ÖZGE ARSLAN

AN INVESTIGATION OF STUDENTS' NUMBER SENSE AND ATTITUDE SCORES AS PREDICTORS OF MATHEMATICS ACHIEVEMENT

A MASTER'S THESIS

BY

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AN INVESTIGATION OF STUDENTS' NUMBER SENSE AND ATTITUDE SCORES AS PREDICTORS OF MATHEMATICS ACHIEVEMENT

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ÖZGE ARSLAN

May 2016

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.

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ABSTRACT

AN INVESTIGATION OF STUDENTS' NUMBER SENSE AND ATTITUDE SCORES AS PREDICTORS OF MATHEMATICS ACHIEVEMENT

Özge Arslan

M.A., Program of Curriculum and Instruction
Supervisor: Prof. Dr. Alipaşa Ayas

May 2016

The main purpose of this quantitative study was to investigate whether middle school students' number sense skills and attitudes towards mathematics provide a useful measure to predict their mathematics achievement levels as they were assessed with schools entrance examinations. A sample was drawn from private foundation schools in Ankara. Data consisted of number sense test, attitude towards mathematics scale, TEOG mathematics scores, and mathematics school grades. The collected data were analyzed first with descriptive statistics. Then, a multiple regression approach was used to further analyze the data. Statistically significant and relatively moderate relationships were found between number sense skills, mathematics achievement and attitude towards mathematic. As a result of the multiple regression analysis, it can be concluded that number sense skills and attitude towards mathematics can be useful to predict to some extent mathematics achievement of students.

Key Words: Number Sense Skills, Mathematics Achievement, Mathematics Attitude, Middle School.

ÖZET

ÖĞRENCİLERİN SAYI DUYUSU VE TUTUM PUANLARININ YORDAYICI OLARAK MATEMATİK BAŞARISINI TAHMİN ETMEDEKİ UYGUNLUĞUNU İNCELEYEN BİR ARAŞTIRMA

Özge Arslan

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Bu nicel çalışmanın temel amacı, ortaokul öğrencilerinin sayı duyusu becerileri ve matematiğe karşı tutumlarının bir üst okula giriş sınavlarındaki matematik başarılarını tahmin etmede uygun birer ölçütler olup olmadıklarını araştırmaktır. Örneklem Ankara'daki kamu ve vakıf üniversitelerinin sahip olduğu okullardan seçilmiştir. Veriler, sayı duyusu testi, matematik tutum ölçeği, TEOG matematik sonuçları ve matematik karne notlarından elde edilmiştir. Toplanan veriler öncelikle betimleyici istatistik kullanılarak, daha sonra çoklu regresyon yöntemi kullanılarak analiz edilmiştir. Sayı duyusu becerisi, matematik başarısı ve matematiğe karşı tutum arasında orta düzeyde bir ilişki olup sonuçlar istatistiksel olarak anlamlı bulunmuştur. Yapılan çoklu regresyon analizin sonuçlarına göre ise, sayı duyusu becerisi ve matematik tutumu, matematik başarısını tahmin etmek için oldukça kullanışlılardır.

Anahtar Kelimeler: Sayı Duyusu Beceresi, Matematik Başarısı, Matematik Tutumu, Ortaokul.

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CHAPTER 1: INTRODUCTION

Introduction

Starting from the 20th century, the philosophy of education began to change. It has affected all educational activities from the general to any single activity in a classroom. The change in teaching was from a teacher-centred approach to a student-centred one. It particularly gained momentum during the last four-five decades. The value attached to mathematics teaching the most was affected. These changes have changed mathematics education theory, and consequent, affected assessment practices as well. Before the student-centred instruction, if a student knew the basic mathematical rules, they were assumed to have mastered the content. This perception of learning continued to be in effect until the last quarter of the twentieth century (Anghileri, 2000).

Since then, this perception evolved into a more constructivist view that students should know how to use numbers and operations in real-life context. In this new understanding, it was not enough to know only the four basic operations; students should also know how to compare the dimension of numbers in real-life context. Today, several mathematics educators assert that a conceptual understanding of arithmetic and abstraction associated with numbers are important prerequisites for future success in mathematics (Olkun, Yıldız, Sarı, Uçar, & Turan 2014). From this point, basic skills such as using numbers and comparing numbers are some related concepts which are interpreted under a larger construct, namely, number sense.

Number sense is a relatively new topic for mathematics education. The construct of number sense was first documented by the National Council of Teachers of

Mathematics (NCTM) in 1989 (NCTM, 1989). This influential association defined it as understanding numbers, the dimension of numbers, and the relationship between numbers. The present research investigates the relationship between students' number sense skills, their mathematics achievement in nation-wide exams (TEOG, *Temel Eğitimden Ortaöğretime Geçiş*) and their attitude towards mathematics. In this chapter, I introduced the background of the development of the number sense construct in addition to the purpose of the research and its associated problem and research questions.

Background

The new ideas on education started to emerge after the Sputnik movement in the US during 1960s. At school level, it was realized that mere theoretical knowledge was not enough for the learners in the US to compete with other nations. The teachers' role in the classroom needed to be less active while students needed be more active in the classroom and assume responsibility for their own learning. In this new perspective, teachers were guides of learning rather than an expert lecturing. Policy makers also started to include more experimental learning activities in the school curriculum. This was an era of innovation in school education as it combined theoretical and practical activities in teaching and learning mathematics (Ayas, Çepni, & Akdeniz, 1994).

There has been another wave of reforms in mathematics education in recent years both at national and international levels. Constructivism, as a paradigm, constituted the theoretical foundation of these reforms in education. The influential US-based National Council of Teacher of Education (NCTM) standards were written under the influence of this paradigm shift. Many countries across the globe adopted the

philosophy which was embedded in NCTM standards. While the curriculum was changing in the US and across the world, the public perception of success in mathematics was also under a process alteration (NCTM, 1989). The premature understanding of success which was limited to fluency in the basic mathematical rules was evolving into a more skill-based interpretation of success in mathematics (Anghileri, 2000). The new expectations for students' success are skilled-based that emphasized problem solving, reasoning and mathematics in real-life applications.

In accordance with this new approach to method, using number sense skills emerged. Although this set of skills was first used by NCTM (1989); the researches have not reached a consensus on a single definition for the term. However, these existing definitions are not too different from one another (Gersten, Jordan, & Flojo, 2005). The most general definition of number sense is "to understand the numbers, dimensions of numbers and the relationship between the numbers" (p. 297). Another definition emphasized flexible thinking, estimation about the operations and making inference about the numeric values (Greeno, 1991). Howden (1989, p.6) Reys, Reys, Emanuelson, Johansson, McIntosh, & Yang, 1999, p.61) defined it as a decent intuition about numbers and their relation.

In the literature, there were some studies about number sense, which investigated the relationship between number sense and mathematics achievement (Bayram, 2013; Kayhan Altay, 2010; Yapıcı, 2013). But the scope of these was narrow. Besides, in these studies specific mathematics topics were used to measure the students' mathematics achievement, such as exponential numbers and percentage (Bayram, 2013; Yapıcı, 2013). Thus, the literature needs more general studies, that is, general mathematics achievement covering at least one school level such as nation-wide (TEOG) exams' results.

Problem

Many studies looked at the relationship between students' number sense skills and mathematics achievement in school. The results indicated that there was a strong correlation between them (Bayram, 2013; Kayhan Altay, 2010; Yapıcı, 2013). However, these studies assessed achievement in one specific topic in mathematics and related it to number sense skills, and did not provide a general view of achievement in mathematics. These studies were narrow in their scope. That is to say, there is a gap in the literature in terms of the relationship between students' general mathematics achievement and number sense skills. Thus, the current study focused on nation-wide exams, TEOG, using mathematics scores as a means of, measuring students' mathematics achievement, and relating it to students' number sense skills.

In addition, studies in the current literature have been done in public schools in Turkey. The sampling for the present study was selected from private foundation schools, which were affiliated to state universities or foundation universities. Another research problem in the current study was to investigate the relationship between number sense and mathematics attitude. There is a need for more study to correlate number sense, mathematics attitude and mathematics achievement in TEOG exams all together. The present study focused on these issues as a main problem.

Purpose

The main purpose of this quantitative study was to investigate whether students' number sense skills and attitudes towards mathematics provide a useful measure to predict mathematics achievement. It was measured in nation-wide exams for 8th

grade students who attended private foundation school. This study also aimed to find out the relationship between number sense, mathematics attitude and mathematics achievement in nation-wide exams, TEOG, together with mathematics achievement as assessed within the schools for 8th grade students.

Research questions

The primary research questions of the current study are:

1. Is there any statistically significant relationship between number sense skills and mathematics achievement for 8th grade students?

   More specifically the following questions were the focus:

   - Is there any statistically significant relationship between number sense skills and mathematics achievement in nation-wide exam, TEOG?
   - Is there any statistically significant relationship between number sense skills and mathematics achievement as assessed within the school?

2. Is there any statistically significant relationship between number sense skills and attitudes towards mathematics for 8th grade students?
3. Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement for 8th grade students?

   More specifically the following questions were the focus:

   - Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement in nation-wide exam, TEOG?
   - Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement as assessed within the school?

In addition, this study seeks to answer the following question:

4. To what extent do number sense's skills and mathematics attitude explain variance in mathematics achievement in TEOG?
5. What are the best predictors of mathematics scores in TEOG?

Significance

Number sense is a significant research area, which has been studied for more than two decades. Although the number of studies about number sense is increasing every year, there is still a need for more research in this area. Most of the studies were done in Turkey, investigated the relationship between number sense and units of mathematics achievement. The literature indicated that there is a strong relationship between number sense and mathematics achievement for the middle schools' students (Bayram, 2013; Kayhan Altay, 2010; Yapıcı, 2013). However these studies cannot be generalized to all grades, samples, schools and countries. Therefore, as suggested by the literature there is a need for further studies in this regard. Moreover, there is no study about number sense and mathematics attitude in the literature (Şengül & Gülbağcı, 2013). Therefore, this study aims to investigate the relationship between number sense and attitude towards mathematics as well.

In addition, although there are many studies done in public schools, this study will be the first done in private foundation schools about number sense.

This study will provide useful information, about number sense test and mathematics attitude scale, to see if it is a good measure to predict 8th grade students' mathematics achievement in TEOG exams. If number sense and mathematics attitude can be used to predict mathematics achievement, students do not need to attend nation-wide exams like TEOG, thus reducing students' anxiety level.

Definitions of key terms and abbreviations

Attitude: The person's idea about the object/objects or individual/individuals. Related to the lesson, "it can be defined as the positive or negative degree of affect associated with a certain subject" (McLeod, 1992; Haladyna, Shaughnessy J. & Shaughnessy M.,1983; cited in Zan & Martino, 2007, p.158).

LYS: Lisans Yerleştirme Sınavı

MA: Mathematics Attitude

MAS: Mathematics Attitude Scale

MEB: Milli Eğitim Bakanlığı

MoNE: Ministry of National Education.

NCTM: National Council of Teacher of Mathematics.

Number Sense: It can be defined as an intuitive way of understanding numbers, their dimensions and the relationship between numbers.

NS: Number Sense

NST: Number Sense Test.

PISA: Program for International Student Assessment (Uluslararası Öğrenci Değerlendirme Programı).

School Report: It shows the lessons' grade, attendance and general attitude about students, given at the end of the fall and spring semesters. They (the lesson's grades) are prepared according to the internal exams' results, which are done and assessed by the schools' teachers.

SES: Socioeconomic status.

TEOG (*Temel Eğitimden Ortaöğretime Geçiş Sistemi*): This is an exam system, which are prepared and arranged by MoNE, for the 8th grade students, to enter the

High School. TEOG it is done twice a year, as on November 2014 (TEOG 1) and April 2015 (TEOG 2).

TIMSS: Trends in International Mathematics and Science Study (Uluslararası Matematik ve Fen Eğilimleri Araştırması).

YGS: Yüksek Öğretime Geçiş Sınavı

YÖK: Yüksek Öğretim Kurumu.

Ethical considerations

In this study, the number sense test and mathematics attitude scale were used to assess the students' number sense level and their attitude towards mathematics. The test and scale were developed by different researchers. The researcher got permission from the original owners to use them. In addition, a personal information questionnaire was applied to collect general information about student and their family, and to learn their study' habits for describing the sample. Besides, there were some questions in the personal information survey, which were about the students' Turkish grade and mathematics grade at the end of the fall semester, and their TEOG 1 and TEOG 2 mathematics scores. If the students wanted to say their grades, they wrote as a volunteer.

The study was done in the private foundation schools in Ankara with 8th grade students. Therefore, the researcher needed MoNE permission to apply the personal information survey, number sense test and mathematics attitude scale. The students' name, their mathematics scores in TOEG 1 (November 2014), TEOG 2 (April 2015) and number sense test and the results of mathematics attitude scale were confidential, and will not be used anywhere.

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

The main purpose of this study was to investigate whether students' number sense skills and attitude towards mathematics provide a useful measure to predict mathematics achievement, as measured in nation-wide exams (TEOG) for 8th grade students who attended private foundation schools. In addition, this study aimed to find out the nature of the relationship between number sense skills, attitude towards mathematics and mathematics achievement in nation-wide exams, TEOG, and mathematics achievement as assessed in schools.

