EXPLORING THE ACADEMIC AND SOCIAL CHALLENGES OF VISUALLY IMPAIRED STUDENTS IN LEARNING HIGH SCHOOL MATHEMATICS

The Graduate School of Education

of

Bilkent University

by

Gözde İrem Bayram

In Partial Fulfilment of the Requirements for the Degree of

Master of Arts

in

The Program of Curriculum and Instruction
Bilkent University
Ankara

June 2014

BILKENT UNIVERSITY

GRADUATE SCHOOL OF EDUCATION

EXPLORING THE ACADEMIC AND SOCIAL CHALLENGES OF VISUALLY IMPAIRED STUDENTS IN LEARNING HIGH SCHOOL MATHEMATICS

GÖZDE İREM BAYRAM

June 2014

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

Asst. Prof. Dr. M. Sencer Çorlu

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

Assoc. Prof. Dr. Emin Aydın

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

Asst. Prof. Dr. Deniz Ortaçtepe

Approval of the Graduate School of Education

Director: Prof. Dr. M. K. Sands

ABSTRACT

EXPLORING THE ACADEMIC AND SOCIAL CHALLENGES OF VISUALLY IMPAIRED STUDENTS IN LEARNING HIGH SCHOOL MATHEMATICS

Gözde İrem Bayram

M.A., Program of Curriculum and Instruction

Supervisor: Asst. Prof. Dr. M. Sencer Çorlu

June 2014

Inclusive education is the practice of integrating visually impaired students into regular classrooms. Differentiation becomes critically important in inclusive education in order to address the academic and social development of all students within the same classroom. However, there is a need to examine the practice of inclusive education in the Turkish context in regard to visually impaired students' experiences. This qualitative study explored the challenges of visually impaired students in learning high school mathematics. Under the influence of naturalistic inquiry, the constant comparison method was used to analyze semi-structured interviews, which were conducted with four visually impaired students. Major findings were presented under six themes: emphasizing the role of the mathematics teachers, the learning styles of visually impaired students, the use of materials, the evaluation of inclusive education, the assessment system, and the participant perspectives for equity in mathematics education. The findings were discussed in terms of the previously conducted research on teacher knowledge, differentiated

instruction and assessment, and motivation. It was concluded that social needs of visually impaired students have been successfully met through inclusive education while their academic needs were far from being satisfactorily addressed.

Key Words: Inclusive education in Turkey, visually impaired students, equity principle in mathematics education.

ÖZET

GÖRME ENGELLİ ÖĞRENCİLERİN LİSE MATEMATİĞİNİ ÖĞRENİRKEN YAŞADIKLARI AKADEMİK VE SOSYAL ZORLUKLARIN İNCELENMESİ

Gözde İrem Bayram

Yüksek Lisans, Eğitim Programları ve Öğretim

Tez Yöneticisi: Yrd. Doç. Dr. M. Sencer Çorlu

Haziran 2014

Kaynaştırma eğitim ile görme engelli öğrenciler standart dersliklere dâhil edilerek öğrencilerin akademik başarılarına ve sosyal gelişimlerine katkıda bulunulması amaçlanmıştır. Ancak, görme engelli öğrencilerin deneyimleri özelinde kaynaştırma eğitim uygulamalarını incelemeye ihtiyaç duyulmaktadır. Bu nitel bir çalışma ile görme engelli öğrencilerin lise matematiğini öğrenirken yaşadıkları sorunlar araştırılmıştır. Natüralist araştırmaların etkisi altında, sürekli karşılaştırma yöntemi dört görme engelli öğrenciyle yapılan yarı-yapılandırılmış mülakatları analiz etmek için kullanılmıştır. Ana bulgular matematik öğretmenlerinin rolü, görme engelli öğrencilerin öğrenme stilleri, materyal kullanımı, kaynaştırma eğitim değerlendirmeleri ve sınav stillerini açıklayan altı ana başlık altında sunulmuştur. Bulgular öğretmenlik bilgisi, farklılaştırılmış öğretim ve değerlendirme ve motivasyon üzerine yapılmış araştırmalar ışığında tartışılmıştır. Görme engelli öğrencilerin sosyal ihtiyaçlarını karşılamada kaynaştırma eğitim uygulamalarının

başarılı olduğu ancak bu uygulamaların akademik ihtiyaçlarını karşılamaktan uzak olduğu sonucuna varılmıştır.

Anahtar Kelimeler: Kaynaştırma eğitim, görme engelli öğrenciler ve matematik eğitiminde eşitlik prensibi.

ACKNOWLEDGEMENTS

I would like to offer my sincerest appreciation to Prof. Dr. Ali Doğramacı and Prof. Dr. Margaret K. Sands, and to everyone at Bilkent University Graduate School of Education for sharing their experiences and supporting me throughout the program.

I would like to express my deepest gratitude to my thesis advisor Asst. Prof. Dr. M. Sencer Çorlu for his substantial effort to assist me with patience throughout the process of writing this thesis. I am extremely grateful for the considerable investment of time and energy given to me with invaluable comments and broaden my horizons with the guidance. I would also like to thank other members of the committee, Assoc. Prof. Dr. Emin Aydın and Asst. Prof. Dr. Deniz Ortaçtepe for their critical comments and feedbacks about my thesis. I would also like to thank Kyle Pfeiffer who proofread my thesis.

The final and most heartfelt thanks are for my wonderful family, my father Gürbüz Bayram, my mother Mehtap Bayram, and my sister İpek Bayram for their endless love and support during this forceful process. I would not complete this writing process without their patience and devotion.

My gratitude extends to numerous friends who have supported, encouraged, and helped me throughout my studies: Merve Niğdelioğlu, Pelin Konuk, and Didem Şahin. Büşra Akçay, Alev Taştoka, and B. Cem Tosun supported me during this process that I felt never alone and always lucky.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Introduction

> The right of education of the disabled people cannot be prevented by any reason. The disabled children, youngsters and adults are provided with equal education with the non-disabled people and in inclusive environments by taking the special conditions and differences into consideration (Turkish Disability Act, Article 15, 2005).

