is assessed understanding number in written and numerical form; solving real world problems presented in written form; mathematical reasoning: figuring out number related information; basic arithmetic with use of a pen and paper.

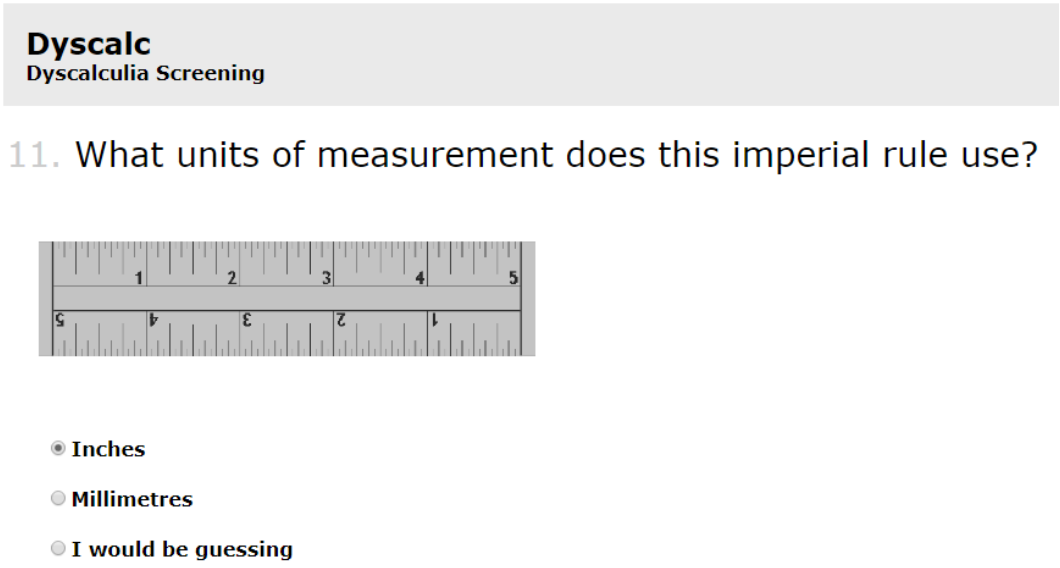

Figure 3. Question 11

It is the 11th question on the screen which is assessed recalling of real-world number related information.

On the other hand, various investigators have proposed that educators struggle to make accurate assessments for dyscalculics. Complex Figure Test, Dyscalculia Screener (Butterworth, 2003) included the items as; The Simple Reaction Time Test, Dot Enumeration and the Numerical Stroop Effect, Arithmetic Achievement Test, and Learning Link Technologies are some of the screeners, which provide ways of assessment for students with dyscalculia. Currently, there is no scientific articles which is mentioning use of that dyscalculia screener in Turkey. However, Sinem & Ayça (2010) mentioned about that screen and its properties in their article.

By considering the lack of standardized dyscalculia test in Turkey, Cangöz et al. (2013) developed a computer-based screening task for developmental dyscalculia. Their test has been designed for 6-9 years old school age children and they attempted to assess some cognitive abilities of those with dyscalculia over five different tasks.

These tasks could be listed as: Dot counting (Subitizing), Number Comparison (Numerical Stroop), Perceptual Quantity Estimation, Number Line Estimation and Simple Arithmetic. Sample items of

screener is shown in the Figure 4.

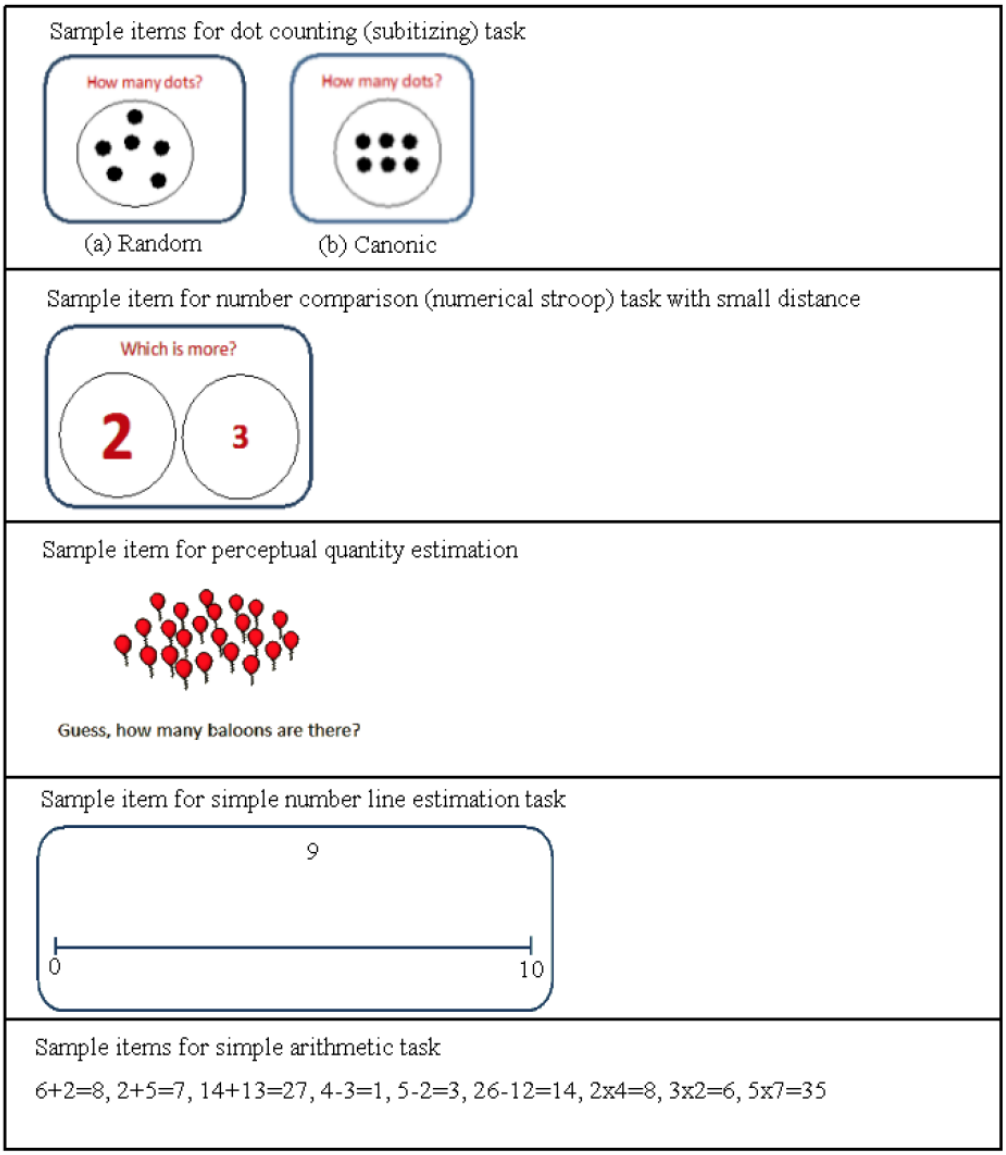

Figure 4. Sample items (Cangöz et al., 2013)

On the other hand, having different screen tests for dyscalculics can lead to discussions in terms of reliability and validity. Eventually, researchers and educators have specific concerns for each screening task, based on the specific skills and

procedures each use to benchmark the student. One could also argue that standardized tests are not the optimal way to assess the students, and more customized assessment tools to fit the characteristics of the student should be administered by the educators.