This chapter includes related literature on curricular reforms in mathematics education, different definitions of number sense, the relationship between number sense and mathematics achievement, and the relationship between mathematics achievement and attitude towards mathematics.

Related literature

Four areas of the research were significant to the background of this study. These were (i) curricular reforms in mathematics education in Turkey, (ii) different definitions of number sense, (iii) the relationship of number sense and mathematics achievement, and (iv) the relationship between mathematics achievement and attitude towards mathematics.

Curricular reforms in mathematics education in Turkey

The first section looked into the mathematics education within the context of this study. The curricular reforms were examined under three sub-sections: (1) mathematics curriculum before 2005, (2) mathematic curriculum between 2005 and 2013 and (3) mathematics curriculum after 2013.

The main objective of mathematics education is for students to gain the mathematics knowledge and skills required for daily life so as to develop problem solving (Van de Walle, 2007). In addition, the principal purpose of middle school mathematics education in Turkey is to encourage students to acquire the knowledge, skills and attitudes relevant to mathematics (MoNE, 2009b).

The philosophy of mathematics education has shifted gradually in recent years in Turkey, and constructivism has influenced some of these changes. In the past, if a student knows the multiplication tables and the four basic operations: addition, subtraction, multiplication and division, he/she was accepted as successful in school mathematics. In recent years, the idea of 'success' has shifted from the traditional view to a more contemporary perspective which regards students as successful if they are able to solve real-life problems and use technology in mathematics lesson (Anghileri, 2000).

The NCTM (National Council of Teacher of Mathematics) determined some standards underlying a framework for mathematics learning. According to their standards, the student should comprehend the numbers, operations, and relationship between numbers and operations (NCTM, 1995).

Following these recommendations, many European countries and Australia have changed their curricula over the last three decades in line with NCTM standards

(Australian Education Council, 1991). Similarly, there have been some changes in the Turkish mathematics curriculum during the last decade. Ministry of National Education (MoNE) has also altered its mathematics curriculum with respect to the NCTM standards in Turkey. Before 2005, there were no objectives which were related to number sense in middle school mathematics curriculum (MoNE, 2005) because the curriculum implemented was mostly teacher centered, that is, the teacher is more active than students during the teaching/learning process. However, the mathematics curriculum was changed in 2005 and 2013. New curricula were prepared, taking into consideration more constructivist ideas, which are more student-centered.

Before 2005 (MoNE, 2005) number sense was not in the elementary and middle schools mathematics curricula. Although, number sense was not mentioned directly in the middle school mathematics curriculum, the topic on operations is related to number sense. The middle school mathematics curriculum was revised in 2009 and 2013 (MoNE, 2009a; MoNE, 2013). However, all these revisions and changes made to the mathematics curriculum did not show any explicit indication of the number sense construct.

Different definitions of number sense

Number sense is a relatively new area in mathematics education. It was firstly mentioned in the meeting of National Council of Teacher of Mathematics (NCTM) in 1989. However, Crowter (1959) used the term 'numeracy' in a similar way to refer to the current ideas behind the concept of number sense.

The concept of number sense has no single definition agreed by mathematics educators. Although, there were several different definitions for number sense in the

literature, two different researchers defined it in almost the same way (Gersten, Jordan, & Floja, 2005). Although it is a difficult concept to define, it is an easy concept to understand (Case, 1998). In addition, several psychologists defined it differently from mathematics educators. For example, Dehaene (1997) alleged that number sense came as a concept you are born with and it could not be developed via education.

A fundamental definition of number sense is having a good intuition about numbers and their relations (Howden, 1989, p.6, Reys, Reys, Emanuelson, Johansson, McIntosh, & Yang, 1999, p.61). A content specific definition of number sense is to understand numbers and four basic operations, and discuss real-life situations, by using numbers (McIntosh, Reys, & Reys, 1992; Reys & Yang, 1998; Yang 1995). A more specific definition comes from Berch (2005, p. 333). Number sense is to be able to develop mathematics and principals of mathematical operations, and numerical expressions. Another definition of number sense is "to understand the meaning of numbers and to perform mathematical comparison in mind" (Gersten & Chard, 1999). Griffin (2003, p. 306) defined it as an ability of understanding numbers', the relationship between numbers and the dimensions of numbers.

Number sense can also be seen as a way of thinking about and understanding numbers, operations and the relationships between numbers and operations (Greeno, 1991). Number sense also includes the ability to develop flexible and efficient strategies, such as mental computation and estimation, as well as solving numerical problems including daily life-related situations (McIntosh, Reys, & Reys, 1992).

Classification about number sense

Since the concept of number sense does not have a single definition, number sense had several classifications. Therefore, researchers did different classifications for number sense, giving ten classifications schemas for number sense (Şengül & Gülbağcı Dede, 2013).

The most detailed classification was done by McIntosh, Reys, & Reys (1992). There were three components in this classification; these were "*knowledge of and facility with numbers*, *knowledge of facility with operations,* and *applying knowledge and facility with numbers and operations to computational settings"*. These three components were divided into sub-components. For instance, "*knowledge of and facility with numbers* had four sub-components, such as numbers sub-components were *sense of orderliness of numbers, multiple representations of numbers, sense of relative absolute magnitude of numbers*, and *system of benchmarks"* (McIntosh, Reys, & Reys, 1992, p.4).

NCTM, which has been studying mathematics education, highlighted the property of children who had number sense skills, instead of stating the components of number sense and doing classification for the number sense (NCTM, 1989; NCTM, 2000). According to the NCTM, if a child knows "*the numbers*, *develops a relationship between numbers, comprehends the dimensions of numbers* and *use the reference points in order to compare numbers"*, then he/she has high number sense skills.

According to Yang's classification (Yang, 1995) number sense has five different components. The first component was "*understanding the meaning of numbers"*. The second component was *separating the numbers and compounding the numbers*. The third component was "*understanding the dimension of numbers"*. The next

component was "*understanding the effects of operations on numbers"*. The last component was "*using the numbers' and operations' knowledge in flexible"*. In addition, Yang did one more classification about number sense (Yang, 2003). The new classification was similar to the earlier classification, but a comparison between the first and second classifications revealed some differences between them. The second classification (Yang, 2003) had five components similarly. The first component was, "*understanding the meaning of numbers*." The first component was the same as in the first and second classifications. Second component was, *understand the dimension of numbers*. Third component was, "*using the computational references appropriately"*. The following component was, "*understand the effects of operations on number"*. This one was the same in the first and second classifications. The final component was, "*using the different strategies effectively and commenting the correct answer whether true or false in terms of minds*" (Yang, 2003).

The other classification was done for examining pre-school students' number sense skills. The researcher did a study in order to determine pre-school students' number sense skills. At the end of the study, the researchers discovered five main areas for pre-school students' number sense. These were "*cardinality principle, the knowledge of numbers, number conversion, estimation and patterns of numbers"* (Jordan, Kaplan, Olah, & Loucniak, 2006). Similarly, one more classification was done for assessing pre-school students' number sense skills (Lago & DiPerne, 2010). The researchers developed a test to measure students' number sense skills According to this test, number sense had five components. These were, "*counting numbers, to measure the concept as a quantitatively"*, that means comparing like more than and/or less than. The third component was "*computation, doing calculation by using*

materials". The next one was "*determining the numbers"*; that is, being able to tell the name of the numbers between 1 and 30 shown to the students. The final one was "*recognizing the value of numbers"* that means demonstrating two boxes with written numbers, from 1 to 20, on them, and asking which one is bigger.

Number sense and mathematics achievement

In this section, the literature was investigated from a perspective looking at the relationship between number sense skills and mathematics achievement. This section revised and discussed the relevant studies about number sense and mathematics achievement.

There are some studies about number sense skills and mathematics achievement that help to shed light on the importance of number sense for students. According to the research by Yang, Li, & Lin (2007), there was a positive relationship between number sense skills and mathematics achievement. This study was done with 1215 5th grade students in Taiwan in 2007. The researchers developed a number sense test in order to measure the number sense skills. The test had four components. These were "*recognizing relative numbers size, using multiple representations of numbers and operations, judging the reasonableness of estimations of computed results* and *recognizing the relative effect operation on numbers*". Moreover, the same scale was used to measure the students' mathematics achievement.

There was another study done in Taiwan (Yang & Tsai, 2010). It was done with 6th grade students with the aim of promoting students' number sense skills. The students were divided into two groups, one was the control group, the other one was the experimental group. At the beginning of the study, the students' number sense skills were determined for both control group and the experimental group. During the

learning process, a traditional method was used for the control group, and technology was used for the experimental group for aiming to promote number sense. At the end of the study, the students' number sense skills were measured with a mathematical test related to the 6th grade mathematics curriculum. The results showed that the experimental group number sense skills were higher than the control group. Besides, according to the post-test the experimental group mathematics results were higher than control group. That is, there was a positive correlation between number sense and mathematics achievement.

A similar study was conducted in Turkey by Kayhan Altay in 2010. This study investigated the relationship between number sense skills and mathematics achievement for 6th, 7th and 8th grade students. This study was carried out with 567 students who went to public schools in Ankara. The researcher developed a test to measure the students' number sense skills. This test was available for the middle schools' students. The same test was used for assessing the students' mathematics achievement. The test included general topics about numbers, such as: "*comparing numbers, flexibility of numbers* and *using reference points for comparing the numbers"*. The results were similar to those of Yang, Li, & Lin (2007). There was a positive relationship between the students' number sense skills and their mathematics achievement.

Yapıcı (2013) also conducted research in Turkey, with 454 students, who were in 5th, 6th and 7th grades in public schools. The aim of this study was to investigate the relationship between number sense skills and mathematics achievement. To assess mathematics achievement one specific topic was used, it was percentage. The results also indicated that there was a positive relationship between number sense and mathematics achievement in terms of percentage (Yapıcı, 2013).

Bayram (2013) did a study about number sense and mathematics achievement. The research was done with 49 students, who were in the 8th grade in a public school. Exponential numbers were used to measure students' number sense skills. The results demonstrated that there was a positive relationship between number sense skills and mathematics achievement.

A qualitative method was used in the research by İymen (2012). The study was done with 20 students who were in the 8th grade in a public school. In this study, exponential numbers were used to determine the students' number sense skills. The performance on number sense was related to the components of number sense and exponential numbers. The results showed that there was a positive relationship between the exponential component of number sense and performance on the number sense (İymen 2012).

Moreover, Harç (2010) did a similar study about number sense. The aim of this study was to determine students' number sense skills. This study was done in Istanbul with 95 6th grade students.

Mathematics achievement and attitude towards mathematics

In this part, a specific focus was given to look at the relationship between mathematics achievement and attitude towards mathematics.

Zan & Martino (2007, p.158) defined attitude "the positive or negative degree of effect associated with a certain subject". A multidimensional definition, which recognizes three components in the attitude: emotional response, beliefs regarding the subject, behavior related to the subject. From this point of view, an individual's attitude toward mathematics can be defined in a more complex way by the emotions

that he/she associates with mathematics (which, however, have a positive or negative value), by the individual's beliefs towards mathematics, and by how he/she behaves (Hart, 1989).

Individuals think that mathematics is difficult to understand. Therefore, attitude towards mathematics affects achievement in mathematics lessons. Early research demonstrated that there was a positive relationship between mathematics achievement and attitude towards mathematics (Yücel, & Koç, 2011; Özgün Koca & Şen 2011).

Michelli (2013) indicated that there was a positive relationship between mathematics attitude and mathematics achievement. The research was done with 5th grade students. The results indicated that there was no strong correlation between mathematics achievement and attitude towards mathematics (r = .28). Similarly, according to Wong's study (1992), there was no strong correlation between mathematics attitude and mathematics achievement (r = .27)

Summary

In this chapter, related literature on mathematics education, number sense, the relation of number sense and mathematics achievement and the relationship between mathematics achievement and mathematics attitude, was summarized. The studies, which were done to investigate the relationship between number sense skills and mathematics achievement, indicated that mathematics achievement significantly correlated with number sense skills. However, there was no research about number sense, mathematics achievement and mathematics attitude (Şengül & Gülbağcı Dede, 2013). In present study, the researcher examined the issue and adds to literature more

for 8th grade students by using number sense test, mathematics attitude scale and students achievement in TEOG exams.

CHAPTER 3: METHODOLOGY

Introduction

The current research investigated the relationships between number sense skills, mathematics grades as given internally by mathematics teachers (school grades), mathematics scores in the mathematics section in nation-wide exams (TEOG [*Temel Eğitimden Ortaöğretime Geçiş*] exams), and attitude towards mathematics.

In this chapter, the research design, pilot study, participants, and data instrument were explained, as well as how the data were collected and analyzed. Reliability and validity for number sense test (NST) and mathematics attitude scale (MAS) score were discussed.