Turkish Disability Act, which was passed by the Grand National Assembly of Turkey in 2005, regulates all practices with regards to disabled individuals in Turkey. The Act legally protects the educational rights of all Turkish citizens. The special attention given to *inclusive education* in Article 15 of the Act was considered an important step forward to ensure that the *equity principle* applies to all members of the society (Akçamete, Kayhan, & Şen, 2012). However, inclusive education was not widely practiced in Turkish schools and several problems have sustained since the Act was passed in 2005, including the inadequate social and academic interactions of disabled students with non-disabled students, poorly-designed educational environments and insufficient preparation and mental readiness of teachers to teach in inclusive classrooms (Özaydın & Çolak, 2011; Sadıoğlu, Bilgin, Batu, & Oksal, 2013).

One of the groups that suffer the most from such problems is visually impaired students. Their particular problems in the classroom and how they manage to deal

with these problems are worth investigating. In this study, I systematically explored the social and academic challenges of visually impaired students in Turkey with a particular focus on their experiences while learning mathematics.

Background

Mathematics is used in every part of life, from calculating grocery shopping costs to making comparisons between quantities or describing the shapes that we touch. People need to have a good mathematical knowledge—more than that needed to satisfy their basic needs—in order to have a high quality life and a decent job (Ersoy, 2003; National Council of Teachers of Mathematics [NCTM], 2000; Organisation for Economic Co-operation and Development [OECD], 2000; World Bank 2012). An advanced level of mathematical thinking and problem solving are important skills for every member of the society to increase the quality of their lives (Kilpatrick, 2000; Mamona-Downs & Downs, 2002; National Center for Employee Development [NCED], 2001; Schoelfeld, 1992; Steen, 2001). In other words, the quality of life is directly related to the level of mathematical knowledge known and used by individuals.

In contrast to those who believe mathematics requires a certain level of innate ability, research shows that everyone can learn mathematics; however, not necessarily under the same conditions or with the same teaching methods (Baki & Çakıroğlu, 2010; Ernest, 2002; Hill, Rowan, & Ball, 2005; Kilpatrick, Swafford, & Findell, 2001; Schoelfeld, 2002). Research claims that learning occurs best when the individual interests and abilities of the students are considered and integrated into teaching (Bransford, Brown & Cocking, 2000; Jonassen, & Grabowski, 1993). This argument

is based on the view that students develop a learning style according to their personal experiences and unique needs, as well as their disabilities, if they exist. This argument requires that the curriculum, teaching, and assessment correspond to students' different learning styles (Sampson, Karagiannidis, & Kinshuk, 2010). Considering students' different learning styles, or differentiation, is claimed to positively affect students' motivation; thus, help learners engage in the subject at advanced levels. Research further suggests that differentiation helps students perform better in mathematics, as well; at both basic and advanced levels (Kilpatrick, Martin, & Schifter, 2003).

Mathematics teachers are expected to create such a learning environment in the classroom where all students are given an abundant number of opportunities to excel according to their interests, skills, and readiness. Such opportunities can occur though differentiation in the mathematics curriculum, instruction, or assessment (Emanuelsson, 2003; Herbel-Eisenmann, Choppin, Wagner, & Pimm, 2012; Tomlinson, 1999). Mathematics teachers should be prepared to anticipate challenges in their classrooms with students of different needs and differentiate their instruction according to the learning styles, aspirations, and expectations of their students (Chronaki, 2011; NCTM, 2000). It may be suggested that mathematics becomes accessible for all learners at all levels only if their learning styles and needs are not neglected.

Mathematics education with high standards should be accessible to visually impaired learners, as well. Mathematics at the school level includes the frequent use of visual elements and abstract representations. However, visually impaired students are

tactile and kinesthetic learners in the sense that they need to touch and illustrate the concepts in their minds (Cox & Dykes, 2001). The learning styles of the visually impaired students present a need (or a challenge) to alter the type of mathematics teaching that does not consider different learning styles (Heacox, 2002). When students' different learning styles are not considered, teaching the visual or abstract notions of mathematics to visually impaired students can be considered a mission impossible. However, it is an established fact that all students, including the visually impaired ones, can learn mathematical content and can be successful in mathematics if their needs are addressed (Tenti, 2006).

Problem

Turkish Disability Act (2005) can be considered a reform that aimed to address the needs of visually impaired students through inclusive education. The assumption behind the Act was that inclusive education would foster both the social and academic development of Turkish students with disabilities (Demir & Açar, 2011). However, there are several criticisms of the lack of alignment between this assumption and reality (Sart, Ala, Yazlık, & Yılmaz, 2004). The inadequate knowledge of the specific challenges of each group of disabled students, whether they are mentally disabled, deaf, or visually impaired, in the classroom and in specific subjects can be considered the main limitation of the difference between what is intended in the Act and how it is implemented. Thus, there is a need to reveal the experiences of visually impaired students by sharing their stories about how they develop solutions to their social and academic problems in learning mathematics.

Purpose

The main purpose of this study was to explore the challenges of visually impaired students in Turkish inclusive classrooms. Specifically in this study, I systematically investigated the academic and social challenges that visually impaired students have to deal with during their high school education, while I presented the particular solutions they developed while learning mathematics.

Research questions

Aligned with the purpose of the study, I sought answers to the following research questions about the teaching, learning, and assessment of high school mathematics in inclusive classrooms with visually impaired students:

1. What are the academic and social challenges of visually impaired students in learning high school mathematics?
2. What kinds of solutions do visually impaired students develop to tackle their unique learning problems?
3. In what ways do mathematics teachers influence the academic and social development of visually impaired students in learning mathematics?
4. In what ways do the classroom and large-scale assessment influence the academic and social development of visually impaired students?

Significance

This study aims to increase our knowledge base on the challenges of visually impaired students in learning high school mathematics in inclusive classrooms. In addition to the challenges cited in the literature, several other specific challenges as they are explored in this study may provide guidance in determining the gap between

the policy and practical applications of inclusive education in Turkey. From this perspective, the current study not only have the potential to enrich research on inclusive education with respect to mathematics teaching and learning but also provide researchers with in-depth information about the specific challenges of visually impaired students in learning high school mathematics.