Diagnosing dyscalculia

In the absence of reliable imaging techniques, diagnosis of developmental dyscalculia has been made on the basis of clinical assessments of arithmetical skills. (Shalev & Gross-Tsur, 2001). Over the years, neuroimaging techniques helped to find the evidence of developmental dyscalculia. Many researchers describe the use of functional magnetic resonance imaging (fMRI) to diagnose developmental dyscalculia, but the research using this technique is still growing.

Adopting the idea that dyscalculia is a specific disorder, a certain element is needed rather than more general tests of mathematical abilities. Based on the literature review of mathematical learning disabilities, Geary (1993) claims that there are no specific benchmarks set forth in diagnosing dyscalculia. Anywhere between 3-6% of children have difficulty on calculating, understanding mathematical language, and comprehending mathematical facts; all signs of dyscalculia. In a wider perspective, the best estimates obtained were the prevalence of discrete exclusion (American Psychiatric Association, 2013) between 3.4 and 10 percent (Lewis, Hitch, and Walker, 1994; Ostad, 1998). This means that between 2 million and 5.8 million people in the Turkey might suffer from a problem that interferes with daily living and academic achievement. Most current diagnostic methods use the Diagnostic and Statistical Manual of Mental Disorders-IV approach to identify dyscalculia

(or mathematical disorder - terms can be interchangeable): an inconsistency between performance in a standardized mathematics and on the basis of measured intelligence (or performance in other school subjects).

In spite of this consistent rate of prevalence, an educator does not know what to do if a student displays these signs. In such a case, the student should be subjected to special education with educational psychologists as in other learning disabilities. Additionally, it is crucial for educators to be trained to seek out deficiencies in mathematics. The involvement of parents is also very essential.

Summative and formative assessment for dyscalculia

If the student is struggling with mathematics, ongoing formal and informal assessments are strongly supported. According to these assessments, teachers should plan for dyscalculics to strengthen their work to raise their level.

Primary school teachers' awareness and dyscalculia

Dyscalculia is a learning disorder affecting the ability to acquire school-level arithmetic skills, affecting approximately 3-6% of individuals (Price and Ansari, 2013). It is indeed a growing concern in the field of education, but unfortunately many of the teachers, specifically primary school teachers, are not aware of dyscalculia (Shalev & Gross-Tsur, 2001) or what to do with dyscalculics' mathematics performance in the classroom (Chin & Ashcroft, 2006). It is necessary for educators to recognize the characteristics of dyscalculia early so as to take remedial steps to help these children. The results from the study conducted by Sinem & Ayça (2010), titled *Teachers' Opinions About Dyscalculia Seen in the Students*

Between the Ages of 6–14 also confirm this lack of awareness. According to the study, teachers were not aware of the term "dyscalculia" and instead used the generic term "learning disability" when discussing these students. Although teachers expressed that they often encountered dyscalculia, they could not help the students who probably had dyscalculia. Furthermore, all the teachers in the study voiced concerns about their inability to seek expert support when encountering dyscalculia. They also stated that families who are suspected to have dyscalculic children are generally careless.

Dias et al., (2013) also conducted research assessing the educators' awareness of dyscalculia. The study concluded that the participating educators had very little specific knowledge on dyscalculia. They also appeared to be insecure about their ability to identify possible causes of dyscalculia. As explained above, these two studies also confirm that educators' often have a low level of awareness on dyscalculia, despite the practical importance of the condition.

Recent studies on mathematics learning disability referred to as dyscalculia or developmental dyscalculia

Researchers started to look dyscalculia with the new perspectives. One of the new perspectives toward dyscalculia is hypothesized by Fragher (2017). She proposed that Developmental Dyscalculia (DD) is likely to comorbid and affect majority of students having Down syndrome (DS). According to her findings, it could be said that some students from DS have succeeded in mathematics in many areas including mathematics, trigonometry and percentages. However, she concluded that students cannot be able to calculate corresponding problems without the support of an electronic calculator.

On the other side, many researchers agreed on that visual tools such as computer-based games help students with dyscalculia or different learning disabilities. Based on that idea, El Kah and Lakhouja (2018) developed an effective educative game for Arabic children primarily dyslexics. Therefore, their results indicate that the educational game plays distinctive role in improving the learning process.

CHAPTER 3: METHOD

Introduction

In this chapter methodology of this study was established to describe primary school teachers' awareness of dyscalculia and to present the intervention methods that they used for students who have dyscalculia. In this context, this chapter covered the methods used, approaches followed and limitations. However, before the detail examination of the methods used, philosophies of the research will be explored in order to provide a philosophical ground for this study.

Research philosophy

Methodical and systematic process of investigation and enquiry of an issue can be defined as research (Collis and Hussey, 2003). Phenomenological, positivist and realist paradigms stand for three major approaches in philosophies of research.

Chronologically, the positivist approach emerged earlier, although firstly it was used in natural sciences and was adopted by social science only later. This philosophy focuses on search for causes and conditions of some particular social phenomena, while largely ignoring subjective status of individual actors. Investigation and research therefore use mainly logical and rigor methods and avoids application of subjective tools, such as intuition and experience (Collis and Hussey, 2003).

According to Smith (1998), "positivist approaches in social sciences assume things and can be studied as hard facts and the relationship between these facts can be established as scientific laws".

These laws are treated as truth by positivists and this allows them to study social objects in same ways and manners as they would study objects in nature. Theories and generalizations are tested through various experiments and quantitative methods in positivism (Patton, 1985). Individual experience and differing perspectives are being fitted into some predetermined categories and variables based on tightly defined groups of population. The research cannot be redirected or redefined on the go by actual research objects themselves.

Phenomenological philosophy provides criticism to traditional positivist approach, as it attempts to explain differences among them. These are the main objections of phenomenological approach:

- Individuals cannot be approached without taking in account the social context they are operating in. Examination of their subjective perspective is crucial to understanding the observed phenomena.
- Creating tightly structured research pattern with many predefined attributes often leads to serious constraints and limitations. Some important specifics and variables can be easily missed this way.
- Research is also influenced by researchers themselves - they are subjective individuals and affect research with their personal values and perspectives.
- Single measure can never be able to comprehensively capture whole complexity and all details of a social phenomenon (Collins and Hussey, 2003).

Phenomenological approach mainly aims to understand individual objects by understanding their personal interpretations of the world and social practices in

which they participate (Babbie, 2010). Researcher represents as an important instrument in phenomenological research. Researcher's own perspective and experience is taken in account and treated as meaningful and highly valuable addition to the research. Rather than focusing on rigor quantitative methods, phenomenological research prefers qualitative tools, because they can uncover more complexities and nuances of the whole picture. Real individual experience of social object is better understood when it's not squeezed into narrow brackets of predefined generalization (Lincoln and Guba, 1985).

In order to "inductively and holistically understand human experience in context-specific settings" (Patton, 1985, p. 37), phenomenological approach applies naturalistic investigation. The particular phenomenon is studied in its natural environment, because only observation of entity in its natural context can provide full understanding of the phenomena (Lincoln and Guba, 1985). Analyzing inductive data is another tool that provides better understanding of all mutual influences which shape the studied phenomena and entities. It allows explicating experiences and interacting perspectives of both researchers and participants (Lincoln and Guba, 1985). It creates flexible research design, which is desirable "because it is inconceivable that enough could be known ahead of time about the many multiple realities to devise the design adequately" (Lincoln and Guba, 1985, p. 41).

Variable perspectives and approaches of participants and researchers are interacting in ways which cannot be predicted, and the influence this has on the research's outcome should be taken in account too (Lincoln and Guba, 1985).