Research design

In educational research, there are three main research paradigms. These are quantitative research, qualitative research, and mixed-method research. This research was designed with respect to the quantitative paradigm. For the current study, correlational research design was used to answer the first, second, and third research questions. Correlational research has six steps. These are problem selection, sample, instrumentation, design and procedure, data collection, and data analysis and interpretation. There are several more complex correlational techniques, and multiple linear regression is one of them (Frankel, Wallen, & Hyun, 2012). The relationship between a single outcome variable (dependent) and at least two or more predictor variables (independent) are generally examined by a multiple linear regression approach (Creswell, 2003). Although data scale of independent variables can be measured at any level (that is, nominal, ordinal, interval or ratio), the dependent

variable (predictor variables) must be measured at the interval or ratio level (Huck, 2011).

In this study, correlational analysis was done to look at the first, second, and third research questions. Multiple linear regression was used to analyze the quality of predictor variables (number sense test and mathematics attitude scale) in producing mathematics achievement in nation-wide exams; TEOG. That is, multiple linear regression was used to analyze the fourth and fifth research questions.

Pilot study

The pilot study was carried out in the fall semester of 2014-2015 academic year with 40 students who were in 8th grade (age: 13, 14, 15 years). The pilot study was conducted for a variety of reasons: (a) to finalize the research plan; (b) to check number sense test and mathematics attitude scale suitability/convenience/appropriateness for the intended sample; (c) to improve the efficiency of the survey logistics (time, response rate) (Cohen, Manion, & Morrison, 2005).

The pilot study was conducted with 40 students (17 female) in a private foundation school (see Table 1). The school was suitable for the intended sample because the main study was intended for students in private foundation schools.

Table 1
Gender distribution for the pilot study

	Frequency (*f*)	Percent (%)
Female	17	42.50
Male	23	57.50
Total	40	100.00

The study utilized a number sense test, which had 17 open-ended questions, and a mathematics attitude scale, which had a five-point Likert scale with 22 items.

The Cronbach's *alpha* coefficient for the number sense test in the pilot data was .78, indicating a strong estimate of internal consistency. The participants completed the number sense test in a given time (one lesson hour: 40 minutes). Similarly, the Cronbach's *alpha* coefficient for the mathematics attitude data was .92, demonstrating a strong estimate of internal consistency (Tavakol & Dennick, 2011). Thus, all items seemed to measure a single construct in both test. The time given to participants to complete the mathematics attitude scale (15 minutes) was evaluated as adequate.

Participants

A convenient sample was drawn from middle school students (at 8th grade) who attended private foundation schools in Ankara, Turkey. The list of schools was acquired from the Ministry of National Education (MoNE) webpage. MoNE permission was given for 10 schools. The response rate was 40%.

The participants in this study (*N*= 224, 117 female, see Table 2) were students enrolled in private foundation schools and the schools met the following criteria: (a) the school has 8th grade class; (b) the school is cooperative and provides data from TEOG and also is helpful to implement the study instruments.

Private foundation schools were affiliated to state universities or foundation universities. Therefore, the socioeconomic status (SES) of students could be regarded as high. The schools had some admission rules for accepting students. For instance, the students were selected with respect to interviews or school-based

written exams, which were developed by school staff. Based on the selection process some students were offered a place with a scholarship, others with half scholarship, and some others with no scholarship. Most students in the private foundation schools started the school from kindergarten or elementary school. This created a consistent school culture for the students.

All schools were private foundation schools. The number of students selected from each school was different (see Table 2). All students participated in the study voluntarily. The response rate was 100%. The number and percentages of boys and girls were quite close to each other.

Table 2
School and gender distribution across school

Type of school	Gender	Frequency (*f*)	Percentage (%)	School's percentage (%)
School 1	Female	14	46.70	
	Male	16	53.30	
	Total	30	100.00	13.40
School 2	Female	26	47.30	
	Male	29	52.70	
	Total	55	100.00	22.60
School 3	Female	28	56.0	
	Male	22	44.00	
	Total	50	100.00	22.30
School 4	Female	49	55.10	
	Male	40	44.90	
	Total	89	100.00	39.70
Total	Female	117	52.20	
	Male	107	47.80	
Total		224	100.00	100.00

Instrumentation

In order to answer the research questions, I collected three types of data: (i) personal information; (ii) number sense skill levels; (iii) mathematics attitude levels. In addition, mathematics grades as given internally by the mathematics teachers (for the semester before data collection), and TEOG mathematics scores were acquired from the schools/students for the 8th graders.

Personal information questionnaire

The aim of the personal information scale was to describe the sample in detail. It has 17 questions (Appendix 1). The questions were about the students, their family members (occupation as indicator of SES), their study habits, reading habits, and their mathematics and Turkish language grades as in their school records for the semester before the data collection. The schools provided the researcher with their TEOG 1 mathematics scores (which was done in the fall semester, November 2014) and TEOG 2 mathematics scores (which was done in spring semester, April 2015).

Number sense test

The test was originally developed by Kayhan Altay (2010). It has 17 open-ended questions (Appendix 2). It was used to assess the students' number sense skills. The test was used without any adaptation.

In the number sense test, students' responses were marked 0 (zero), 1 or 2 with a maximum score of 34 points from 17 questions.

- 0 (zero) means: The student did not write anything or did not give correct answer.
- 1 means: The student gave incomplete/inaccurate answer.
- 2 means: The student gave the answer correctly.

The number sense test has three sub-sections, (1) *flexibility in calculating*, which has eight questions, (2) *conceptual thinking in fraction*, which has four questions and (3) *using the reference point for comparing numbers*, which has five questions. The data were internally-scaled.

In this study, the number sense test was used in order to answer the first, second, fourth and fifth research questions.

Mathematics attitude scale

The scale was originally developed by Önal (2013). The scale, which has 22 items, is a five-point scale, aimed to assess students' attitude towards mathematics. The test was used without any adaptation.

In the mathematics attitude scale, students' responses were marked 0 (zero) to 4 with a maximum score 88 points with 22 items.

- 0=strongly disagree.
- 1=disagree
- 2=neutral
- 3=agree
- 4=strongly agree

In the scale, 11 items were positively and 11 items were negatively-worded. When the mathematics attitude scale was evaluated, the negative items were transformed: For the negative items;

- 0 was transformed into 4.
- 1 was transformed into 3.
- 2 was transformed into 2.
- 3 was transformed into 1.
- 4 was transformed into 0.

The scale has four sub-sections; (1) *interest* which has ten items, (2) *anxiety*, which has five items, (3) *study*, which has four items and (4) *necessity*, which has three items.

The data were ordinaly-scaled. In order to obtain final scores, item scores were added, then divided by the number of items, which was 22 in total.

In this research, the mathematics attitude scale was used related to second, third, fourth and fifth research questions.

Enrollment for the secondary education exams, TEOG exams (*Temel Eğitimden Ortaöğretime Geçiş)*

The aim of using the TEOG mathematics test in this study was to assess students' mathematics achievement in nation-wide exams (TEOG). TEOG exams are organized by MoNE once per semester. The content covers only that semester. Another purpose of TEOGs' exam results was to enroll students into the different types of high schools. The school does three mathematics exams in a school semester for assessing students' grades within school assessment, and the TEOG scores are used as a second exam in giving students' final achievement.

TEOG's questions are from six different areas: Turkish language, mathematics, science and technology, foreign language, revolution history, education of religion and ethics.

Every subject area, including mathematics, has 20 questions. Each question is worth 5 points. Data obtained from this instrument were internally-scaled. The score range was 0 (zero) to 100.

In this study, the researcher used the TEOG's mathematics scores in order to answer the first, third, fourth and fifth research questions.

School grades in mathematics

The school grades (*Karne Notu* in Turkish) are given to students for each semester (January and June) for every subject. The school report includes grades as assessment of students, given by subject teachers. The grades for each subject are given based on classroom assessment procedures which include written and oral exams, performance homework, and project work. Mathematics requires three exams in a semester. For only the 8th grade students, TEOG's results are used as a replacement of a second exam. For instance, TEOG 1, which is done in November, mathematics scores are used as second exams results in the fall semester. Similarly, TEOG 2, which is done in April, mathematics scores are used as second exams results. The data was ordinaly-scaled.

In this study, TEOG mathematics scores were related to first, third, fourth and fifth research questions.

Method of data collection

The researcher submitted a proposal to the Provincial Directorate for National Education of Ankara (*Ankara İl Milli Eğitim Müdürlüğü*) to get permission to conduct the survey at Turkish private schools. The written permission was granted at 18.05.2015. After taking the MoNE permission, the researcher visited the schools and talked with school administration and mathematics teachers about the research and its importance. Then, the researcher talked with students about the study and their contribution. It was clearly explained that participations to the study is

voluntary. They could withdraw any time. The researcher went to each school more than once, if necessary, to gather the data. The data were collected in two steps. Firstly, the students filled the personal information questionnaire and the mathematics attitude scale. It took about 20 minutes. Secondly, the students answered the number sense test's questions. This test took about 40 minutes. Table 3 shows the samples, instrumentation and data collection in summary.

Table 3
Samples, instrumentation and data collection for the study

Instrumentation	Time implemented	Piloted
PIS	May – June, 2015	No
NST	May – June, 2015	Yes
MAS	May – June, 2015	Yes
TEOG 1	November, 2014	No
TEOG 2	April, 2015	No

Notes. PIS: Personal Information Survey; *NST*: Number Sense Test; *MAS*: Mathematics Attitude Scale; *TEOG 1 & 2*: The exams were done by MoNE, for this study results were from November 2014 and April 2015 each academic year; *Piloted*: Whether the piloted study was done or not.

- *number sense*: This variable showed students' number sense scores. It was measured as internally-scaled data. The possible range of the number sense was from 0 to 34.
- *attitude*: This variable showed the students' attitude towards mathematics. It was measured as ordinaly-data. The range was from 0 to 88.
- *teog 1*: This variable showed the students' mathematics scores in TEOG 1. The data were internally-scaled. The range was from 0 to 100.
- *teog 2*: This variable showed the students' mathematics scores in TEOG 2. The data were internally-scaled. The possible range was from 0 to 100.

- *grade*: This variable show students' mathematics school grade at the end of the fall semester. The scores were measured in ordinal scale. The possible range was from 0 to 4.

Reliability and validity

The reliability of the Number Sense Test (NST) and Mathematics Attitude Scale (MAS) scores were estimated by using Cronbach's *alpha* for this study because it is commonly used in reliability analysis in related literature (Huck, 2011; Tavakol & Dennick, 2011).

The number sense test and mathematics attitude scale's Cronbach *alpha* level were .86 (NST Croanbach's *alpha* is .86 and MAS Cronbach' *alpha* is .93), which indicate strong reliability (internal consistency of scores).

The number sense test had three sub-sections; these *were flexibility in calculating*, *conceptual thinking in fraction*, and *using the reference point for comparing numbers*. Their Cronbach's *alpha* was .77, .66, and .65, respectively, which indicate strong reliability (internal consistency of scores).

The mathematics attitude scale has four sub-sections: *interest*, *study*, *anxiety* and *necessity*. Their Cronbach's *alpha* was .91, .87 .68 and .73, respectively, which may indicate strong reliability (internal consistency of scores).

As evidence for the Number Sense Test and Mathematics Attitude Scale, the researcher received opinion from experts, who are mathematics educators, in education faculties and teachers in middle school. In addition, Number Sense Test was developed for the middle school's students. Similarly Mathematics Attitude Scale was also developed for middle school's students.

Method of data analysis

Data were first analyzed descriptively in order to compute means and standard deviations for each continuous variable (Number Sense Test, Mathematics Attitude Scale and TEOG). Pearson product-moment correlation *r* was computed. The correlation coefficient was used to describe the isolated relationship between the variables (Huck, 2011). Then, the multiple linear regressions were conducted. The result of regression is a generalization, which represent the best prediction of dependent variable from several continuous independent variables (Thompson, 2008). The regression takes the following equation;

$$TEOG = \beta_1 * number\_sense + \beta_2 * attitude$$

Data were checked for the regression's assumptions; these were;

- normality of residuals,
- linearity,
- homoscedasticity,
- multicollinearity threat.

Histogram, scatter plots, and skewness-kurtosis were checked for all the violations (Tabachnick & Fidell, 2007). There was no multicollinearity threat. Detailed information is given in Appendix 8 and 9. No outliners or missing scores were detected in the sample.

Structure coefficients (r_s) were used. The aim of these was to determine the strength of the relationship between dependent and independent variables (Courville & Thompson, 2001). The detailed information is given in Appendix 10.

Summary

In this chapter, research design, pilot study, participants, instrumentation, which were personal information survey, number sense test, mathematics attitude scale, TEOG, school grades, data collection procedure and reliability and validity were explained.

CHAPTER 4: RESULTS

Introduction

In this chapter, results from the analysis are reported to address the following research questions:

1. Is there any statistically significant relationship between number sense skills and mathematics achievement for 8th grade students?

   More specifically the following questions were the focus:

   - Is there any statistically significant relationship between number sense skills and mathematics achievement in nation-wide exam, TEOG?
   - Is there any statistically significant relationship between number sense skills and mathematics achievement as assessed within the school?