The findings of the study may have broader impacts on the teachers, parents, policy makers, and large-scale project managers. Mathematics teachers can benefit from this study by being informed about the specific learning styles of visually impaired students. Mathematics teachers who are given the challenging task of teaching visually impaired students in inclusive classrooms can evaluate their teaching methods and assessment tasks. Parents can look deep inside the challenges and support their children by helping them adopt some of the solutions developed by other visually impaired students. The policy makers can deduct several lessons from those individuals whose stories are presented in the study, and consider the importance of the evaluation of the current practices at an individual level—in contrast to finding flashy solutions to chronic problems, which otherwise would stay unrevealed. Lastly, large-scale projects, such as the FATIH Project, can be re-evaluated by considering the individual learning styles of all students, including visually impaired students.

Definition of key terms

MoNE [MEB]: The Ministry of National Education is a centralized governmental organization in Turkey. The MoNE determines regulations related to education and organizes curriculum reforms.

The Braille alphabet: The alphabet that visually impaired students use to take notes.

Nemeth codes: The codes that show the mathematical notations in the Braille alphabet.

JAWS: A screen reader for visually impaired people.

CCTV: Close Circuit Television.

NCTM: National Council of Teachers of Mathematics.

WHO: World Health Organization.

OSYM: Student Selection and Placement Center.

SBS: Student Placement Exam (For the high school entrance).

YGS: Transition to Higher Education Exam.

LYS: Undergraduate Placement Exam.

FATİH Project: Increasing Opportunities and Act for Improving Technology Project.

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

In this study, I aimed to explore the academic and social challenges of visually impaired students in learning high school mathematics. The literature review chapter consists of the education research conducted with visually impaired students. The chapter is organized under three headings; (a) mathematics for everyone, (b) education for disabled students, and (c) visually impaired students and mathematics education. The first section, mathematics for everyone, explains the need for mathematics for success in life and how the need is relevant to all members of society. The second section, education for disabled students, synthesizes different definitions of concepts related to the education of the disabled students and specific regulations introduced for visually impaired students in Turkey. The last section, visually impaired students and mathematics education, introduces the challenges in learning mathematics and research-based teaching methods developed for visually impaired students. In this section, the role of mathematics teachers in academic and social development of these students in inclusive classrooms is critically analyzed.

Mathematics for everyone

Mathematics emerges as a critical school subject that determines success in life. According to the National Council of Teachers of Mathematics (NCTM, 2000), understanding and making sense of mathematics is an important tool to climb the social ladder. This influential organization in mathematics education (2000) expresses an ambition to provide all students with equal opportunities to be successful in life. The organization declares its commitment to excellence in

teaching, learning, and assessment of mathematics while working towards ensuring equity for all learners. In particular, it is stated in the Principles and Standards (NCTM, 2000) document that success in school mathematics helps students have a fulfilling professional life. This can be realized through advanced mathematical knowledge, which is more than a literacy level, in addition to skills such as problem solving, communication, and critical thinking. The rationale is that these skills are frequently sought by employees (Kane, Berryman, Goslin, & Meltzer, 1990).

In contrast to studying the theoretical knowledge produced by mathematicians, advanced mathematical knowledge refers to learning mathematics by *doing mathematics* (Mamona-Downs & Downs, 2002). Problem solving, communication, and critical thinking are some of the skills that can be gained in an effective mathematics classroom where students produce mathematics (Schoenfeld, 1992). With the help of these skills, learners can develop strategies for solving real-life problems because mathematics help them develop the habit of asking *why* and *how* questions, communicate effectively, and be precise with the language of mathematics or explain their reasoning while solving real-life problems. In fact, some believe that learning mathematics, that is by doing and producing mathematics, is a civil rights issue. Low expectations from and limited opportunities provided to the majority of the students can be transformed into a system where expectations are high for all students and opportunities are distributed equally to all students (National Research Council, 1989).

Education for disabled students

Learning styles

"Learning is the process whereby knowledge is created through the transformation of experience" (Kolb, 1984, p. 38). The term learning style is individual specialized effective learning system differing according to the mode of instruction and personal study (Pashler, McDaniel, Rohrer, & Bjork, 2008). The individual differences in ability and thinking style affect the learning styles of students (Jonassen & Grabowski, 1993). There are three learning modalities: visual, auditory, and kinesthetic learning styles (Barbe, Swassing, & Milone, 1979). Visually impaired students are tactile and kinesthetic learners in that they need to touch to learn the content (Şahin & Yörek, 2009). The differences in learning styles and related teaching style play a crucial role to ensure equity in mathematics lessons (Dunn, Honigsfeld, Doolan, Bostrom, Russo, Schiering, Suh, & Tenedero, 2009). In a classroom, the teaching methods and lesson activities vary according to the learning styles of students so that each student can find an option for learning and the whole class can achieve the lesson objectives (Hall, 2002).

An overview of education for disabled students

The term disability is defined as the set of all permanent problems or limitations in physical activity. Visual impairment includes both a low level of vision and complete blindness. Low vision is defined as the inability of having clear vision at a distance of more than 6 meters. Blindness is the inability of having clear vision at a distance of more than 3 meters. A person with a normal vision can see distances up to 18 meters without any difficulty (World Health Organization [WHO], 2004).