There is a philosophical paradigm that combines elements from both explained philosophies; realism (Healy and Perry, 2000). Scholars of realism argue that numerous understandings of a single, perception-autonomous social world is possible (Healy and Perry, 2000). This standpoint on the nature of reality, perceives the latter as something that the individual or their consciousness cannot ever fully grasp or explain reality is always beyond human cognition. According to Lincoln and Guba (1985), unlike positivist approaches that are allegedly value-free and phenomenological approaches that are inherently subjective, realism approves of a reality that is value-conscious. That is, it has an understanding and acceptance of the fact that both researcher and the individuals being researched have values that cannot be overlooked. In this light, realists acknowledge that human perception is flexible and that there is a significant distinction between reality and how that reality is filtered and understood by human perception (Seale, C., Gobo, G., Gubrium, J. and Silverman D., 2004)

Considering the ultimate objective of this study which is to investigate the awareness of primary school teachers of dyscalculia as a condition, and their knowledge and treatment of students with dyscalculia, it can be said that following a realist approach in this study would be useful. It is because, in this study, awareness of the teachers will be found out through using questionnaire and the findings will be interpreted through using statistical analysis. However, in the questionnaire open-end question will also be given to understand teachers' knowledge and understanding of dyscalculia. Therefore, in this study, realist approach is followed in order to accomplish the objective of the study.

Research approach

The two main approaches applied in research are known as deductive and inductive approaches. Deductive approach to research can be described as methodology where hypothesis is formulated upfront and consequently tested by various pragmatic experiments (McBurney and White, 2009). In this context, individual cases are tested and observed based on general presumptions.

In this study, deductive approach was followed. In this perspective, first of all theories were reviewed in the literature review part and then the questionnaire's questions were created in order to understand the teachers' opinions of dyscalculia.

Research method

Two most prolific research methodologies are qualitative and qualitative. Quantitative methodology emphasizes statistical inquiry into the observed problems. In this study, closed-end questions in the questionnaires collected quantitative data and they are analyzed by using quantitative methods. However, in this study, obtaining some verbal information was also important; therefore, qualitative methodology was also used. Qualitative methods are preferred over quantitative ones because of their ability to capture complex information on the researched issue including better appreciation to the participant's background (Taylor, 2005). Qualitative methods are capable to describe the observed situation with all its details, as its goal is to define and understand social relations and practices in-depth (Watzlawik and Born, 2007). In this study, open-end question in the questionnaires collected qualitative data and they were analyzed by using qualitative methods.

Research design

Three main types of the research design are recognized: descriptive, explanatory and exploratory. Differences between them are defined by McBurney and White (2009) as follows:

- Exploratory design attempts to identify sources of the idea in relation to the subject, while it also assesses the issue from a new point of view.
- Descriptive method aims to depict comprehensive image of the observed phenomena, subjects or situations.
- Explanatory methods require researcher to pay attention to every aspect and cause separately and in its own context. It aims to assess the possibility that the cause is able to generate some particular effects.

This study was conducted under the descriptive design. Reason for this lies in the method's ability to take accurate picture of the present state of situation. In this context, the researcher aimed to describe existing conditions without making relationship between variables. Accordingly, this study was applied a survey method and researcher used questionnaire. However, before the questionnaire conduction, it was translated into Turkish.

Methods of data collection

Data can be divided into primary and secondary data. Primary data represents information that was collected particularly for this specific research. Secondary data usually originates from some other sources and was gathered for different purposes. It's often collected in order to create some theoretical framework - for example by reviews of other researches and studies (Saunders, M., Lewis, P. and Thornhill, A.,

2007). In this study, secondary data were collected for the formation of literature part of this study. In this context, books, journal articles and website information were used as secondary data sources. The primary data were collected through the questionnaire named as “Evaluation of primary school teachers’ awareness of dyscalculia”.

Questionnaire: “Evaluation of primary school teachers’ awareness of dyscalculia”

Questionnaire is one of the most preferred techniques of obtaining data and information. Questionnaire gathers data directly from volunteer primary school teachers. Each respondent was asked to provide his/her answer to one general list of questions. This allows gathering data from large sample of respondents, which can be later effectively used in quantitative analysis of collected information (Saunders et al., 2007).

A semi-structured questionnaire was adopted for this study, consisting of mixed set of open-ended and close-ended questions. Close-ended are those questions, which allowed respondent to select one of predetermined answers only. They are mainly used to collect facts. Open-ended alternatives let respondent express their opinion in their own wording and make their responses more personalized and individual (Collis and Hussey, 2003). Gathered data were consequently coded and analyzed.

In this study, the questionnaire used by Dias et al., (2013) - “Assessment of the awareness of dyscalculia among educators” - was used. Validity of the instrument used was established by Dias et al., (2013) and in their article no reliability value was reported.

Questionnaire was in English therefore, firstly, the questionnaire was translated into Turkish. At the stage of the translation, the researcher translated and received assistance from English linguists at Graduate School of Education at Bilkent.

After the questionnaire was translated into Turkish, it was presented to MoNE committee with the permission of the questionnaire's owners (Appendix A). The final version of the questionnaire comprised of two parts: demographic questions and specific questions regarding the awareness of dyscalculia. This survey instrument consists of 8 demographic and 9 specific questions which were expected to obtain teachers' awareness of dyscalculia. (Appendix B).

The second part of the questionnaire has specific questions with special objectives. For example, questions from 9 to 11 aimed to obtain information about teacher's training on the topic. Questions 12 to 15 on the other hand enquire teachers' experiences and understanding about the dyscalculia and how they estimated adequate competency to identify and deal with dyscalculia. Questions 16 and question 17 concerned the knowledge of the clinical diagnosis of dyscalculia, and the ways dyscalculia may present in their classrooms. Question 17 aimed to find out the professional treatment way that teachers would prefer for dyscalculic students to answer the research question. Except the question 12, the questions between 9 and 17 were close-ended questions.

Population and sampling

Population can be defined as a comprehensive set of investigated analysis (Davis, 2000). Sample represents an adequate portion of the population that is under current

survey (Oakshott, 2001). Methods of sampling can be classified as methods of probability and non-probability.

Probability is a technique that uses known and predetermined chance of some case or scenario being selected from the general population. This probability is different from zero (Saunders et al., 2007). Some of widely used probability methods are systematic sampling, random sampling and stratified sampling. Non-probability is a technique that works without knowing probability or chance of any case being chosen in the sample (Saunders et al., 2007) Quota sampling, purposive sampling, snowball sampling and convenience sampling all belong among non-probability sampling methods.

This study was conducted in Çankaya district of Ankara. Çankaya district was chosen because the researcher's university campus is established there and thus choosing this district allow her to save time and money for travelling. This study took place at the elementary school level which has the approval of Turkish Ministry of Education. Accordingly, the researcher reached to list of elementary schools of Çankaya district. The updated list for the year of 2015 had a number of 143 elementary schools. Because of the high number to be accessed, the researcher used sampling method. Sample size was determined by using the calculator available over the internet (Creative Research Systems, 2012). In the calculation, population was entered as 143, confidence level was taken as 95% and the error percentage was taken as 15%. Accordingly, sample size was determined as 33. For that reason, 33 private and public schools in Çankaya district were included into the study nevertheless, due to several factors (i.e. not being able to obtain permission for

research by the school principle and/or teachers; being closed, not being able to arrange meeting and time work permission constrains) the research was carried out in 16 schools. From these schools, in total, 113 teachers participated in this study. Teachers were chosen conveniently. In this context, participated teachers were the ones that they were available when the researcher was in their school to conduct questionnaire. The questionnaire was conducted between the months of March-April 2017.