2. Is there any statistically significant relationship between number sense skills and attitudes towards mathematics for 8th grade students?
3. Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement for 8th grade students?

   More specifically the following questions were the focus:

   - Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement in nation-wide exam, TEOG?
   - Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement as assessed within the school?

4. To what extent do number sense skills and mathematics attitude explain variance in mathematics achievement in nation-wide exam, TEOG?

5. What are the best predictors of mathematics scores in nation-wide exams; TEOG?

Descriptive statistics

Data were first analyzed descriptively with respect to means and standard deviations for the continuous variables. The results were summarized in Table 4.

Table 4
Descriptive statistics

	Mean	SD	Range
teog_1	77.20	22.98	0-100
teog_2	76.47	20.82	0-100
teog's_ mean	76.84	21.04	0-100
number_sense	11.67	7.25	0-34
fc	6.43	4.18	0-16
ctf	3.38	2.18	0-8
urpcn	1.86	2.11	0-10
attitude	2.30	.87	0-4
interest	2.18	1.05	0-4
anxiety	2.15	1.21	0-4
study	2.63	.85	0-4
necessity	2.46	1.13	0-4

Notes. teog_1: This variable shows students' mathematics scores in TEOG 1; *teog_2*: This variable shows students' mathematics scores in TEOG 2; *teog's_means*: the arithmetic mean of *teog_1* and *teog_2; number_sense*: Number Sense Test; *fc*: Flexibility in Calculating; *ctf*: Conceptual Thinking in Fraction; *urpcn*: Using Reference Point for Comparing Numbers; *attitude*: Mathematics Attitude Scale; *interest*: one of the sub-components of mathematics attitude scale; *anxiety*: one of the sub-components of mathematics attitude scale; *anxiety*: one of the sub-components of mathematics attitude scale; *necessity*: one of the sub-components of mathematics attitude scale; SD: Standard Deviation.

TEOG 1 and TEOG 2 mathematics scores were calculated out of 100. The TEOG 1 mathematics test mean was 77.20, while TEOG 2 mathematics score's mean was 76.47. Based on the descriptive statistics, the participants' mathematics score in TEOG exams were above 75% of the overall possible scores.

Number Sense Test has 17 open-ended questions. The mean score for the number sense test was 11.67 out of 34. Based on the descriptive statistics, the participants' number sense was lower than 50%.

Mathematics Attitude Scale has 22 items, with a five-point Likert scale. The mathematics attitude scale's mean was 2.29 out of 4. It means participants attitude towards mathematics was between 2 and 3 (2=neutral and 3=agree). The mean score for the attitude scale was 2.29 over 4.

Correlations

Correlation coefficient describes the bivariate relationship between variables. Table 5 demonstrates that there was a statistically significant correlation between number sense skills and TEOG 1 mathematics scores ($r_{number\_sense\text{-}teog\_1} = .53$, $p < .05$). Similarly, there was a statistically significant correlation between number sense skills and TEOG 2 mathematics scores ($r_{number\_sense\text{-}teog\_2} = .56$, $p < .05$). This relatively moderate correlation specified that students, who were more successful in TOEG mathematics section, were also likely to have strong number sense skills.

Table 5 displays correlations between the variables in order to answer first, second and third research questions.

Table 5
Bivariate correlations

	teog_1	*teog_2*	*teog's_mean*	*number_sense*	*attitude*	*grade*
teog_1	1	.85*	.96*	.53*	.40*	.78*
teog_2		1	.96*	.56*	.43*	.73*
teog's_mean			1	.57*	.43*	.79*
number_sense				1	.53*	.50*
attitude					1	.46*
grade						1

Note. *Correlation is statistically significant ($p < .05$).

teog_1: This variable shows students' mathematics scores in TEOG 1; *teog_2*: This variable shows students' mathematics scores in TEOG 2; *teog's_means*: the arithmetic mean of *teog_1* and *teog_2; number_sense*: Number Sense Test; *attitude*: Mathematics Attitude Scale;, *grade:* mathematics school grade at the end of the fall semester.

Table 5 indicates that the strength of the linear relationship between *number sense* and *teog's mean* ($r = .57$, $r^2 = .32$, $p < .05$) is greater than the strength of the linear relationship between *number sense* and *school's grade* ($r = .50$, $r^2 = .25$, $p < .05$). That may indicate that the content of the TEOG exams is closer to number sense, so more than the school's content.

Major findings

As predictive values of number sense and mathematics attitude to estimate TEOG's mathematics scores

Relevant to research questions:

1. To what extent do number sense skills and mathematics attitude explain variance in mathematics achievement in TEOG?
2. What are the best predictor mathematics scores in TEOG?

Model fit with respect to TEOG 1 mathematics scores

The analysis of variance (ANOVA) table indicates that the model was statistically significant. Table 6 shows ANOVA output for the mathematics scores in TEOG 1.

Table 6
ANOVA table results for TEOG 1

	Sum of squares	df	MS	F_{cal}	p
Regression	35,029.96	2	17514.98	46.63	<.05
Residual	82,627.99	220	375.58		
Total	117,657.96	222			

Notes. Predictors: *number_sense, attitude.*
Dependent variable: *teog_1*

The model summary shows that the multiple correlation coefficient (R) was .55 (R^2 = .30; $R^2_{adjusted}$ = 0.29), indicating that 29% of variance in TEOG 1 mathematics scores was explained, Table 7.

Table 7
Model of summary of TEOG 1 mathematics score

Model	R	R Square	Adjusted R Square
	.55	.30	.29

Notes. Predictors (Constant*), number_sense, attitude.*
Dependent variable = teog_1

TEOG 1 mathematics scores

Table 8 shows that *b (unstandardized)* weights, *β (standardized)* weights and structure coefficients for each predictor variable of TEOG 1 mathematics scores.

Table 8
Unstandardized and standardized regression coefficients for TEOG 1 mathematics scores

	B	*Beta*	r_s	*p*
(Constant)	50.85			<.05
number_sense	1.41	.44	.98	
attitude	4.31	.16	.15	

Note. r_s = structure coefficient.

A multiple regression analysis was carried out to evaluate how well number sense scores and mathematics attitude predicted TEOG 1 mathematics scores. The multiple regression equation is given unstandardized b coefficient in the equation.

$$teog\_1 = 50.85 + 1.41*number\_sense + 4.31*attitude$$

$$Z_{teog\_1} = 0.44*number\_sense + 0.16*attitude$$

This equation showed that if the students could increase their number sense scores by one standard deviation, their TEOG 1 mathematics scores would increase 0.44 standard deviations. Similarly, if the students could increase their mathematics attitude scores by one standard deviation, their TEOG 1 mathematics scores would increase 0.16 standard deviations. In the light of the exams, number sense is a better predictor.

Model fit with respect to TEOG 2 mathematics scores

The ANOVA table indicates that the model was statistically significant. Table 9 shows that ANOVA output for the mathematics scores in TEOG 2.

Table 9
ANOVA table results for TEOG 2

	Sum of squares	df	MS	F_{cal}	p
Regression	31,745.76	2	15872.88	55.25	<.05
Residual	63,202.84	220	287.29		
Total	94,948.60	222			

Notes. Predictors: *number_sense, attitude*.
Dependent variable: *teog_2*

The model summary shows that the multiple correlation coefficient (R) was .58 (R^2 = .33; $R^2_{adjucted}$ = 0.32), indicating that 32% of variance in TEOG 1 mathematics scores was explained, Table 10.

Table 10
Model of summary of TEOG 1 mathematics score

Model	R	R Square	Adjusted R Square
	.58	.33	.32

Notes. Predictors (Constant*), number_sense, attitude.*
Dependent variable = *teog_2*

TEOG 2 mathematics scores

Table 11 shows *b* weights, *β* weights and structure coefficients for each predictor variable of TEOG 2 mathematics scores.

Table 11
Unstandardized and standardized regression coefficients for TEOG 2 mathematics scores

	B	*Beta*	r_s	*p*
(Constant)	51.01			<.05
number_sense	1.30	.46	.96	
attitude	4.53	.19	.12	

Note. r_s = structure coefficient.

A multiple regression analysis was carried out to evaluate how well number sense scores and mathematics attitude predicted TEOG 2 mathematics scores. The multiple regression equation is given unstandardized *b* coefficient in the equation.

$$teog\_2 = 51.01 + 1.30*number\_sense + 4.53*attitude$$

$$Z_{teog\_1} = 0.46*number\_sense + 0.19*attitude$$

This equation showed that if the students could increase their number sense scores by one standard deviation, their TEOG 2 mathematics scores would increase 0.46 standard deviations. Similarly, if the students could increase their mathematics attitude scores by one standard deviation, their TEOG 2 mathematics scores would increase 0.19 standard deviations. In the light of the exams, number sense is a better predictor.

Model fit with respect to TEOG's mean mathematics scores

The ANOVA table indicates that the model was statistically significant. Table 12 shows ANOVA output for the TEOG's mean.

Table 12
ANOVA table for TEOG's mean mathematics score

	Sum of squares	df	MS	F_{cal}	p
Regression	33,361.27	2	16680.62	46.63	<.05
Residual	64,735.27	220	294.25		
Total	98,096.47	222			

Notes. Predictors: *number_sense, attitude*.

Dependent variable: *teog's_mean*

The model summary shows that the multiple correlation coefficient (R) was .58 (R^2 = .34; $R^2_{adjucted}$ = 0.33), indicating that 33% of variance in TEOG's mean was explained, Table 13.

Table 13
Model of summary of TEOG's mean

Model	R	R Square	Adjusted R Square
	.58	.34	.33

Notes. Predictors (Constant*), number_sense, attitude.*

Dependent variable = *teog's_mean*

TEOG's mean

Table 14 shows *b* weights, *β* weights and structure coefficients for each predictor variable of TEOG's mean.

Table 14
Unstandardized and standardized regression coefficients for TEOG's mean mathematics scores

	B	*Beta*	r_s	*p*
(Constant)	50.93			<.05
number_sense	1.35	.47	.82	
attitude	4.43	.18	.17	

Note. r_s = structure coefficient.

A multiple regression analysis was carried out to evaluate how well number sense scores and mathematics attitude predicted TEOG's mean mathematics scores. The multiple regression equation is given unstandardized b coefficient in the equation.

$$teog's\_mean = 50.93 + 1.35*number\_sense + 4.43*attitude$$

$$Z_{teog's\_mean} = 0.47*number\_sense + 0.18*attitude$$

This equation showed that if the students could increase their number sense scores by one standard deviation, their TEOG's mean mathematics scores would increase 0.47 standard deviations. Similarly, if the students could increase their mathematics attitude scores by one standard deviations, their TEOG's mean mathematics scores would increase 0.18 standard deviations. In the light of exams, number sense is a better predictor.

Summary

Mathematics score in TEOG 1 was the dependent variable, number sense scores and mathematics attitude scores were independent variables for this regression. The result indicated that number sense score was a better variable to estimate the student's TEOG 1 score because it affects the result (β =0 .44). Attitude score was a weaker predictor for TEOG 1 mathematics score (β = 0.16).

Mathematics score in TEOG 2 exam, which was done in April, was the dependent variable, and number sense total point and mathematics attitude scale's mean were the independent variables for this regression. The result indicated that number sense score was a better variable in order to estimate the mathematics score in the TEOG exam since it affects the result (β = 0.46). Mathematics attitude was not a good variable as the number sense test to estimate the TEOG mathematics scores

(β = 0.19). When compare TEOG exams for November and April, the number sense test and mathematics attitude scale were more efficient variables in order to estimate the mathematics scores in April.

Table 15
Summary of findings

First variable	Second variable	Pearson *r*
number sense	*teog 1*	.52
number sense	*teog 2*	.56
number sense	*teog's mean*	.57
number sense	*attitude*	.52

Table 16
Summary of findings
TEOG= β_1 * Number sense + β_2* Mathematics Attitude

Variables	β_1	β_2
teog 1	$\beta_1 = 0.44$	$\beta_2 = 0.16$
teog 2	$\beta_1 = 0.46$	$\beta_2 = 0.19$
teog's mean	$\beta_1 = 0.19$	$\beta_2 = 0.18$

CHAPTER 5: DISCUSSION

Introduction

The main purpose of this study was to investigate students' number sense skills and attitude towards mathematics to provide a useful measure to predict mathematics achievement as measured by nation-wide exams (TEOG). The second purpose was to investigate the relationship between number sense, mathematics attitude and mathematics achievement in nation-wide exams and also mathematics achievement as assessed within the school. This chapter included an overview of the study, discussion of the major findings, implications for practice, suggestions, and limitations.

Overview of the study

Summary of all findings

In this part, the results reported in chapter four were summarized.

1. Is there any statistically significant relationship between number sense skills and mathematics achievement for 8th grade students?

   More specifically the following questions were the focus:

   - Is there any statistically significant relationship between number sense skills and mathematics achievement in nation-wide exam, TEOG?
   - Is there any statistically significant relationship between number sense skills and mathematics achievement as assessed within the school?

2. Is there any statistically significant relationship between number sense skills and attitudes towards mathematics for 8th grade students?

3. Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement for 8th grade students?

   More specifically the following questions were the focus:

   - Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement in nation-wide exam, TEOG?
   - Is there any statistically significant relationship between attitude towards mathematics and mathematics achievement as assessed within the school?

4. To what extent do number sense skills and mathematics attitude explain variance in achievement in TEOG?
5. What are the best predictors of mathematics scores in TEOG?

Findings with respect to the first, second and third research questions are as follows:

1. There was a positive relationship between number sense skills and mathematics achievement in TEOG 1. First, the bivariate correlation indicated moderately strong relationship (r = .53, see Table 5). Second, there was a moderately strong relationship between number sense skills and mathematics achievement in TEOG 2. (r = .56, see Table 5). Third, as expected, there was a moderately strong relationship between number sense skills and TEOG's mean scores (r = .57, see Table 5).

   There, there was a moderately strong relationship between number sense skill and mathematics achievement in TEOG on the average (r = .50, see Table 5).
2. There was a moderately strong relationship between number sense skill and attitude towards mathematics (r = .53, see Table 5).

3. There was a positive relationship between attitude towards mathematics and mathematics achievement in TEOG 1. First, the bivariate correlation indicated a moderately strong relationship (r = .40, see Table 5). Second, there was a moderately strong relationship between attitude towards mathematics and mathematics achievement in TEOG 2. (r = .43, see Table 5). Third, as expected there was a moderately strong relationship between attitude towards mathematics and TEOG's mean scores (r = .43, see Table 5). There, there was a moderately strong relationship attitude towards mathematics and mathematics achievement as assessed within the school and mathematics attitude (r = .47, see Table 5).

Findings with respect to the fourth and fifth research questions are as follows:

4. Number sense scores were found to be a better predictor in order to estimate TEOG 1 mathematics scores. Scores on the mathematics attitude scale could not be as good a predictor as number sense test. ($\beta_{number\ sense}$ = .44 and $\beta_{mathematics\ attitude}$ = .16, see Table 8). Number sense scores were found to be a better predictor to estimate TEOG 2 mathematics scores. Mathematics attitude scale could not be as good a predictor as number sense test ($\beta_{number\ sense}$ = .46 and $\beta_{mathematics\ attitude}$ = .19, see Table 11). Consequently, in order to estimate the mean of the TEOG exam, number sense scores could be used as a better predictor. Mathematics attitude scale was not a better predictor than number sense test. ($\beta_{number\ sense}$ = .47 and $\beta_{mathematics\ attitude}$ = 0.18, see Table 14).

Discussion of the major findings

In this section, the major findings are discussed. First**,** the most noteworthy findings of the study are discussed followed by the other findings.

As regard to research questions four and five, number sense skills and mathematics attitude could be used to estimate mathematics achievement in the nation-wide exam, TEOG. The multiple regression results indicated that the number sense scores and attitude towards mathematics affect mathematics achievement (for TEOG 1 $\beta_{number\ sense}$ = .44 and $\beta_{mathematics\ attitude}$ = .16, for TEOG 2 $\beta_{number\ sense}$ = .46 and $\beta_{mathematics\ attitude}$ = .19 and for TEOG's mean $\beta_{number\ sense}$ = .47 and $\beta_{mathematics\ attitude}$ = .18). It is evident that number sense skill is a better predictor than mathematics attitude in order to predict the students' mathematics achievement because previous research showed that there was a strong relationship between number sense skills and mathematics achievement (Kayhan Altay, 2010). It is expected that number sense skills are a better predictor to estimate mathematics achievement to compare mathematics attitude scale.

Related to the first research question, the results indicated that there was a positive relationship between number sense skills and mathematics achievement. In the literature, studies about number sense and mathematics achievement demonstrated that there was a positive relationship between number sense and mathematics achievement (Bayram, 201; Kayhan Altay, 2010; Yang, Li, & Lin 2007). But this study population is different from the previous studies in that the population is from private foundation schools.

Yang, Li, & Lin (2007) indicated that there was a positive correlation between number sense skills and mathematics achievement (r = .57, r^2 = .32, p < .01). The

study was done with 5th grade students attending public schools in Taiwan. The same test was used to not only measure number sense skills but also mathematics achievement. The value of r^2 is close to in the present study. Number sense test cannot be available to measure mathematics achievement, which may be a possible reason for this similar r^2.

Research (Kayhan Altay, 2010) on number sense skills and mathematics achievement demonstrated that there was a positive relationship between number sense skill and mathematics achievement at public middle school students (r = .88, r^2 = .77, p < .01). Compared to the Kayhan Altay's study, the value of r^2 is higher than in the present study because the same test was used in order to measure students' number sense skills and mathematics achievement. Using the same test to measure number sense skills and mathematics achievement may be a possible reason for this high correlation.

Another research in the literature (Bayram, 2013) on number sense skills and mathematics achievement indicated that there was a positive relationship between number sense skills and mathematics achievement (r = .81, r^2 = .66, p < .01). The study was done with 8th grade students in public schools. Compared to the present study, there was strong relationship between number sense skills and mathematics achievement because using specific topic to measure both number sense skills and mathematics achievement topic can cause this high correlation. Using specific topic in order to measure number sense skills and mathematics attitude may be a possible reason for this high correlation.

Yapıcı's research in Turkey was conducted with 454 students in 5th, 6th and 7th grades in public schools. The aim of this study was to investigate the relationship

between number sense skills and mathematics achievement. To assess mathematics achievement one specific topic was used, it was percentage. The results also indicated that there was a positive relationship between number sense and mathematics achievement in terms of percentage (Yapıcı, 2013).

A further study in the literature about number sense and exponential numbers (İymen, 2012) was a qualitative study. In this study, the sample was selected from 8th grade students who attended public schools. The study investigated the components of number sense, which was related to exponential numbers, and number sense. The results showed that the components of number sense, which was about the exponential numbers, were related to number sense.

As regards to the second research question, attitude towards mathematics and its relations to number sense was investigated. It was a positive relationship between number sense and attitude towards mathematics. This positive correlation can be explained as following: It is generally accepted that if a student has a positive attitude towards a subject, the student can achieve higher (McLeod, 1992; Haladyna, Shaughnessy, & Shaughnessy, 1983). For this reason, if there was a positive attitude towards mathematics, it is accepted that the number sense level is high. The study's result supports this argument. There is a positive correlation between number sense and attitude towards mathematics.

As regards to the third research question, mathematics achievement and its relations to mathematics attitude were investigated. There was a positive relationship between number sense skills and mathematics achievement and there was a positive relationship between number sense skills and mathematics attitude. As a result of

these (for the moderating variable), There may be positive a relationship between mathematics achievement and attitude towards mathematics.

Implications for practice

After conducting this study, I believe that there is a moderate relationship between number sense skill and mathematics achievement in nation-wide exam, TEOG. To develop students' number sense level, curriculum and learning outcomes should specially emphasize support on number sense.

This study was different from other as the population used was selected from private foundation schools. That means this study provides more supportive evidence that number sense, mathematics achievement are highly correlated in mathematics. A possible reason behind this positive relationship is that TEOG's exams mathematics content is similar to including number sense test. TEOG' mathematics content is related to the mathematics text books, and they were prepared after the curriculum revision. It means, however, the concept of number sense is not directly mentioned in the curriculum. Some sub-components of number sense, such as estimation, is in the middle school mathematics curriculum. Another possible reason is that number sense skills require to conceptual understanding. According to the results, if students are good at conceptual understanding, they are more successful in the nation-wide exams (Uzun, Bütüner, & Yiğit 2010).

Suggestions

Implications for developing students' number sense

In this part, some suggestions are given to develop students' number sense. First, the middle school's mathematics curriculum was developed with the constructivist view

in 2005. This curriculum brings a new meaning. For instance, before 2005, if the students want to be successful in mathematics class, they should have known the mathematical rules, but now they should also solve real-life problems and integrate technology in mathematics learning in order to be successful. In this situation, number sense is significant because according to a study, which was done in Turkey with middle school students, the level of number sense affects students' achievement (Kayhan Altay, 2010). That is, the concept of number sense should be in the curriculum. In addition, number sense should be as a part of learning outcomes. Second, the MoNE (Ministry of National Education) should provide in-service training activities on number sense. This will help to create awareness about number sense amongst teacher.

Implication for future research

In this study, I basically investigate the private foundation schools students' number sense skills. The sample was purposively selected from private foundation schools in Ankara. Future studies can be done in both public and private schools, and to compare the two. In addition, in this study only quantitative method was used. I suggest future researchers to undertake qualitative or mixed method studies about number sense. Moreover, number sense skills are mostly studied in the early years of schooling, so further research is needed at the undergraduate level.

Limitations

The findings of the study were limited to some private foundation schools in Ankara, Turkey. The results cannot be generalized to other types of schools. A generalization may be possible for schools with a similar context. Another limitation was that the

study was done with 8th grade students, so it cannot provide any evidence for other grades in schooling. In this study, the TEOG mathematics score was used to assess students' mathematics achievement in nation-wide exams. Therefore, the results cannot be generalized for other exams, such as school exams, PISA (Program for International Student Assessment-*Uluslararası Öğrenci Değerlendirme Programı*), and TIMSS (Trends in International Mathematics and Science Study- *Uluslararası Matematik ve Fen Eğilimleri Araştırması*), YGS (*Yüksek Öğretime Geçiş Sınavı*) and LYS (*Lisans Yerleştirme Sınavı*).

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APPENDICES

APPENDIX 1: Personal information questionnaire

Adınız Soyadınız:

Sınıfınız ve Şubeniz:

1. Yaşınız:

2. Cinsiyetiniz: K ( ) E( )

3. Kasım ayında yapılan TEOG matematik sınavından kaç puan aldınız? ( )

4. Nisan ayında yapılan TEOG matematik sınavından kaç puan aldınız? ( )

5. Birinci dönem sonunda matematik karne notunuz kaçtı?

1 ( ) 2 ( ) 3 ( ) 4( ) 5 ( )

6. Birinci dönem sonunda Türkçe karne notunuz kaçtı?

1 ( ) 2 ( ) 3 ( ) 4( ) 5 ( )

7. Toplam kardeş sayısı kaçtır? (kendiniz dâhil olmak üzere)

1 ( ) 2 ( ) 3 ( ) 4 ve daha fazla ( )

8. Anneniniz eğitim durumu nedir?

İlkokul mezunu ( ) Ortaokul mezunu ( ) Lise mezunu ( )

Üniversite mezunu ( )Yüksek Lisans mezunu ( ) Doktora mezun( )

9. Annenizin mesleği nedir?

10. Babanınız eğitim durumu nedir?

İlkokul mezunu ( ) Ortaokul mezunu ( ) Lise mezunu ( )

Üniversite mezunu ( )Yüksek Lisans mezunu ( ) Doktora mezun( )

11. Babanızın mesleği nedir?

12. Yakınlarınızdan (anne ve babanız dışında) matematiğe dayalı (matematik-fizik öğretmenliği, mühendislik, vs.) herhangi bir iş yapan var mı? Cevabınız evet ise yaptığı işi ve yakınlık derecenizi yazınız.

Evet ( ) Hayır ( )

13. Evinizde kendinize ait çalışma odanız var mı?

Evet ( ) Hayır ( )

14. Kitap okumayı seviyor musunuz?

Evet ( ) Hayır ( )

15. Bir yılda ortalama kaç tane kitap okursunuz?

1 ( ) 2 - 5 arası ( ) 6 - 10 arası ( ) 11'defazla

16. Okuldan sonra ödev yapmak ve diğer çalışmalarınız için günde ortalama kaç saat çalışıyorsunuz?

17. Okul sınavlarına hazırlanırken ortalama kaç saat ders çalışıyorsunuz

APPENDIX 2: Number sense test

1) 0,25 x 16 işlemini kısa yoldan nasıl çözersiniz? Nasıl yaptığınızı gösteriniz.

Açıklama:

2) Aşağıdaki kesirlerin arasına uygun bir kesir yazınız. Nasıl bulduğunuzu açıklayınız.

$\frac{1}{2}$ ile $\frac{6}{7}$

Açıklama:

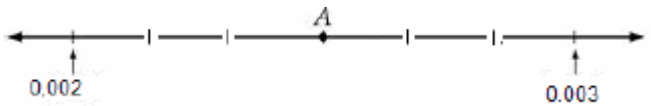
3) 6464 x 0,54 işleminin sonucu 3232'den büyük müdür, yoksa küçük müdür? Neden?

Açıklama:

4) 372 – 38 = 334 ise 372 – 18 işleminin sonucunu kısa yoldan bulunuz. Nasıl bulduğunuzu gösteriniz.

Açıklama:

5) Aşağıdaki sayı doğrusunda A yerine gelebilecek sayı hangisi olmalıdır? Neden?



Açıklama:

6) Aşağıdaki eşitliğin sağlanması için parantezlerin içine hangi sayılar yazılabilir? Nasıl düşündüğünüzü açıklayınız.

50 + ( ) ÷ ( ) = 65

Açıklama:

7) "4,358 ondalık sayısının 10 fazlası kaçtır?" sorusu için dört öğrencinin çözüm yolu aşağıda verilmiştir. Size en yakın gelen yol hangisidir? Neden?