There are three types of education that can be provided to disabled students: special education, inclusive education, and mainstream education. In *special education*, disabled students are taught in isolation from their non-disabled peers. Such settings are specifically designed according to the needs of the disabled students (Kurz, Elliott, Lemons, Zigmond, Kloo, & Kettler, 2014). One example of such settings is a school that is specialized in educating visually impaired students. As opposed to isolating disabled students from regular classes, *inclusive education* brings disabled and non-disabled students together in the same educational environment (Phinias, Jeriphanos, & Kudakwashe, 2013). One example of inclusive education is a school where both sighted and visually impaired students take their classes together. In inclusive education, students need to be supported by teachers and other stakeholders about their individual needs and have social interaction with the non-disabled students. Inclusive education is more appropriate for conserving the equity principle in education by putting it directly into the practice (Wang, 2009). Mainstream *education* is similar to inclusive education in the sense that students, whether they are disabled or not, are educated in the same classroom (Crockett & Kauffman, 1999). The difference between mainstream education and inclusive education is the amount of the support provided to disabled students. One example of mainstream education is the classroom settings where the regular lesson teacher is assisted by a special education teacher, who is only in charge of the students with disabilities. Support can include adaptations of lesson materials or a modification of the instructional practices and assessment tasks or support services provided outside of the school environment (Allen & Cowdery, 2011).

Legal base with respect to inclusive education, individualized learning program, and visually impaired students

Aligned with the Turkish Disability Act (2005), MoNE (2006) renewed the Education Regulations of the Disabled Students [ERDC] (Özel Eğitim Hizmetleri Yönetmeliği) and introduced inclusive education as a solution to the sustained problems of students with disabilities. However, it would be incorrect to assume that MoNE is discouraging the special education for those who really need it (Tortop, 2012). The rationale behind this new regulation was the belief that inclusive education would solve both the social and academic problems in the classroom of those students without severe disabilities while it would help the policy makers better make use of the limited funds and allocate them accordingly. In inclusive education practices, MoNE suggested that parents and other members of the school communities, including sighted students in the classroom, be involved in the inclusive education process (MoNE, 2006). The assumption was that inclusive education would create an ideal and affordable educational environment for students with disabilities, including visually impaired students (Wang, 2009).

ERDC document included 96 items that explain the regulations that should be considered by schools who educate students with disabilities. This following section includes a translation of some of the most relevant items for the education of visually impaired students. Some of the topics, that the items referred to, were inclusive education, individualized education program (IEP), and specific topics about visually impaired students. Inclusive education, the disabled students are expected to continue their education together with their non-disabled peers (Item 23). Students with disabilities should be placed in suitable schools, which has resources and trained

personnel (Items 12 and 23). The education programs are chosen according to the disabled students' academic success and social needs (Item 12/1).

Inclusive education is defined as the "the education of individuals with special needs and the support of their peers without disability by providing training services along with public and private pre-school, primary, secondary and adult education institutions with their peers are on the basis of special education practices" (Item 23/1, translated by the author). The aim of inclusive education is enabling an education for disabled students with non-disabled students by considering the students' education performance and individual needs (Item 23/2). Therefore, the classroom sizes are decided in the pre-school education classes to be limited to 10 to 20 students, and in other levels, 25 to 35 students, according to the number of disabled students in the classroom (Item 23/2). The classroom environment needs to be modified according to student needs and academic levels (Item 23/2). Moreover, the school personnel, students, teachers, and the family of the students are informed about the special needs of the students with disabilities (Item 23/2). The inclusive student success is assessed by the school provisions in addition to the feedback acquired from the individualized education program. The assessment methods, techniques, measurement tools and the evaluation time, and the frequency are diversified according to the disabled students by the responsible people; teachers, and other stake holders, for the evaluation and assessment (Item 24).

Individualized education programs (IEP) are commonly used in many countries and considered an integral component of the education of visually impaired students. The IEP "outlines academic goals and incorporates all the services and supports

necessary to meet the child’s unique needs” (Aron & Loprest, 2012, p. 105). For the students who need special support for their education, the IEP for education program has been developed according to the students' academic success (Item 5/d). School programs based on individual competence and development are individualized in accordance with specifications (Item 37). Achieving the objectives of the individualized education program is based on meeting the needs of students (Item 46). Special education teachers and students realize their required educational performance objectives, taking part in the preparation of individualized education programs and implementations (Item 49). Individualized education programs developed by teachers, parents, and other stake holders for individuals who require special education with the approval obtained from the family. Individualized education programs are evaluated by observation and assessment scales that use the developmental objectives in line with the overall aim. Students with disabilities are prepared for their individualized education program, and the most decisions are taken based on their feedbacks (Item 62). Teachers take precautions to ensure the social acceptance of the disabled students by the class, assess the achievement of visually impaired students according to their individual development, and apply the program by individualizing according to the students. In this context, families, relevant institutions, and organizations work in cooperation with teachers (Item 72). Inclusive students are evaluated according to their own school provisions in examinations. By considering their individual progress, appropriate precautions and modifications are applied in the exams (Item 73).

In addition to items relevant to students with all types of disabilities, Items 24, 26, and 38 specifically regulate the practices for visually impaired students. In item 24,

the assessment techniques are regulated. In written examinations, visually impaired student responses are written in Braille and immediately assessed by the teacher while the visually impaired student reads the exam responses. These students are exempt from the questions with visual components. For students with low vision, exam questions are written with thick and large print. According to item 26, inclusive education for visually impaired students can start from any level. The classroom teacher teaches the first four grades while from 5th grade on, students and their peers are provided with the same education.

Visually impaired students and mathematics education

Equity principle in mathematics education

Equity in mathematics education is defined as providing "high expectations and strong support for all students…raising expectations for students' learning, developing effective methods of supporting the learning of mathematics by all students, and providing students and teachers with the resources they need" (NCTM, 2000, p.12). High-quality teaching methods and lesson materials are required to fulfill the equity for all students (NCTM, 2007). The equity principle is one of the six principles of mathematics education, together with curriculum, teaching, learning, assessment, and technology (NCTM, 2000). These principles were introduced in the United States to guide mathematics educators and teachers in their classroom practices. These six principles are interdependent with one another; however, the principle of equity is at the core of all other principles (Bartel & Meyer, 2008).