As stated in the previous section, I obtained the permission for the chosen schools through the MoNE by providing office documents through the Graduate School of Education, Bilkent. This document was including brief descriptions of this research. The document included the information such as the purpose of the study, statement of the problem, research questions, significance of the study, brief information about related literature, method of data collection, participant/sampling strategy, and method of data analysis.

Data analysis

Coding was used to transform descriptive data collected through questionnaire into quantitative information. A frequency distribution - range of frequencies organized according to their size in a chart, diagram or table – was then used (Collis and Hussey, 2003).

Summary

This chapter presented the methodology of the research that was used. Before explaining the methodology, briefly philosophy of the research was written and type of the approach was indicated as deductive. Moreover, an explanation of quantitative

research as a method for data collection and analysis was given. Steps followed during the data collection were discussed in this chapter and the information about the sample was provided. To make it clearer, table 1 is given to show the steps of the research according to semesters of Bilkent University.

Table 1
Time table of thesis

Year	2015		2016		2017		2018	
Semester STEPS	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Literature review	x	x	x	x	x	x		
Meetings with supervisor	x	x	x	x	x	x	x	
Permission from MoNE		x						
Collecting data from schools					x			
Analysis of the data						x		
Interpreting the results							x	
Organizing the thesis							x	x
Submission of thesis								x

CHAPTER 4: RESULTS

Introduction

This chapter reports the data analysis of the dissertation. The purpose of this study was to describe primary school teachers' awareness of dyscalculia and present the treatment methods that used for students who have dyscalculia.

Demographic data of participants

The following table shows the demographic data of primary school teachers included in the study.

Table 2
Demographic data of participants

Variable	(N)
Primary school teachers' ages in years	
• No Answer	7
• 20-29	4
• 30-39	40
• 40-49	16
• 50-59	35
• >60	11
TOTAL	113
Teaching experience of primary school teachers' in chosen schools	
• No Answer	1
• 1 Year	10
• 2 Years	13

Table 2 (cont'd)
Demographic data of participants

• 3 Years		10
• 4 Years		14
• 5 Years		6
• 6 Years		5
• 7 Years		3
• 8 Years		5
• 9 Years		3
• More Than 9 Years		43
	TOTAL	113
School type of primary school teachers		
• No Answer		1
• Private School		45
• Public School		67
	TOTAL	113
Total teaching experience of primary school teachers		
• No Answer		4
• Less Than 1 Year		3
• Between 2 And 5 Years		6
• Between 5 And 10 Years		17
• More Than 10 Years		83
	TOTAL	113
Graduated schools of participants		
• No Answer		12
• University/Faculty		91
• School		6
• Institute		4

Table 2 (cont'd)
Demographic data of participants

Diploma degree of primary school teachers		
• No Answer		1
• Undergraduate		102
• Postgraduate		8
• Doctorate		1
• Post-Doctoral		1
	TOTAL	113

Age of the primary school teachers

The following table depicts the distribution of the teachers' ages through their answers. Results of table 3 was gathered by the second question in the questionnaire.

Table 3
Age of the primary school teachers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No answer	7	6.2	6.2	6.2
	20-29	4	3.5	3.5	9.7
	30-39	40	35.4	35.4	45.1
	40-49	16	14.2	14.2	59.3
	50-59	35	31.0	31.0	90.3
	60 and more	11	9.7	9.7	100.0
	Total	113	100.0	100.0	

According to the table 3, most of participant teachers (35%) were between 30-39 years old. This was followed by the participants who were 50-59 years old (31%); 40-49 years old (14%). Overall the teachers that took part in this study could be

classified as mature in-service teachers. These numbers reflect a typical ages distributions of Turkish primary school teachers' ages.

Teaching experience in chosen schools

The following table depicts the distribution of the years in terms of teaching experience of the primary school teachers' in chosen schools. Following table was gathered by third question in the questionnaire.

Table 4
Teaching experience in chosen schools

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Answer	1	.9	.9	.9
	1. Year	10	8.8	8.8	9.7
	2. Year	13	11.5	11.5	21.2
	3. Year	10	8.8	8.8	30.1
	4. Year	14	12.4	12.4	42.5
	5. Year	6	5.3	5.3	47.8
	6. Year	5	4.4	4.4	52.2
	7. Year	3	2.7	2.7	54.9
	8. Year	5	4.4	4.4	59.3
	9. Year	3	2.7	2.7	61.9
	9 Years and more	43	38.1	38.1	100.0
	Total	113	100.0	100.0	

According to the table 4, most of the participant teachers (38%) were teaching for more than 9 years. This was followed by teachers who had thought for 4 years (12%) and for 2 years (11%).

Participants' school types

The following table depicts the distribution of the school types where primary school teachers are working. Question that the table was gathered is fourth question in the questionnaire.

Table 5
Participants' school types

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Answer	1	.9	.9	.9
	Private School	45	39.8	39.8	40.7
	Public School	67	59.3	59.3	100.0
	Total	113	100.0	100.0	

According to the above table, 59% of the participant teachers taught in public schools and 40% in private school. In this sense, most of the participant teachers are teaching in public school.

Total teaching experience of the participants

Table 6 depicts the distribution of the years in terms of total teaching experience of the primary school teachers Question that the table was gathered is fifth question in the questionnaire.

Table 6
Total teaching experience of the participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Answer	4	3.5	3.5	3.5
	Less than 1 Year	3	2.7	2.7	6.2
	Between 2 and 5 Years	6	5.3	5.3	11.5
	Between 5 and 10 Years	17	15.0	15.0	26.5
	10 Years and more	83	73.5	73.5	100.0
	Total	113	100.0	100.0	

According to the above table, majority of the participant teachers (74%) had more than 10 years of teaching experience.

Graduated schools of the participants

The following table depicts the distribution of the school types where the primary school teachers graduated from. Following table was gathered by seventh question in the questionnaire.

Table 7
Graduated schools of the participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Answer	12	10.6	10.6	10.6
	University/Faculty	91	80.6	80.6	91.2
	School	6	5.3	5.3	96.5
	Institute	4	3.5	3.5	100.0
	Total	113	100.0	100.0	

According to the above table, most of the participant teachers (80.6%) were trained in universities or faculties.

Degree

The following table depicts the. distribution of the diploma degree of primary school teachers. Following table was gathered by eighth question in the questionnaire.

Table 8
Degree

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Answer	1	.9	.9	.9
	Undergraduate	102	90.3	90.3	91.2
	Postgraduate	8	7.1	7.1	98.2
	Doctorate	1	.9	.9	99.1
	Post-doctoral	1	.9	.9	100.0
	Total	113	100.0	100.0	

According to the above table, majority of the participant teachers (90%) have an undergraduate degree. This is followed by the participants who have a postgraduate degree (7%).

Awareness of dyscalculia

The following table depicts the distribution of awareness of dyscalculia of the primary school teachers. Following table was gathered by ninth question in the questionnaire and it is a multiple-choice question.

Table 9
Awareness of dyscalculia

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Answer	1	.9	.9	.9
	Yes	54	47.8	47.8	48.7
	No	58	51.3	51.3	100.0
	Total	113	100.0	100.0	

According to the above table, 48% of the participants answered “yes” and declared that they know dyscalculia; 51% of the participant answered “no” and declared that they were not aware of dyscalculia.

Facing with dyscalculia during professional training

Table 10, Table 11, and Table 12 depict the distribution when primary school teachers face with dyscalculia during their professional training. Following table was gathered by tenth question in the questionnaire and it is multiple-choice question.