Gökşin'in yolu	İhsan'ın yolu	Mirkan'ın yolu	Mert'in yolu
4,358 *+ 10* *14, 358'dir.*	*4, 358* *+ 10* *4, 368'dir.*	*4,358* *+ 10* *4,458'dir.*	*Tam kısımları toplasam yeter.* *4 + 10 = 14* *Cevap 14,358'dir.*

Açıklama:

8) Aşağıdaki kolay yoldan nasıl yaparsınız? Nasıl yaptığınızı açıklayınız.

5 000 032 + 2 000 725 + 1 000 068 – 1 000725

Açıklama:

9) Hangi toplam 1'den büyüktür? Nasıl düşündüğünüzü açıklayınız.

a. $\frac{5}{11}+\frac{3}{7}$ b. $\frac{7}{15}+\frac{5}{12}$ c. $\frac{1}{2}+\frac{4}{9}$ d. $\frac{5}{9}+\frac{8}{15}$

Açıklama:

10) Aşağıdaki ondalık sayıları sıraladıktan sonra ortaya düşen sayıyı kolayca bulmanın yolu nedir? Sayıyı bulun ve nasıl bulduğunuzu açıklayınız.

0,10 0,98 0,198 1,3 1,6

1,602 0,835 9,345 0,01

Açıklama:

11) Aşağıdaki şeklin 4/9 unu boyayın. Nasıl bulduğunuzu açıklayınız.

Açıklama:

12) Boyalı alanı (siyah kısmı) ifade eden kesir hangi aralıktadır? Nasıl düşündüğünüzü açıklayınız.

a. 0 ile ¼

b. ¼ ile ½

c. ½ ile ¾

d. ¾ ile 1

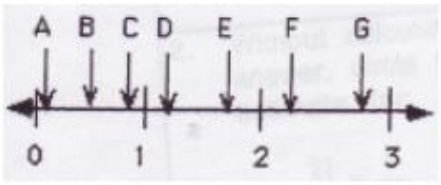
Açıklama:

13) Sizce aşağıdaki ifade doğru mudur? Açıklayınız.

"9468 x $\frac{1}{2}$ işleminin sonucu, $\frac{9468}{\frac{1}{2}}$ işleminin sonucundan büyüktür."

Açıklama:

14) Aşağıdaki sayı doğrusu üzerindeki hangi harf, payı paydasından çok az büyük olan bir kesre karşılık gelir? Nasıl bulduğunuzu açıklayınız.

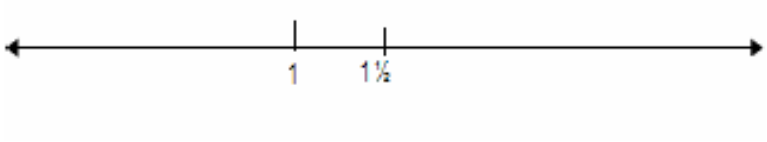


Açıklama:

15) Aşağıda verilen sayı doğrusundaki noktaları düşünerek

$\frac{1}{2}$, $2\frac{1}{2}$ ve $\frac{1}{4}$

kesirlerini yerleştiriniz. Nasıl yerleştirdiğinizi açıklayınız.



Açıklama:

16) 86424 x 500 işlemini kısa yoldan nasıl çözersiniz? Nasıl düşündüğünüzü gösteriniz.

Açıklama:

17) Ayşegül öğretmen, sınıftaki 60 öğrenciye sevdikleri spor dallarını sormuştur. Aşağıdaki tabloda spor dallarının sevilme oranları gösterilmiştir. Sınıftaki öğrenciler tarafından en çok sevilen spor dallarını kısa yoldan nasıl bulursunuz? Nasıl düşündüğünüzü açıklayınız.

EN ÇOK SEVİLEN SPORLAR

Sporlar	Öğrenciler
Futbol	2/5
Basketbol	7/12
Masa Tenisi	1/12
Voleybol	1/10

Açıklama:

APPENDIX 3: Mathematics attitude scale

İFADELER	Tamamen Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Kesinlikle Katılmıyorum
1. Matematik kolay bir derstir.					
2. Matematik çalışırken canım sıkılır.					
3. Matematik, en çok sevdiğim dersler arasındadır.					
4. Matematik derslerinde kendimi rahat hissederim.					
5. Matematik problemleri çözmekten zevk alırım.					
6. Matematik dersini sevmem.					
7. Matematik dersi insanlara yaratıcı düşünme yolları kazandırır.					
8. Matematik problemlerini çözmek kendime olan güvenimi artırır.					
9. Matematiksel kavramları diğer derslerde kullanmak beni mutlu eder.					
10. Matematik bulmacaları çözmekten hoşlanırım.					
11. Matematik sınavları benim için önemli bir stres sebebidir.					
12. Matematik dersinde tahtada soru çözmek beni kaygılandırır.					
13. Matematik sınavlarından korkarım.					
14. Matematikte arkadaşlarımın benden daha başarılı olacağını düşünürüm.					
15. Matematiği anlamayacağımı düşünürüm.					
16. Matematik dersinin olduğu gün sonunda işlenen konuları düzenli olarak tekrar ederim.					
17. Matematik dersinde öğretmeni dikkatli dinlerim.					
18. Matematik sınavlarından düşük not almayı umursamam					
19. Matematik sınavları öncesinde konu tekrarı yaparım.					
20. Matematik öğretmenleri dersleri sıkıcı hale getirir.					
21. Mecbur kalmasaydım matematik dersini öğrenmek istemezdim.					
22. Matematiği sosyal hayatımda hiç kullanmam.					

APPENDIX 4: Informed consent form

Veli Bilgilendirme ve İzin Yazısı

Sevgili 8.sınıf velileri,

Bilkent Üniversitesi Eğitim Bilimleri Enstitüsünde çalışmalarımızı yapmaktayız. Bu programda ben de dahil olmak üzere birçok öğretmenimiz lisansüstü çalışmalar yapmaktayız. Programımızın hedeflerinden bir tanesi, öğretmenlerimizin öğretim becerilerini geliştirmek ve onları araştırma yapmaya teşvik etmektir.

Yapacağım tez çalışmasının ana amacı öğrencilerin sayı duyusunu ve matematik tutumunu araştırmaktır. Bende bir öğretmen olarak 8.sınıftaki tüm öğrencilerin bu çalışmaya katılmalarının onlara faydalı olacağını düşünmekteyim. Bu çalışma sırasında ekte bir örneğini sunduğum anket sorularından yararlanacağım. Bu anketi sorularını öğrencilerin cevaplamasını isteyeceğim. Ayrıca, bu anket sorularına verilen cevapları daha anlamlı hale getirmek bazı öğrencilerle mülakat gerçekleştirmeyi planlamaktayım. Mülakat sırasında öğrencilere cevaplayamadıkları soruları neden cevaplayamadıklarını soracağım (bunu yapmaktaki amacım, eğer öğrenci sadece zamanı yetmediği için soruyu cevaplayamadıysa onu öğrenebilmektir).

Bu çalışmayla toplanan hiçbir veride isim kullanılmayacaktır. Her türlü verinin gizli kalacağını, öğrenciler hakkında edindiğim bilgilerin diğer öğrenciler, çalışanlar ve velilerle paylaşılmayacağını vurgulamak isterim. Çalışmalar sonunda sonuçlar açıklanacak fakat bireysel katılımcıların adı ve özellikleri tanımlanmayacaktır.

Bu çalışmada bana destek vereceğinizi umuyorum. Bu çalışma ile ilgili daha fazla bilgi almak isterseniz aşağıda belirttiğim e posta adresimden bana ulaşabilirsiniz.

Desteğiniz için şimdiden teşekkür ederim.

Saygılarımla,

Özge ARSLAN

e-posta: o.arslan@bilkent.edu.tr

ozgearslan34@gmail.com

Telefon: 537 924 3401

APPENDIX 5: Utilization permit for data collection tool

Sayı duyusu ölçeği kullanım izni.

Ölçek Sahibi: Yrd. Doç. Dr. Mesture KAYHAN ALTAY, Hacettepe Üniversitesi, Eğitim Fakültesi, Matematik Eğitimi Ana Bilim Dalı, İlköğretim Bölümü.

Subject: Re:
From: "Mesture Kayhan Altay" <mkayhanaltay@gmail.com>
Date: Sun, November 2, 2014 11:41 am
To: o.arslan@bilkent.edu.tr
Priority: Normal
Allow Sender: Allow Sender | Allow Domain | Block Sender |
Create Filter: Automatically | From | To | Subject
Options: View Full Header | View Printable Version | Download this as a file | View Message Details | Add to Address Book | Spam

Merhaba Ozge,
Tabi ki gelistirdigimiz olcegi kullanabilirsin.
Tezinde basarilar dilerim.
İyi calismalar.
Mesture
On 2 Nov 2014 11:39, <o.arslan@bilkent.edu.tr> wrote:

> Merhaba Mesture Hanım;
>
> Ben Özge Arslan. Bilkent Üniversitesi Curricurulum Instruction and
> Mathematics Teaching Certificate Ptogramında Master Öğrencisiyim.
>
> Yüksek Lisans tezimde "Number Sense" çalışmak istiyorum. Araştırma
> ve okuma yaparken sizin Doktora tezinizde sayı duyusu çalıştığınızı
> ve geliştirdiğiniz ölçeği gördüm. Eğer herhangi bir sakıncası yoksa
> çalışmam sırasında geliştirdiğiniz ölçeği kullanamam için izin
> misiniz?
>
> Cevabınızı bekleyeceğim. İyi Günler. İyi Çalışmalar.

APPENDIX 6: Utilization permit for data collection tool

Matematik tutum ölçeği kullanım izni.

Ölçek Sahibi: Yrd. Doç. Dr. Nezih Önal,Niğde Üniversitesi, Eğitim Fakültesi,

Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü.

Current Folder: **INBOX**

Compose Addresses Folders Options Search Help Filters

Message List | Unread | Delete Previous | Next Forward | Forward as Attachment | Reply

Subject: Re: Özge Arslan.Bilkent Üni. Matematik tutum ölçeği
From: Nezih Önal <nezihonal@nigde.edu.tr>
Date: Tue, January 6, 2015 4:43 pm
To: "o arslan" <o.arslan@bilkent.edu.tr> (more)
Priority: Normal
Allow Sender: Allow Sender | Allow Domain | Block Sender |
Create Filter: Automatically | From | To | Subject
Options: View Full Header | View Printable Version | Download this as a file | View Message Details | Add to Address Book | Spam

Merhaba Özge hanım,
ölçeğin nihai hali ektedir. Benim yaptığım açımlayıcı ve doğrulayıcı faktör analizi
sonucu 22 madde çıkmıştı.
Siz kendi örnekleminize yeni alpha güvenirliğini vererek 20 madde de
uyarlayabilirsiniz, size kalmış. Ama bence 22 maddelik halini kullanmanızı öneririm.
Çünkü tekrardan açımlayıcı faktör analizi yapmanız gerekebilir.
İyi çalışmalar dilerim.

Dr.Nezih ÖNAL

APPENDIX 7: Permission for data collection tools, Ankara İl Milli Eğitim Müdürlüğü

178/ 007885

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

Sayı : 14588481-605.99-E.5045395
Konu: Araştırma izni

14.05.2015

BİLKENT ÜNİVERSİTESİNE
(Eğitim Bilimleri Enstitüsü)

İlgi: a) MEB Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2012/13 nolu Genelgesi.
b) 30/04/2015 tarihli ve 7074 sayılı yazınız.

Üniversiteniz Eğitim Bilimleri Enstitüsü Yüksek Lisans Öğrencisi Özge ARSLAN' ın **"Ortaokul öğrencilerinin sayı duyusu, merkezi sınavlardaki başarısı ve matematik tutumu arasındaki ilişkinin incelenmesi"** başlıklı tezi kapsamında çalışma yapma talebi Müdürlüğümüzce uygun görülmüş ve araştırmanın yapılacağı İlçe Milli Eğitim Müdürlüğüne bilgi verilmiştir.

Uygulama formunun (9 sayfa) araştırmacı tarafından uygulama yapılacak sayıda çoğaltılması ve çalışmanın bitiminde bir örneğinin (cd ortamında) Müdürlüğümüz Strateji Geliştirme (1) Şubesine gönderilmesini arz ederim.

Ali GÜNGÖR
Müdür a.
Şube Müdürü

Elektronik İmzalı
Aslı Aynıdır.
14/5/2015
Şef

Atatürk Blv. 06648 Kızılay/ANKARA
Elektronik Ağ: www.meb.gov.tr
e-posta: adsoyad@meb.gov.tr

Ayrıntılı bilgi için: Ad SOYAD Ünvan
Tel: (0 312) XXX XX XX
Faks: (0312) XXX XX XX

18.5.15
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Bu evrak güvenli elektronik imza ile imzalanmıştır. http://evraksorgu.meb.gov.tr adresinden c457-c174-335b-b4de-2681 kodu ile teyit edilebilir.