Equity is important for addressing student needs by creating a fair environment in the mathematics classroom in which all students have an equal opportunity to reach their

potential (Bartell & Meyer, 2008). Equity requires high-quality curriculum, materials and resources, and effective teaching, so that the gap among students with different needs can be narrowed while students learn mathematics in a productive environment (Allexsaht-Snider & Hart, 2001). Research suggests that students' efforts to close the gap were not enough alone when the classroom environment was not productive or their teachers were not effective (Zhou, Parker, Smith, & Griffin-Shirley, 2011). Therefore, the equity principle is a complex issue which requires the collaboration of all stakeholders.

The challenges in learning mathematics

In a report of the Royal National Institute of Blind People (RNIB), A UK-based organization, it was indicated that visually impaired students needed to deal with extra challenges in learning mathematics (RNIB, 2011). First, it was highlighted that visually impaired students had little or no ability for observation. Therefore, the automatic knowledge that came from observation for sighted people was usually missing for the visually impaired students. Second, visually impaired students learned the concepts slower than sighted students. The main reasons for slow learning are not necessarily due to innate abilities but are relevant to several factors, including their disadvantages in estimating knowledge, necessity of using their body for learning (i.e., hands on materials), and illustration of the information (enlarging tables and diagrams). For a visually impaired student, noting down knowledge, graphing data, reading the given, and asking for the clarification of knowledge were the main processes which were not only time consuming, but also discouraging. According to the visually impaired students' descriptions, they were trying to complete a puzzle that they had never seen. As a result, the expectations for students

with disabilities were lower than the expectations from the other students (Levy, 2008).

For increasing academic success, visually impaired students needed to keep notes while they were learning the content. The visually impaired students used Braille alphabet for note keeping in mathematics lessons. Reading and writing mathematics with the Braille alphabet is more problematic than reading and writing a text in Braille see *figure 1*.

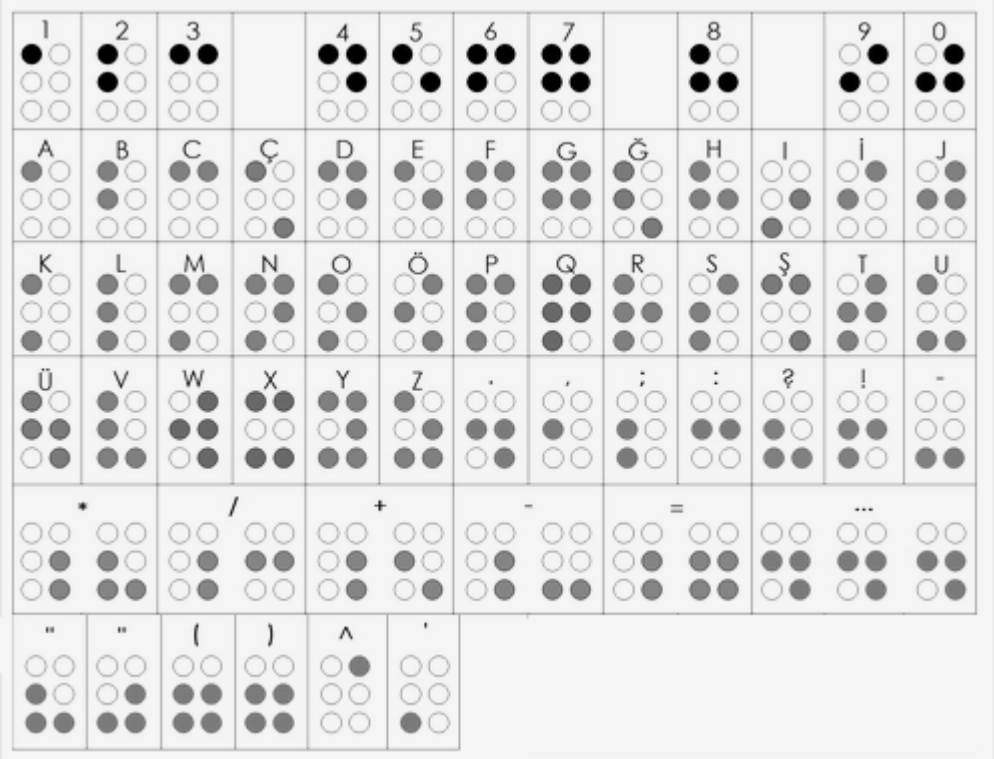

Figure 1. The letters and symbols in the Braille alphabet (Retrieved from http://forum.donanimhaber.com/m_30114034/tm.htm)

According to Karshmer and Bledsoe (2002), there were two reasons for these problems: the first one is the linearity of the alphabet and character set problem. Because the Braille alphabet is linear, there are no problems in writing simple

equations or expressions in mathematics. For example, if a student wanted to write f(x)=ax^2+b, the characters that correspond to f(x)=a*(x^2)+b are used. If more complicated equations or expression are written in Braille, it could be significantly problematic. For example, if the expression is $(x) = \frac{3-x^3}{x^2+4}$, the student needs to use the characters f(x)=[3*(x^3)]:[(x^2)+4]. Therefore it gets more complicated when the equations are more complex. The other problem is the character set of the alphabet. The letters can represent different notations and its capital position or other conditions could affect the writing of mathematical expressions. In order to eliminate these problems, the Nemeth codes were invented for mathematical writing. However, according to Rosenblum and Amato (2004), most of the students do not know the Nemeth codes.

Rosenblum and Amato (2004) added that there were several problems in the lesson books such as reading the textbooks, accuracy in the textbook in the Braille form, and having the translated textbook access. Since the textbooks were not designed specifically for visually impaired students they needed to be adapted for visually impaired students. When the books were translated into the Braille alphabet, there were several accuracy problems and printed version differences between the Braille version and the textbook version. Therefore, lesson books were not useful for visually impaired students as much as they were for the sighted students. According to the article, without reading and writing mathematical content, learning mathematics became harder for visually impaired students.