Facing with dyscalculia during undergraduate training

Table 10
Facing with dyscalculia during undergraduate training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No answer	1	.9	.9	.9
	Yes	25	22.1	22.1	23.0
	No	87	77.0	77.0	100.0
	Total	113	100.0	100.0	

According to the results, 22% of the participants answered “yes” and informed to have had contact with the topic of dyscalculia; 77% of the participant answered “no” and confirmed that they did not have contact with the topic of dyscalculia during undergraduate training.

Facing with dyscalculia during postgraduate training

Table 11
Facing with dyscalculia during postgraduate training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No answer	103	91.2	91.2	91.2
	Yes	5	4.4	4.4	95.6
	No	5	4.4	4.4	100.0
	Total	113	100.0	100.0	

According to the results, 4% of the participants answered “yes” and informed to have had contact with the topic of dyscalculia; 4% of the participant answered “no” and confirmed that they did not have contact with the topic of dyscalculia during postgraduate training. 91% of the participant did not answer this question because they had an undergraduate degree.

Facing with dyscalculia during doctorate training

Table 12
Facing with dyscalculia during doctorate training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No answer	111	98.2	98.2	98.2
	No	2	1.8	1.8	100.0
	Total	113	100.0	100.0	

According to the results, 2% of the participant answered “no” and confirmed that they did not have contact with the topic of dyscalculia during undergraduate training. 98% of the participant did not answer this question because they did not have a doctorate degree.

Suspecting situation which may be dyscalculia

Table 13 depicts the distribution of suspecting the situation as dyscalculia of the primary school teachers. Following table was gathered by eleventh and twelfth questions in the questionnaire and it is a multiple-choice question.

Table 13
Suspecting situation which may be dyscalculia

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No answer	4	3.5	3.5	3.5
	Yes	40	35.4	35.4	38.9
	No	69	61.1	61.1	100.0
	Total	113	100.0	100.0	

According to the above table, most of participant teachers (61%) answered “no” and confirmed that they did not encounter situations during their professional career that made them suspect a dyscalculia. Just the opposite, 35% of the participants answered this question by claiming that they have come across with a dyscalculia. In this question it was also asked to understand approach of the teachers towards the situation. In the context of recognizing dyscalculia among the students, several answers were obtained from the participants which can be grouped into following:

- Higher length of attention and focus on lessons
- Continuous need for repeat to understand issues
- Repeatedly missing the alphabet in words
- Problems in writing
- Moving subject to subject in verbal expressions
- Not being able to solve problems compared to fellow students

In terms of offering ways to solve, it was understood that teachers use the followings:

- To work on to increase students’ interest in lessons especially for the mathematics
- Offering parents to get professional help for their child
- Trying to work on solid problems with the student in order to overcome the issue
- Patiently try to understand the student
- Get help from psychologist available in the school
- Offering parents to get private lessons in order for student to catch up with others

Ability to identify a student with dyscalculia

The following table depicts the distribution of identifying a student with dyscalculia of the primary school teachers. Following table was gathered by thirteenth question in the questionnaire and it is a multiple-choice question.

Table 14
Ability to identify a student with dyscalculia

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No answer	8	7.1	7.1	7.1
	Yes	59	52.2	52.2	59.3
	Maybe	40	35.4	35.4	94.7
	No	6	5.3	5.3	100.0
	Total	113	100.0	100.0	

According to the results, more than half of the participants (52%) answered “yes” and confirmed that they were able to identify a student with dyscalculia in their class. 35% of the participant teachers were not sure and answered “maybe”. Just a small percentage of the participant teachers (5%) answered the question with “no” and declared that they were not able to identify a child with dyscalculia in their class.

Conditions could be mistaken for dyscalculia

The following figure depicts the distribution of conditions could be mistaken for Dyscalculia. Figure 5 was gathered by fourteenth question in the questionnaire.

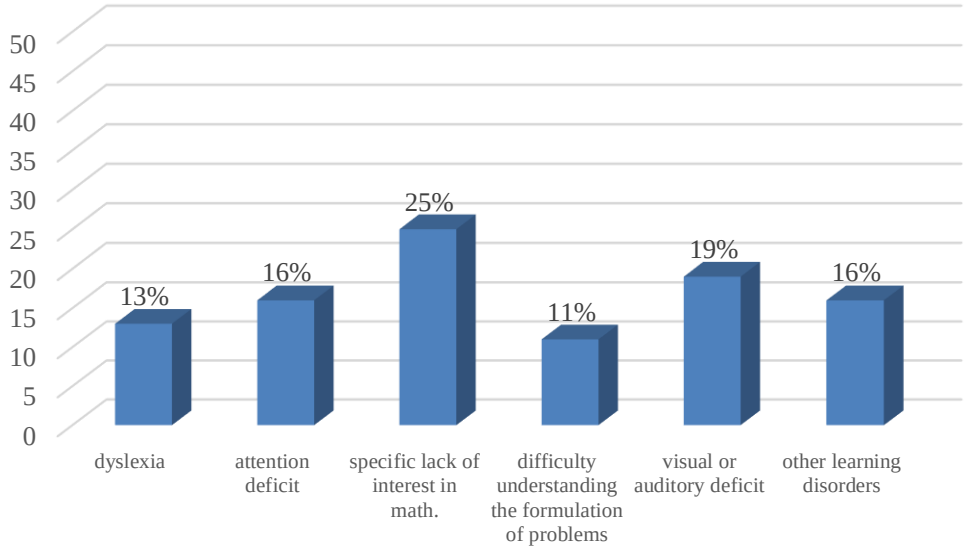

Figure 5. Conditions could be mistaken for dyscalculia

In this question, participants were allowed to mark more than one conditions. According to the results, the option “specific lack of interest in mathematics” was marked by 25% of the participants. 19% of the participants marked “visual or auditory deficit”; 16% of the participants marked “other learning disorders” and “attention deficit”; 13% of the participants marked “dyslexia”; 11% of the participants marked “difficulty understanding the formulation of problems”.

Opinion about dyscalculia

The following table depicts the distribution of primary school teachers' opinions about dyscalculia. Table 15 was gathered by fifteenth question in the questionnaire and it is a multiple-choice question.

Table 15
Opinion about dyscalculia

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No answer	13	11.5	11.5	11.5
	Yes	54	47.8	47.8	59.3
	No	46	40.7	40.7	100.0
	Total	113	100.0	100.0	

According to the above table, 48% of the participant teachers answered this question with "yes" and declared that dyscalculia was a condition that causes discomfort, anxiousness and behavioral changes and be the reason of educational or professional failure. Just the opposite, 41% of the participants answered "no".

Opinion about professional that should treat a student with dyscalculia

The following figure depicts the distribution of opinions of primary school teachers about professional that should treat a student with dyscalculia. Figure 6 was gathered by sixteenth question in the questionnaire.