APPENDIX 8: Normality assumptions

For the normality assumptions, data were inspected by the histogram, scatter plots, and skewness and kurtosis. If the skewness is between plus one and half and minus one and half, then the distribution is generally assumed normal (Tabachnick, & Fidell, 2007). See the histogram of standardized residuals in Figure 1 for TEOG 1 mathematics scores.

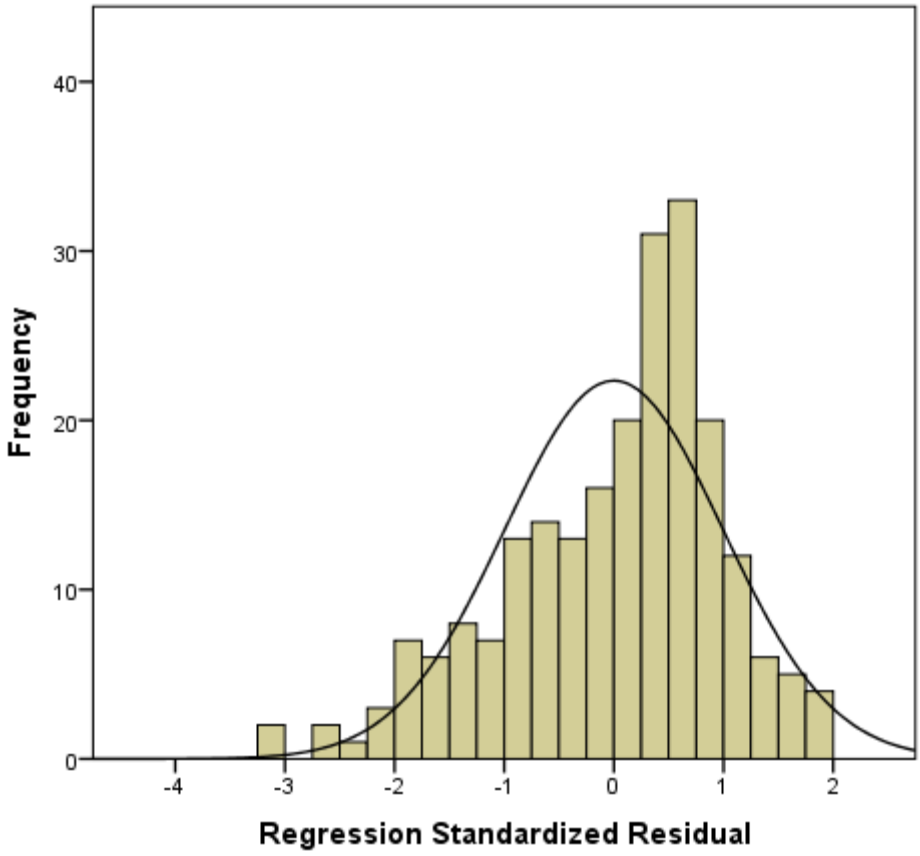

Figure 1. Histogram of standardized residuals for TEOG 1 mathematics scores.

Figure 1 demonstrates that standardized residuals for *teog1* was assumed to be normally distributed because the frequency distribution for *teog 1* looked like a

symmetrical bell-shaped or a normal curve. Normal P-P plot was checked. Figure 2 shows that plot of residuals for *teog 1*, which was matched with the diagonal line, indicates the normally distributed (Figure 2).

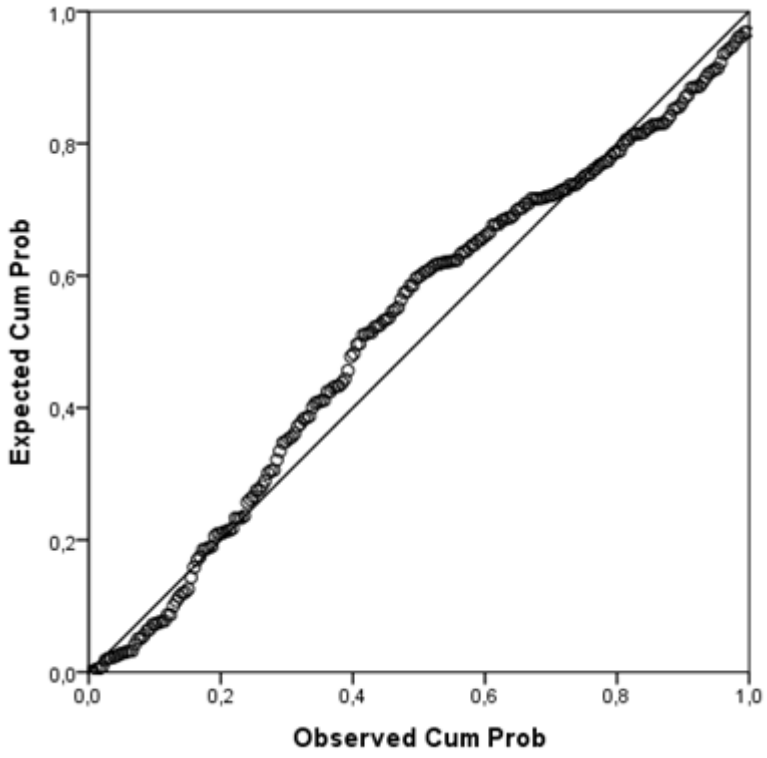

Figure 2. Normal P-P plot of residuals for TEOG 1 mathematics scores.

The value of skewness was -0.92. That is, teog 1 skewness value was between -1.5 and 1.5 (Table 17).

For the normality assumptions, data were inspected by the histogram, scatter plots, and skewness and kurtosis. If the skewness is between plus one and half and minus one and half, the distribution is generally assumed normal (Tabachhnick, & Fidell, 2007). See the histogram of standardized residuals in Figure 3 for TEOG 2 mathematics scores.

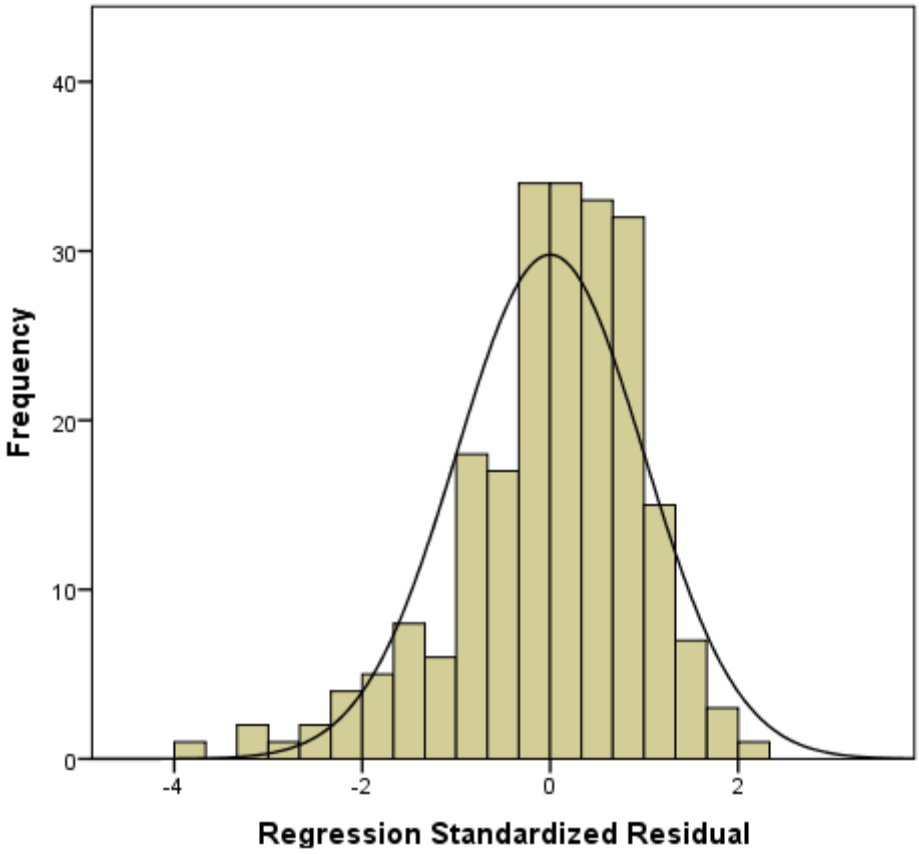

Figure 3. Histogram of standardized residuals for TEOG 2 mathematics scores.

Figure 3 demonstrates that standardized residuals for *teog 2* was assumed to be normally distributed because the frequency distribution for *teog 2* look liked a symmetrical bell-shaped or a normal curve. Normal P-P plot was checked. Figure 4 shows that the plot of residuals for *teog 2*, which was matched with the diagonal line, indicates the normally distribution (Figure 4).

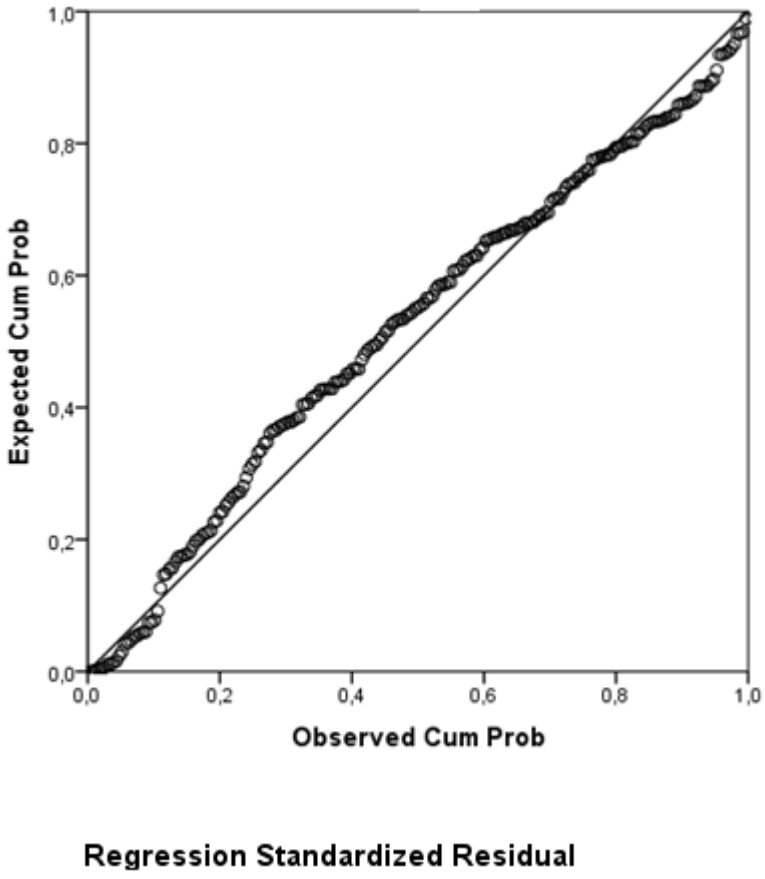

Figure 4. Normal P-P plot of residuals for TEOG 2 mathematics scores.

The value of skewness was -1.04. That is, *teog 2* skewness value was between -1.5 and 1.5 (see, Table 17).

For the normality assumptions, data were inspected by the histogram, scatter plots, and skewness and kurtosis. If the skewness is between plus one and half and minus one and half, then the distribution is generally assumed to be normal (Tabachnick, & Fidell, 2007). See the histogram of standardized residuals in Figure 5 for TEOG's mean.

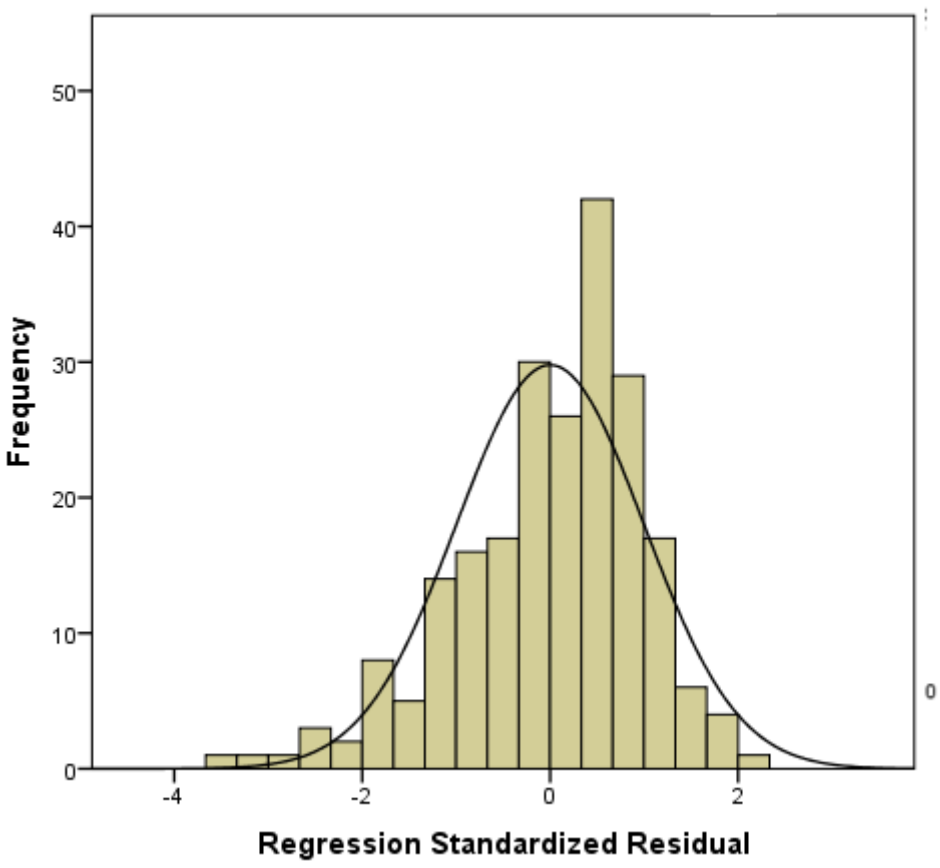

Figure 5. Histogram of standardized residuals for TEOG's mean.