What works in the mathematics classroom for visually impaired students

The learning needs of visually impaired students differ from the sighted students' in terms of their learning style and learning needs. Spindler (2006) listed important points in his study. This article was about the experiences of a tutor, teaching a visually impaired student in the university. It was found that although there were similarities and differences in the teaching strategies of visually impaired students and sighted students, the visually impaired students could also learn advanced topics of mathematics when specific techniques were used. First, the *explicit explanation* was an important point in the teaching process. He emphasized avoiding the use of uncertain directional cues in the teaching process. He explained that when words such as *that* and *this* were used, the learner got confused. Second, *the use of materials* became important when the tutor focused on the two and three dimensional calculus. When the student felt the materials, visualization of the vectors and curves became easier. Third, the *writing process* was helpful for the students in remembering the algebraic expressions, focusing on the problem, and reaching for the solution. Fourth, *teaching the content in the easiest and most meaningful way* was beneficial for student understanding and exploration. Teaching in one manner and then changing to a different manner made the student confused about the solution process. Therefore, a simple way of teaching should have been chosen. Fifth, he indicated that *repetition* was important for the memorization process. Review of the previous lesson and choosing a sample problem made the student more successful at memorization. The students memorized and reviewed these sample problems, and used them to solve new ones. Sixth, *giving extra time* was necessary for the academic success of visually impaired students; understanding the content and getting mastery. The time required to master a topic for visually

impaired students was far more than the studying time required for sighted students. Lastly, *the attitude during exams* was important for assessing the student achievement. The reader should have helped only illustrating the questions, not in solving problems for the visually impaired students in the exams. In other words, giving a verbal clue was not the same as solving the problem for the students.

The role of mathematics teachers in inclusive education for visually impaired students

Effective teachers prepare mathematics lessons and set challenges appropriately for students to construct their own knowledge by connecting with the students' own interests and experiences (Anthony & Walshaw, 2009). Visually impaired students are tactile and kinesthetic learners that they need to have information about the objects and use their senses (Cox & Dykes, 2001). They need appropriate teaching methods that match with their learning styles (Anthony & Walshaw, 2009). They need differentiated education according to their readiness levels (Levy, 2008). Using beneficial teaching techniques and teaching materials are tended to ensure academic achievement if they addressed students' learning styles (Quek & Mcneill, 2006).

The mathematics teachers had a great effect on visually impaired students' learning because they had to face serious problems with writing and reading mathematics in Braille. Therefore, they need to learn mathematical content in the classroom and ask questions to their mathematics teachers. However, mathematics teachers were not educated to teach visually impaired students; therefore, their help could have been limited. Kohanova (2008) highlighted that because the teachers were not specialists or guided by a specialist in inclusive schools, they were using *the trial and error*

method (p.2). They did not know the Braille alphabet or how to use the necessary technology. They were searching for the best way to teach and communicate to those special needed students. In another study, conducted by Rosenblum and Herzberg (2011), the challenges were examined through the teachers' point of view. According to the study, there was a need for qualified teachers and useful materials. Moreover, tactile materials and Nemeth or Braille code learning were necessary for teachers. Because they did not know about the useful materials and teaching methods, teachers participating in the study found that teaching visually impaired students was a time-consuming process because of the long and detailed steps in the teaching process. Rosenblum and Amato (2004) stated that teacher-made lesson materials were problematic. Since the teachers did not have enough knowledge to develop lesson materials for visually impaired students, the materials were not well-prepared for the visually impaired students. The last concern they emphasized was that teachers did not have enough resources for the education of visually impaired students. There was an educational need for teachers in this field. Although teachers had limited knowledge of giving inclusive education to visually impaired students, they may have been more competent in giving inclusive education if their perceptions of self-efficacy levels were higher (Dolapçı, 2013). The informational programs had positive effects on in service teachers with regards to inclusive education by increasing the self-efficacy levels of teachers (Gözün & Yıkmış, 2004).

Moreover, the use of assistive technology, such as books in the appropriate format, mobile devices, computer programs with screen readers, CCTV (Close Circuit Television), and Braille devices, may increase the mathematical achievement of visually impaired students by eliminating the exclusion of visually impaired students

in a learning environment (Freire, Linhalis, Bianchini, Fortes, & Pimentel, 2010; Zhou, et al., 2011). Hence, teachers should know and implement the use of assistive technology in their classrooms (Smith, Kelley, Maushak, Griffin-Shirley, & Lan, 2009). However, mathematics teachers do not know how to use or reach the assistive technology in their lessons (Freeland, Emerson, Curtis, & Fogarty, 2010). In light of having a lack of mathematical code knowledge in the Braille alphabet, knowing the Nemeth alphabet can make learning mathematics very useful due to its reduction of writing time and length (Rosenblum & Amato, 2004).

CHAPTER 3: METHOD

Introduction

The main purpose of this study was to explore the academic and social challenges of visually impaired students in learning high school mathematics by drawing from their learning experiences in inclusive education. In order to achieve this goal, I used a naturalistic inquiry as a qualitative research methodology. The patterns were recognized by quoting the words of participants in their own language. Presenting the overall themes that illustrated the experiences of the participants was conducted systematically.

Research design

The intuitive process was shaped during the exploration and description of the research problem. Hence, a naturalistic paradigm of inquiry was chosen for the data collection and data analysis. A naturalistic inquiry can be defined as one that "… cannot be given in advance; it must emerge, develop, unfold" (Lincoln, Yvonna, & Guba, 1985, p. 225). The main reason for this decision was the appropriateness of the inquiry being shaped by the purposes, stating questions according to the situations, and reaching the unexpected unique consequences (Merriam, 1988). In this study, the research problem was determined and research questions emerged from the problem. Results were illustrated in themes, which were derived from the experiences and challenges of visually impaired students with high school mathematics.

Participants

The participants of the qualitative study were chosen conveniently in order to reach information-rich cases (Lincoln & Guba, 1985). The sample was a group of visually impaired students who had inclusive education during their high school education. Although purposive sampling was suggested for qualitative research studies (Lincoln & Guba, 1985), convenient sampling was more appropriate for this study for two reasons: (1) visually impaired students belong to an isolated group; and (2) reaching the information-rich participants was a serious problem because they belonged to an isolated group and a few wanted to share their experiences. However, I continued collecting data until the data was saturated. Data saturation means the replication of the data and the absence of new information added to it from the observations, tutoring sessions, and interviews (Morse, Barrett, Mayan, Olson, & Spiers, 2008).