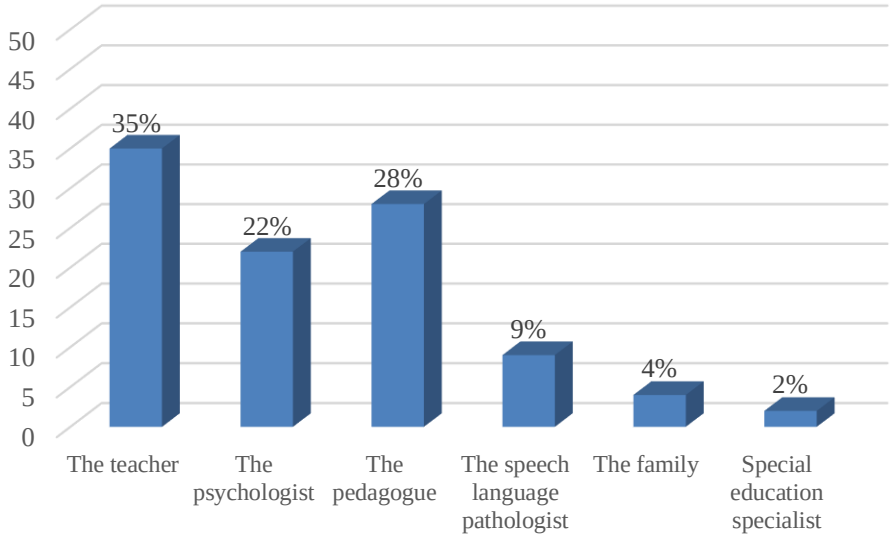

Figure 6. Opinion about professional that should treat a student with dyscalculia

In this question, participants marked more than one conditions. According to the results, the option “teacher” was marked by most of participants (35%). This is followed by the “pedagogue” (28%). The option “psychologist” was marked by the 22% of the participants; “language pathologist” was marked by 9% of the participants and “family” was marked by 4% of the participants.

Opinion about the cause of dyscalculia

The following figure depicts the distribution of opinions of primary school teachers about cause of dyscalculia. Figure 7 was gathered by seventeenth question in the questionnaire.

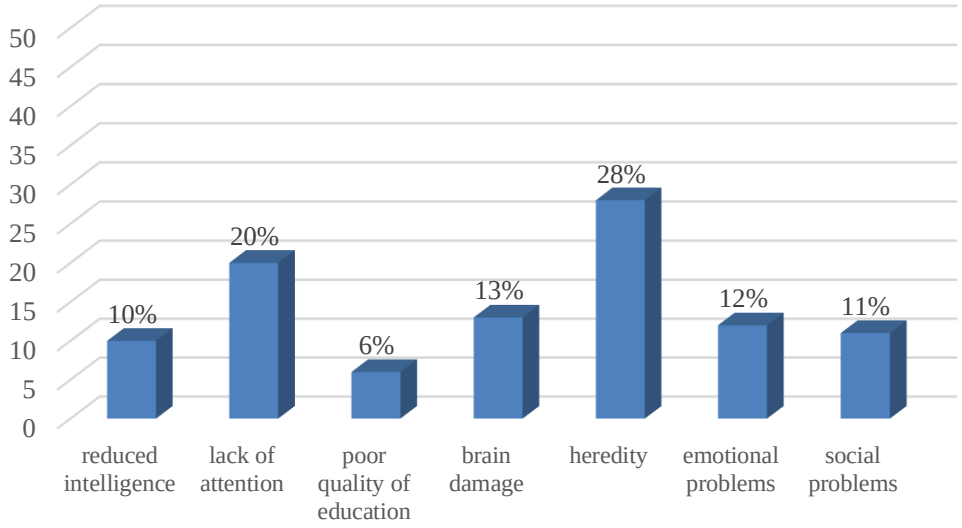

Figure 7. Opinion about the cause of dyscalculia

In this question, participants marked more than one conditions. According to the results, the option “heredity” was marked by most of the participants (28%). 20% of the participants marked “lack of attention”; 13% of the participants marked “brain damage”; 12% of the participants marked “emotional problems”; 11% of the participants marked “social problems”; 10% of the participants marked “reduced intelligence” and 6% of the participants marked “poor quality of education”.

CHAPTER 5: DISCUSSION

Introduction

In this chapter, the summary of the findings will be given, major findings will be indicated, implications for practice will be provided and suggestions will be made for further researches. In addition, limitations of this study will also be given in this chapter.

Overview of the study

The objective of this study which was to investigate the awareness of primary school teachers of dyscalculia as a condition, and to find out their knowledge and possible treatment of students with dyscalculia. In this study realist approach was follow and the questionnaire method was used to reach to collect data for the study.

In the literature, dyscalculia is defined as the learning disorder affecting the ability to acquire school-level arithmetic skills, affecting approximately 3-6% of individuals (Price and Ansari, 2013). It was identified in this study that concerns on dyscalculia indeed should be given the field of education, but unfortunately many of the teachers, specifically primary school teachers, were not aware of dyscalculia or a dyscalculics' mathematics performance in the classroom. Throughout the analysis conducted in this study it was understood that awareness about dyscalculia was low among the teachers and many of them did not know how to deal let alone treat dyscalculics.

Major findings

The major finding of this study was the lack of awareness about dyscalculia among the teachers. In fact, this shows the possibility of dealing wrongly with children/students with dyscalculia in schools. This finding was also confirmed by the earlier findings presented in the literature. For example, the results from the study conducted by Sinem and Ayça (2010), titled Teachers' Opinions About Dyscalculia Seen in the Students Between the Ages of 6 –14 also confirm this lack of awareness. According to the study, teachers were not aware of the term "dyscalculia" and instead used the generic term "learning disability" when discussing these students.

In Sinem and Ayça (2010)'s study it was also identified that although teachers expressed that they often encountered dyscalculia, they could not help the students who probably had dyscalculia. This finding of them was also confirmed in this study. Indeed, many of the teachers were not aware how to deal with dyscalculics. Similar findings were also found by Dias et al., (2013). Their study also concluded that the participating educators had very little specific knowledge on dyscalculia. They also appeared to be insecure about their ability to identify possible causes of dyscalculia. Overall it can be said that educators often have a low level of awareness about dyscalculia, despite the practical importance of the condition.

Implications for practice

Early detection of any problem including those found in mathematics education, will result in possible effective treatments and in creating and bettering intervention policies. With this logic, it is important to work with primary school teachers, since they play a pivotal role in the early stages of a child's formal education. Especially,

when it is considered problems in mathematics education such as dyscalculia. The results show that we need to broaden the research sample to reach a wider audience, since it seems that primary school teachers are ill informed.

Based on the results of this study, several managerial and academic practices can be suggested. Among them the first one is to improve the awareness of dyscalculia among the primary school teachers. In this manner, training programs can be prepared by the Ministry of Education and teachers can be encouraged to participate. Online videos can also be prepared in order to increase the awareness. Several public videos can also be prepared and can be aired in TVs in order to increase the awareness of dyscalculia among the citizens.

In addition to these, coordinative working environment should be created among the Ministry of Health and Ministry of Education in order for both ministries to work on causes and consequences of dyscalculia and how to deal with child with dyscalculia. Universities can also take part on these actions in order to find a right way to deal with dyscalculia.

Ministry of Education can also focus on identifying the level of dyscalculia in education through using online surveys. Currently, there are several screening methods for both identifying and assessing dyscalculics. One specific screening method for identification is Dyscalculia Screening Quiz. It is a free, on-line quiz that asks questions regarding mathematical concepts. When the test taker has difficulty with these concepts, the test concludes that the test-taker may show signs of dyscalculia or another learning disability. Identifying this can help teachers to focus

further on these students and accordingly, quality of education can be improved and the success rates among the students can be increased.

Implications for further research

In this study the awareness of primary school teachers of dyscalculia as a condition, and their knowledge and treatment of students with dyscalculia was realized by using a questionnaire method. It was understood from the findings that most of the teachers even do not aware of the dyscalculia. Therefore, the next study must focus on to identify the ways that teachers' awareness can be increased about the dyscalculia.

Moreover, as with primary school teachers, Turkish special education teachers may be used in the prediction of dyscalculia in another study. It would be a comparison of predictors of teachers' knowledge about characteristics and effective intervention strategies of dyscalculia as the researchers Sousa, Dias and Cadime (2016) did.