Figure 5 demonstrates that standardized residuals for *teog's mean* was assumed to be normally disturbed because the frequency distribution for *teog's mean* look liked a symmetrical bell-shaped or a normal curve. Normal P-P plot was checked. Figure 4 shows that the plot of residuals for *teog's mean*, which was matched with the diagonal line and it indicates the normally distribution (Figure 6).

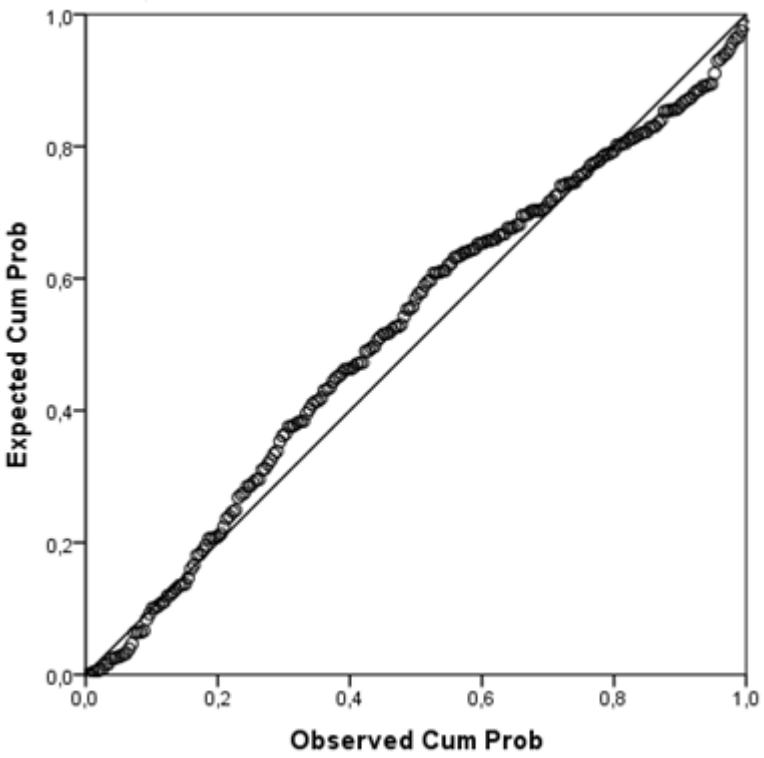

Figure 6. Normal P-P plot of residuals for TEOG's mean.

The value of skewness was -0.97. That is, teog's mean skewness value was between -1.5 and 1.5 (Table 17).

Table 17- Normality

		Statistics	SD
TEOG 1	Skewness	-.92	.16
	Kurtosis	-.16	.32
TEOG 2	Skewness	-1.04	.16
	Kurtosis	.46	.32
TEOG's Mean	Skewness	-.97	.16
	Kurtosis	.01	.32
School Grade	Skewness	-1.41	.16
	Kurtosis	1.07	.32
Number Sense	Skewness	.34	.16
	Kurtosis	-.61	.32
Mathematics Attitude	Skewness	-.35	.16
	Kurtosis	-.51	.32

Note. SD: Standard Deviations.

APPENDIX 9: Linearity & homoscedasticity assumptions and multicollinarity

Linearity is the important assumption for the multiple linear regression. It means that the relationship between dependent and independent variables should be linear. Homoscedasticity means that the variance of errors is random across all levels of the independent variable, and was also checked by visual examination of a plot of standardized residuals (the errors) and the regression standardized predicted values plot (Cohen, 1968).

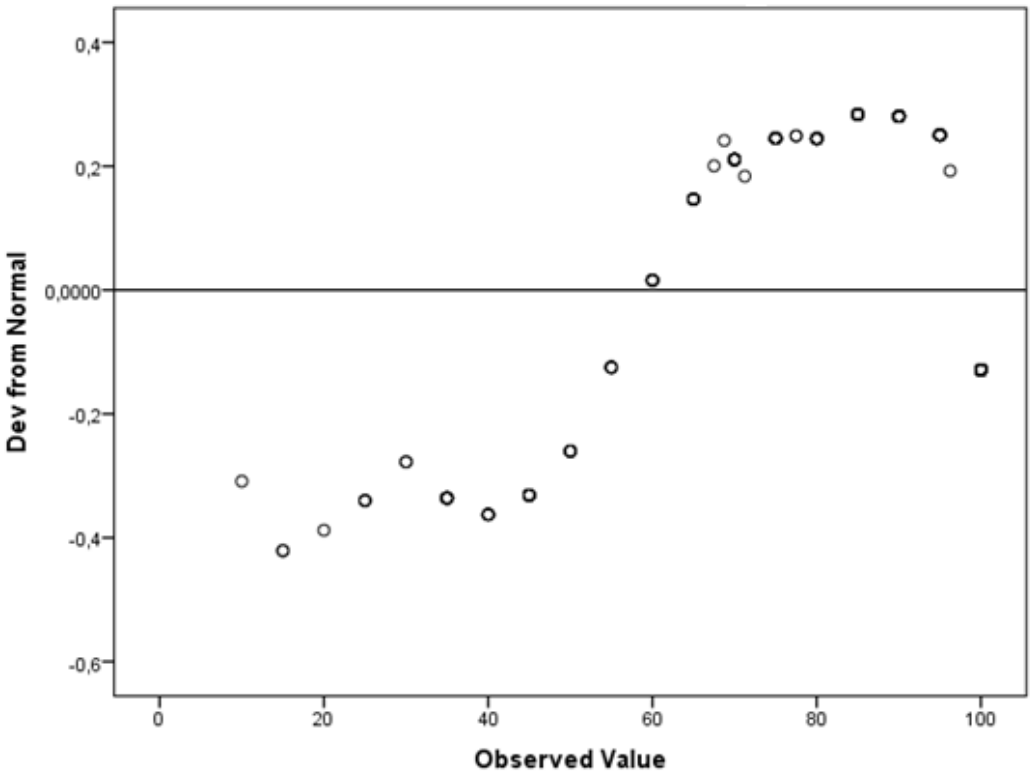

Figure 7. Scatter plots of residuals for TEOG 1 mathematics scores.

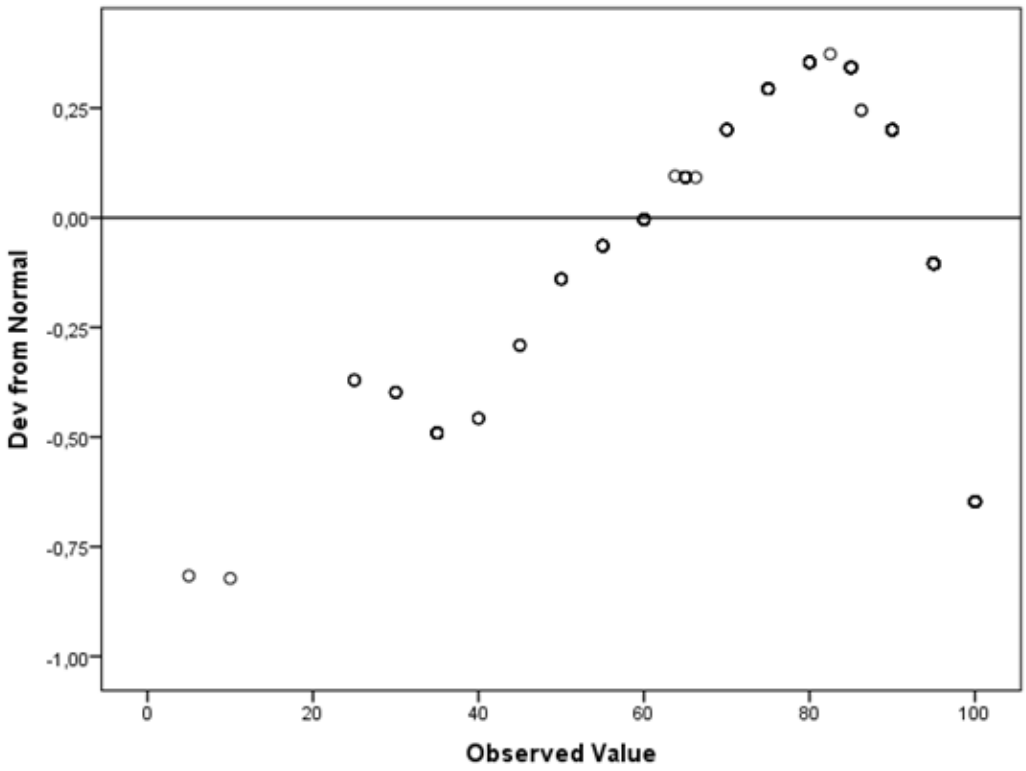

Figure 8. Scatter plots of residuals for TEOG 2 mathematics scores.

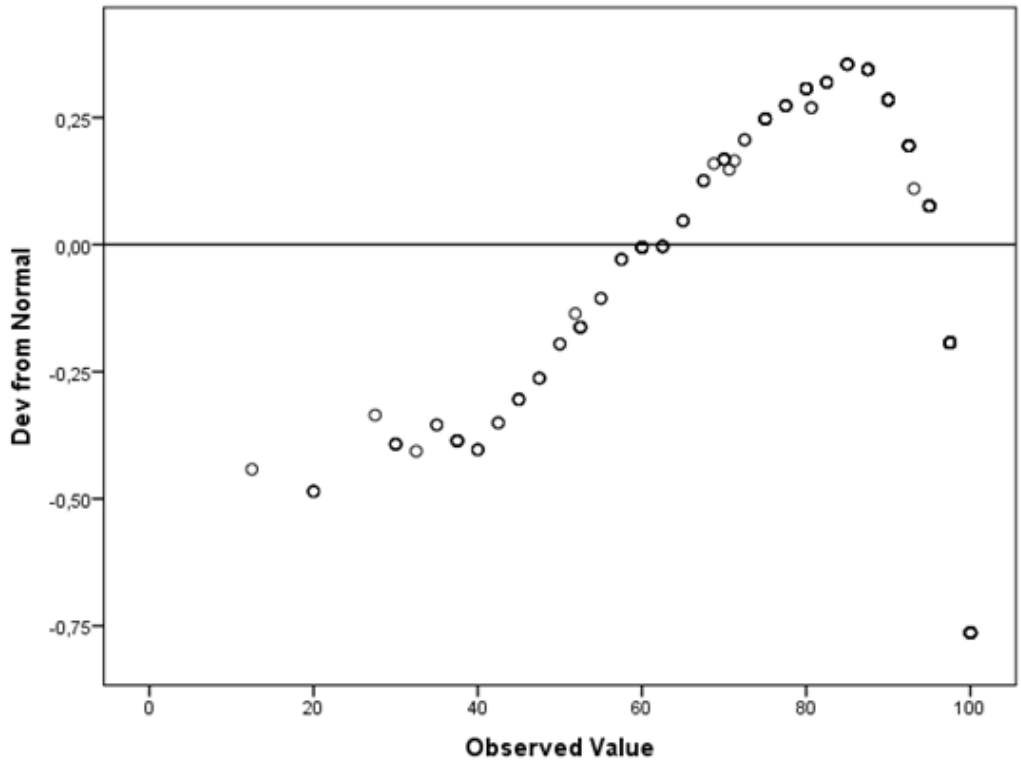

Figure 9. Scatter plots of residuals for TEOG's mean.

The final issue includes the checking of assumptions of multicollinearity with In Variance Inflation Factor (VIF) and tolerance statistics. VIF should be less and equal to 10 not to be threat, that is if VIF≤ 10, there is no threat between two or more independent variables (Tabachnick & Fidell, 2007). In the current study, VIF values for *teog 1*, *teog 2* and *teog's mean* were 1.38 both for *teog 1*, *teog 2* and *teog's mean*.

APPENDIX 10: Structure coefficients

In order to analyze the correlation between independent variables and latent variable the structure coefficient was used. The aim of this was to provide a better understanding the worth of predictors. The structure coefficient can be computed like in the following formula:

$$r_s = r_{xy}/R$$

r_{xy} is the bivariate correlation between the independent variable (X) and the dependent variable (Y) and R is the multiple correlation coefficient between Y and synthetics *Y_hat* scores (Yağız, 2014).