I was informed by three gatekeepers. A gatekeeper is someone who can give access to and information about individuals who would provide a rich array of data (Seidman, 2012). Three gatekeepers helped me to provide contact with the participants. The gatekeepers were a mathematics teacher, a tutor in one of the foundations that a participant went to, and a nurse that had a close relationship with one of the participants. The gatekeepers helped me to find the information rich participants according to my research profile. Moreover, they helped me gather further information about data and check the trustworthiness of study.

As a result, availability, accessibility and commitment levels of some possible participants: Four high school students (aged 18 - 24) were chosen as participants. The participants were three male students and one female student who took inclusive

high school education and had the support from different volunteer foundations. The profiles of the participants are given in detail in the profiles section of chapter four.

Data collection

Data of the current study consisted of interviews conducted in the native language of the participants (Turkish), field notes, observations during tutoring and interviews, which were kept in a reflective journal, other relevant documents, and artifacts. The artifacts consisted of all of the written documents acquired from the participants such as lesson materials and teaching notes. Different strategies were utilized to contact the participants and conduct the interviews. The four participants committed an appropriate time for the interviews. All participants received a formal invitation letter, explaining the purpose of the study and procedures. The interview protocol for the interviews, which explained the purpose and confidentially criteria of the study, were read to the participants, and their permission was asked for. The participants were contacted through face-to-face meetings at a certain place that they chose. A sample interview protocol is given in Appendix B.

Instrumentation

In naturalistic inquiry, human experiences and insights are data. Therefore, the human element is given a central role (Lincoln and Guba, 1985). Data of this study is interpreted according to my knowledge, skills, and training. Therefore, the quality of the study is determined by my qualifications, interests, and ethical values (Patton, 2002). According to Lincoln and Guba (1985), “the researcher, by necessity, engages in a dialectic and responsive process with the subject under the study” (p. 44-45).

That is why this study was dialectic and responsive which neccessiates the inclusion of my profile, as well.

I was born in 1988, in Ankara. I obtained a Bachelor of Science degree from Middle East Technical University, specializing in mathematics. My four-year long education was focused on mathematics. I loved doing volunteer work during these four years and specialized in tutoring mathematics lessons. I was tutoring the students with poor financial statuses together with another friend, who was tutoring visually impaired students. He was always talking about what a different and challenging experience it was compared to his other tutoring sessions. He was always highlighting the fact that that there were several problems within the education of visually impaired students. I was curious about this issue; however, I did not have a chance to experience these kinds of sessions myself. After graduating from Middle East Technical University, I decided to turn my volunteer work into a profession: teaching, and I applied to Bilkent University Graduate School of Education's Curriculum and Instruction with Teaching Certificate. During the interview, I asked if there would be a chance to study the ways to teach students with disabilities. They loved this idea and accepted me. During my master education, I took several courses which improved my outlook and informed me about the dimensions of education and reforms in Turkey. I was introduced to inclusive education during this time and wondered how the problems were handled. I decided to examine inclusive education more closely and started volunteer tutoring with a visually impaired student. I observed that there were several problems related to the education of disabled students. I decided to conduct a research study to reveal the problems of visually impaired students in learning high school mathematics during their inclusive education.

I am the main data-gathering instrument because of my personal interest and strengths had a direct effect on all stages of data collection, which can be explained in several dimensions: First, I worked as a volunteer mathematics teacher of visually impaired students in a private foundation for one year. Second, during the volunteer job, I kept a teaching journal about the needs and successes of my students by comparing the results of other studies. Third, I studied mathematics teaching and differentiated education during my initial teacher education at Bilkent University, which helped me be informed on both theoretical and practical issues of mathematics teaching education and differentiated education in the classroom. Fourth, I am educated in conducting qualitative research.

Developing the interview protocol

There were three sections in the interview protocol: interview arrangement, interview questions, and member check. Developing the interview protocol allowed me to specify my research design (Lincoln & Guba, 1985). The first section of the interview protocol was the arrangements in regard to the interviews. I worked carefully to determine the settings (time and place), flow, equipment (voice recorder), questions, and clarification of the answers of the interviews. In each interview, I reminded the participants about the procedures and the purpose of the research. I asked for permission to use a voice recorder before each interview. During the interviews, both the participants and I had opportunity to ask for clarification of the questions or answers. Moreover, the participants could choose not to answer the questions, stop the interview, or withdraw from the study.

The second section of the interview protocol was the interview questions. The initial set of interview questions was prepared according to my readings of the literature, observations, and personal contact with the tutoring teachers of visually impaired students. The questions were modified to reach clearer answers or further information, whenever needed during data collection. Some questions were asked repeatedly or were connected to other questions to obtain additional information. For example, in an interview, the effect of learning style differences was asked three times. The answers differed from each other regarding the assessment system, mathematics lessons, and the use of technology.

The last part of the interview protocol was the member checking procedure; participant confirmation of their interview responses. During the interviews, the member check procedure was implemented by asking for clarification and confirmation of the answers of participant. After the interviews, the member check procedure was conducted by contacting about my interpretation of the interview data. All interviews lasted at least an hour and were conducted in the native language of the participants, Turkish.

Interview process

The data of this study came from the semi-structured interviews that lasted at least one hour and a variety of other resources. All of the interviews were conducted face-to-face, which gave me a chance to observe and gather deeper information about the participants. During the interviews, I used the information related to the participants' background, the literature, observation notes, reflective journal notes, and tutoring experiences with a visually impaired student. All interviews took at least one hour

and were carried out in Turkish. The interview location was chosen by the interviewee according to the conditions stated in the consent form.

Observations and volunteer tutoring

Observations were defined as the "systematic description of events, behaviors and artifacts in the social setting chosen for study" (Marshall & Rossman, 1989, p. 79). Observations were suggested to be conducted in the participants' natural setting in order to understand their perceptions and experiences (Spradley, 1980). However, I was able to observe only one of the participants while learning mathematics. These observations occurred during the volunteer mathematics tutoring sessions with the participants. By keeping notes during these experiences, I had a chance to gather a lot of information about the learning environment and learning needs of the participants. All these experiences that further helped me improve the quality of the follow up interviews.