Limitations

In order to create contextual framework for the topic, secondary data was used in this study, which provides some related limitations. Electronic journals, Ma/PhD Thesis and books where used in the review of literature. Secondary data applied in this study coming from various internet sources may not be completely updated.

Another limitation lies in the selected method of sampling. A non-scientific method of non-probability sampling was used because of lack of monetary resources and time. The sample may cause a bias in the representation of the population. To finish research on time, sample size was also rather limited, which provides another limitation.

REFERENCES

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Ansari, D. (2008). Effects of development and enculturation on number representation in the brain. *Nature Reviews Neuroscience, 9*(4), 278-291. doi:10.1038/nrn2334

Ansari, D., & Karmiloff-Smith, A. (2002). A typical trajectories of number development: a neuroconstructivist perspective. *Trends in Cognitive Science, 6*(12), 511-516.

Babbie, E. (2010). *The practice of social research* (12th ed.). Belmont: Wadsworth

Bugden, S., & Ansari, D. (2014). Why your brain can't do 2 + 2: A case of developmental dyscalculia. Frontiers for young minds, *2*(8). doi:10.3389/frym.2014.00008

Butterworth, B. (2003). *Dyscalculia screener: Highlighting children with specific learning difficulties in mathematics*. Retrieved from http://sebastien.brunekreef.co/dyscalculie/Dyscalculia_Screener_Manual.pdf

Cangöz, B., Altun, A., Olkun, S., & Kacar, F. (2013). Computer based screening dyscalculia: Cognitive and neuropsychological correlates. *Turkish Online Journal of Educational Technology, 12*(3), 33-38. Retrieved from https://www.learntechlib.org/p/153711/

Cipolotti, L., Butterworth, B., & Denes, G. (1991). A specific deficit for numbers in a case dense acalculia. *Brain, 114,* 2619-2637.

Chinn, S., & Ashcroft, R. (2006). *Mathematics for dyslexics: Including dyscalculia* (3rd ed.). West Sussex: Wiley.

Creative Research Systems. (2012), *Sample size calculator.* Retrieved from https://www.surveysystem.com/sscalc.htm

Collis, J., & Hussey, R. (2003). *Business research: A practical quide for undergraduate and postgraduate students* (2nd ed.). New York: Palgrave Macmillan.

Cowan, R., & Powell, D. (2014). The contributions of domain-general and numerical factors to third-grade arithmetic skills and mathematical learning disability. *Journal of Educational Psychology, 106*(1), 214-229.

David, M., & Sutton, C.D. (2011). *Social research: An introduction* (2nd ed.) London: Sage Publications.

Davis, D. (2000). *Business research for decision making* (5th ed.). California: Duxbury.

Dias, M. deA. H., Pereira, M. M. deB., & vanBorsel, J. (2013). Assessment of the awareness of dyscalculia among educators. *Audiology - Communication Research, 18*(2), 93-100.

DfES. (2001). The daily mathematics lesson: Guidance to support pupils with dyslexia and dyscalculia, DfES Ref: 05/12/2001.

El Kah, A., & Lakhouaja, A. (2018). Developing effective educative games for Arabic children primarily dyslexics. *Education and Information Technologies, 23*(6), 2911-2930.

Faragher, R. (2017). Hypothesis of developmental dyscalculia and down syndrome: Implications for mathematics education. In A. Downton, S. Livy, & J. Hall (Eds.), *40 years on: We are still learning! Proceedings of the 40th Annual Conference of the Mathematics Education Research Group of Australasia* (pp. 245–252). Melbourne: MERGA.

Fletcher, J. M. (2009). Dyslexia: The evolution of a scientific concept. *Journal of the International Neuropsychological Society, 15*(4), 501-508.

Francis, T., Smith, G., Wareham, J. and Wood, H. (2013). *Dyscalc.* Retrieved from http://www.educational-psychologist.co.uk/screening/dyscalculic/

Geary, D. (1993). Mathematical disabilities: Cognition, neuropsychological and genetic components. *Psychological Bulletin*, *114*, 345-362.

Geary, D., & Hoard, M. K. (2001). Numerical and arithmetical deficits in learning-disabled children: Relation to dyscalculia and dyslexia. *Aphasiology*, *15*(7), 635-647.

Geary, D. (2004). Mathematics and learning disabilities. *Journal of Learning Disabilities, 37*(1), 4-15.

Ginsburg, H. P. (1997). Mathematics learning disabilities: A view from developmental psychology. *Journal of Learning Disabilities, 30*, 20-33.

Healy, M., & Perry, C. (2000). Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm. Qualitative Market Research, *3*(3), 118-126.

Henschen, S. E. (1920). *Klinische und anatomische beitrage zu pathologie des gehirns.* Stockholm: Nordisko Bokhandeln.

Iuvulano, T., Tang, J., Hall, C., & Butterworth, B. (2008). Core information processing deficits in developmental dyscalculia and low numeracy. *Developmental Science, 11*(5), 669-680. (ERIC Document Reproduction Service No. EJ849745)

Jordan, N., Hanich, L. B., & Kaplan, D. (2003). A longitudinal study of mathematical competencies in children with specific mathematics difficulties versus children with co-morbid mathematics and reading difficulties. *Child Development, 74*, 834-850.

Jordan, N., & Montani, T. (1997). Cognitive arithmetic and problem solving: A comparison of children with specific and general mathematics difficulties. *Journal of Learning Disabilities, 30*(6), 624-634.

Karagiannakis, G., Baccaglini-Frank, A., & Papadatos, Y. (2014). Mathematical learning difficulties subtypes classification. Frontiers in human neuroscience, *8*, 57. doi:10.3389/fnhum.2014.00057

Kirby, J. R., & Becker L. D. (1988). Cognitive components of learning problems in arithmetic. *Remedial and Special Education, 9*, 7-16.

Kosc, L. (1974). Developmental dyscalculia. *Journal of Learning Disabilities, 7*(3), 164-177.

Kucian, K., & von Aster, M. (2015). Developmental dyscalculia. *European journal of pediatrics, 174*. doi:10.1007/s00431-014-2455-7.

Landerl, K., Bevan, A., & Butterworth, B. (2004). Developmental dyscalculia and Basic Numerical Capacities: A study of 8-9 years-old pupils. *Cognition, 93*, 99-125.

Lewis, C., Hitch, G., & Walker, P. (1994). The prevalence of specific arithmetic difficulties and specific reading difficulties in 9- and 10- year old boys and girls. *Journal of Pupil Psychology and Psychiatry, 35*, 283–92.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry*. Thousand Oaks: Sage Publications.

Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2003). A definition of dyslexia. *Annals of Dyslexia, 53*, 1–14.

McBurney, D.H., & White, T.L. (2009). *Research methods* (8th ed.). Belmont, CA: Wadsworth/Thomson Learning.

Monei, T., & Pedro, A. (2017). A systematic review of interventions for children presenting with dyscalculia in primary schools. *Educational Psychology in Practice, 33*(3), 277-293. doi: 10.1080/02667363.2017.1289076

Munro, J. (2003). Dyscalculia: A unifying concept in understanding mathematics learning disabilities. *Australian Journal of Learning Disabilities, 8*(4), 1–13. doi:10.1080/19404150309546744.

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2016). *TIMSS 2015 International results in mathematics*. Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/

Mussolin, C., De Volder A., Grandin C., Schlögel X. Nassogne M. C., & Noel M. P. (2010). Neural correlates of symbolic number comparison in developmental dyscalculia. *Journal of Cognitive Neuroscience, 22*(5), 860-874.

Oakshott, L. (2001). *Essential quantitative methods for business management and finance* (2nd ed.). New York: Palgrave.

Ostad, S. (1998). Developmental differences in solving simple arithmetic word problems and simple number-fact problems: a comparison of mathematically normal and mathematically disabled children. *Mathematical Cognition, 4*, 1-19. doi: 10.1080/135467998387389.

Patton, M. (1985). *Qualitative evaluation and research methods* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Price, G. R., & Ansari, D. (2013). Dyscalculia: Characteristics, causes, and treatments. *Numeracy, 6*(1). doi: http://dx.doi.org/10.5038/1936-4660.6.1.2

Russell, R. L., & Ginsburg, H. P. (1984). Cognitive analysis of children's mathematical difficulties. *Cognition and Instruction, 1*, 217-244.

Saunders, M., Lewis, P., & Thornhill, A. (2007). *Research methods for business students* (4rd ed.). Harrow: FT Prentice Hall.

Seale, C., Gobo, G., Gubrium, J., & Silverman D. (2004). *Qualitative research practice*. London: Sage Publications.

Shalev, R. S., & Gross-Tsur, V. (2001). Developmental dyscalculia. *Pediatric Neurology, 24*(5), 337–342. doi:10.1016/S0887-8994(00)00258-7.

Sinem, S., & Ayça, A. (2010). Teachers' opinions about dyscalculia seen in the students between the ages of 6–14. *Elementary Education Online, 10*(2), 757-775. Retrieved from http://ilkogretim-online.org.tr/vol10say2/v10s2m28.pdf

Smith, M. J. (1998). *Social science in question*. London: Sage Publications.

Sousa, P., Dias, P.C., & Cadime, I. (2017). Predictors of primary school teachers' knowledge about developmental dyscalculia. *European Journal of Special Needs Education, 32*(2), 204-220. doi:10.1080/08856257.2016.1216635

Taylor, G.R. (2005). *Integrating quantitative and qualitative methods in research* (2nd ed.). Oxford: University Press of America.

Thioux, M., Seron, X., & Pesenti, M. (1999). Functional neuroanatomy of the semantic system: The case for numerals. *Brain and Language, 69*, 488-490.

Wadlington, E., & Wadlington, P. (2008). Helping pupils with mathematical disabilities to succeed. *Preventing School Failure, 53*(1), 2-7. (ERIC Document Reproduction Service No. EJ814412).

Watzlawik, M. and Born A. (2007). *Capturing identity: Quantitative and qualitative methods*. Lanham: University Press of Americ

APPENDICES

APPENDIX A: Permission for Questionnaire

Meltem Karasakal <meltem.karasakal@bilkent.edu.tr> 3 Ekim 2015 16:49

Alıcı: john.vanborsel@ugent.be

Dear Mr. John Van Borsel,
I am Meltem Karasakal. I am a M.Sc student and studying at Bilkent University in Curriculum and Instruction Teaching Certificate program (http://gse.bilkent.edu.tr/programs/ma-in-cite.html).
I am writing to obtain your permission to use your questionnaire: “Evaluation of the perception of dyscalculia by educators” that was published in "Assessment of the awareness of dyscalculia among educators"
I am in the process of doing research on teacher awareness of dyscalculia among the Schools in Turkey, Ankara, Çankaya as similar as you did. The Ministry of education requires formal permission of all authors' instruments to grant research permissions.
I could not reach Ms. Pereira by e-mail that was written at this article (http://www.scielo.br/scielo.php?pid=S2317-64312013000200007&script=sci_arttext&tlng=en#back)
Therefore, I kindly ask you to grant me to use your interview form, I am looking forward to hear back from you soon.
Kind Regards
Meltem Karasakal

John Van Borsel <John.VanBorsel@ugent.be> 4 Ekim 2015 09:50
Alıcı: Meltem Karasakal <meltem.karasakal@bilkent.edu.tr>

Dear Ms. Karasakal,
thank you for your interest in our research. We are happy to grant you to use the interview form, please just make sure to reference our article. We wish you all the best with your dissertation.
Sincerely,
John Van Borsel
Mônica Medeiros de Britto Pereira

APPENDIX B: Questionnaire: "Evaluation of primary school teachers' awareness of dyscalculia"

(Anket: "Eğitimcilerin diskalkuli algısının değerlendirilmesi")

Genel Sorular

1. İsminizin baş harfi:

2. Doğum tarihiniz:

3. Bu anketi doldurduğunuz tarih:

4. Öğretmenlik yaptığınız okulda kaçıncı yılınız:

( ) 1. Yıl ( ) 2. yıl ( ) 3. yıl ( ) 4. yıl ( ) 5. yıl

( ) 6. yıl ( ) 7. yıl ( ) 8. yıl ( ) 9. yıl ( ) 9'dan fazla

5. Öğretmenlik yaptığınız okul:

( ) Özel Okul ( ) Devlet Okulu

6. Kaç senedir öğretmenlik yapıyorsunuz:

( ) 1 yıldan az ( ) 2 ile 5 yıl arasında ( ) 5 ile 10 yıl arasında

( ) 10 yıldan fazla

7. Öğretmenlik eğitimini aldığınız kurum (Üniversite, Fakülte, Okul):_____

8. Dereceniz:

( ) Lisans ( ) Yüksek Lisans ( ) Doktora ( ) Doktora Sonrası

Belirli Sorular

9. Diskalkuli kavramı ile daha önce karşılaştınız mı?

( ) Evet ( ) Hayır

10. Diskalkuli kavramı ile mesleki eğitiminiz süresi içerisinde mi karşılaştınız?

Lisans: ( ) Evet ( ) Hayır

Yüksek Lisans: ( ) Evet ( ) Hayır

Doktora: ( ) Evet ( ) Hayır

11. Mesleki kariyeriniz boyunca diskalkuli olarak şüphelendiğiniz bir durumla karşılaştınız mı? ( ) Evet ( ) Hayır

12. Evet ise, bu duruma karşı yaklaşımınız nasıl oldu?

---

13. Sınıfınızdaki matematik öğrenme bozukluğu olan öğrenci veya öğrenciler hakkında fikir yürütebileceğinizi düşünüyor musunuz?

( ) Evet ( ) Belki ( ) Hayır

14. Sizce aşağıdaki durumlardan hangisi veya hangileri diskalkuli için koşul olmamaktadır?

( ) Disleksi olma ( ) Dikkat eksikliği ( ) Matematik ilgi eksikliği

( ) Problemlerin formülasyonunu anlama zorluğu

( ) Görsel veya işitsel eksiklik

( ) Diğer öğrenme bozuklukları

15. Size göre diskalkuli, rahatsızlık veren, endişe ve davranış bozukluğuna neden olabilecek, ayrıca eğitim veya mesleki başarısızlığa sebebiyet verebilecek bir koşul mudur?

( ) Evet ( ) Hayır

16. Size göre, diskalkuliye sahip olan çocuklara profesyonel yardım edebilecek kişi kim veya kimlerdir?

( ) Öğretmenler ( ) Psikologlar ( ) Pedagoglar

( ) Konuşma-dil patoloji uzmanları

( ) Diğer _____

17. Size göre diskalkulinin nedeni nedir? (Birden fazla alternatif işaretlenebilir)

( ) Zekâ geriliği ( ) Dikkat eksikliği ( ) Düşük eğitim kalitesi

( ) Beynin hasar görmesi ( ) Kalıtsal sebepler ( ) Duygusal sorunlar

( ) Sosyal sorunlar ( ) Diğerleri_____