Artifacts

The artifacts included written the documents of field notes; from observations and tutoring sections. The data triangulation helped me strengthen the information given by the participants (Patton, 2002). Through triangulation, the information collected from each participant was analyzed separately, and combined with and compared to each other at the end of the process (Patton, 2005).

Journals

I kept two journals, one methodological and one reflective, for increasing the trustworthiness of the data (Gonzales, 2004). In the reflective journal, I wrote about

my observations; interview and tutoring notes. In the methodological journal, I wrote about my methodological reflections; the discussions with my peer-debriefer and literature in order to construct a working hypothesis and improve the details of the study. Both journals helped me in constructing the research design, determining the working hypothesis, analyzing the data, and interpreting the results.

Data analysis

The data analysis method used was the constant comparison method. The analysis consisted of unitizing the data, categorizing the data, recognizing the patterns, collecting the similar categories together, and finally identifying the themes (Glasser & Strauss, 1967 as cited in Gonzalez, 2004). These critical themes emerged inductively from the similar categories when they were grouped together (Patton, 1990). The themes showed the commonalities and differences between the experiences of the participants during their inclusive education, particularly of high school mathematics. The data analysis and collection were conducted interactively and continued until I believed that data reached a saturation level (Guest, Bunce, & Johnson, 2006).

The main data of this study came from the interviews. First, the interviews were transcribed into Turkish. In order not to lose the integrity of the data, the interviews were conducted and analyzed in Turkish. The data were first unitized into small codes. I continued the analysis by writing memos for each of those codes. I used my observation notes, reflective journals, and all of the other artifacts when writing my memos. In total, one thousand five hundred fifty three (1553) cards were created from 72 double-spaced pages of transcriptions of the five interviews. After that, data

were transferred into cards in four different colors indicating each of the four participants. See the sample unit card below:

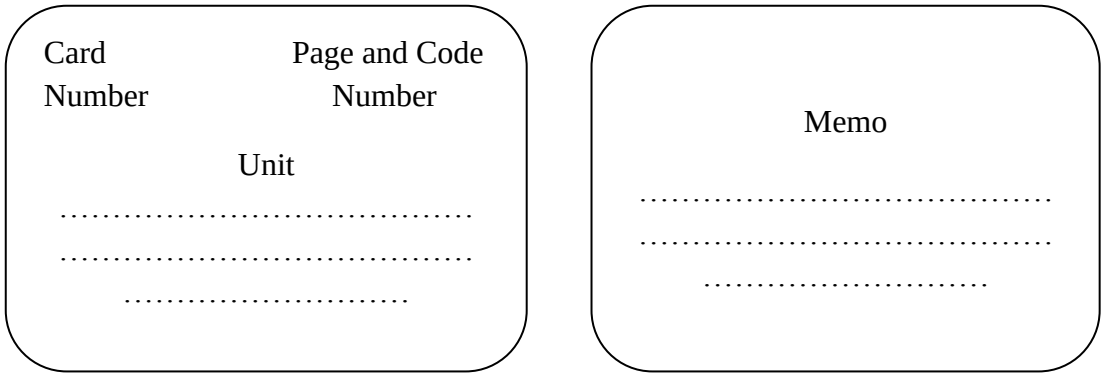

Figure 2. Example of a Unit Card

The purpose of categorization was to collect the related cards in one category and relate them to the same theme (Lincoln & Guba, 1985). For categorization and discovery, coded cards were used. Each card was assigned to at least one category. When some cards needed to be included in more than one category, they were re-written. The process involved selecting one card, studying it, checking the relevancy of the card with the existing categories, and placing the card within the related category or creating a new category for it. This process continued until all of the cards were categorized. After analyzing all of the cards, similar data were placed in the same category. The same process was repeated several times to ensure of the appropriateness of the categories (Alsmeyer, 1994). At the end, a name related to all of the cards was assigned (Lincoln & Guba, 1985). Each category was also analyzed within itself to re-check whether the cards belonged to the appropriate category. Table 1 represents the 50 categories identified by the analysis.

Table 1
Categories of the study

Categories			
1. Physical consequences of disability	2. Emotional effect	3. Equity	4. Teacher support
5. Differences of learning styles	6. Individual learning style	7. Target	8. Individual studying method
9. Braille alphabet	10. Voice recorder	11. Text books	12. Technology use
13. Friendship	14. Large scale examination	15. School examination	16. Lecturing
17. The reader	18. Mathematics topics	19. Self-confidence	20. Peer-support (in lessons)
21. Social support from friends	22. Inclusive education	23. Teaching methods	24. Assessment system (in general)
25. Special education	26. Foundation support	27. Mathematics usage in real life	28. Geometry
29. Teacher attitude	30. Student awareness	31. Motivation	32. Teacher education knowledge
33. Material use	34. Problems with teachers	35. Social support	36. Criticism of the system
37. Mathematical language use	38. Technology effect	39. Family support	40. Content
41. Memorization	42. Educational background	43.Communication with friends	44. Examination problems
45. Assessment problems	46. Prejudice of teachers	47. Classroom facilitates	48. Exam preparation methods
49. Courses	50. Teacher perspective		

Next, similar categories were combined to construct themes. I discussed the categories with my peer-debriefer to identify the patterns in order to develop the themes. The themes are presented in Table 2.

Table 2
Identified Themes of the Study

Themes
1. Teaching practices
2. Learning styles
3. Use of materials in the classroom
4. Evaluation of inclusive education
5. The assessment system
6. Perceptions on equity

Ensuring trustworthiness

There are four types of trustworthiness: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). To ensure the trustworthiness of this study, I used six elements: prolonged interviews, peer-debriefing, member check, triangulation, researcher reflexivity, and a working hypothesis, as shown in Figure 2.

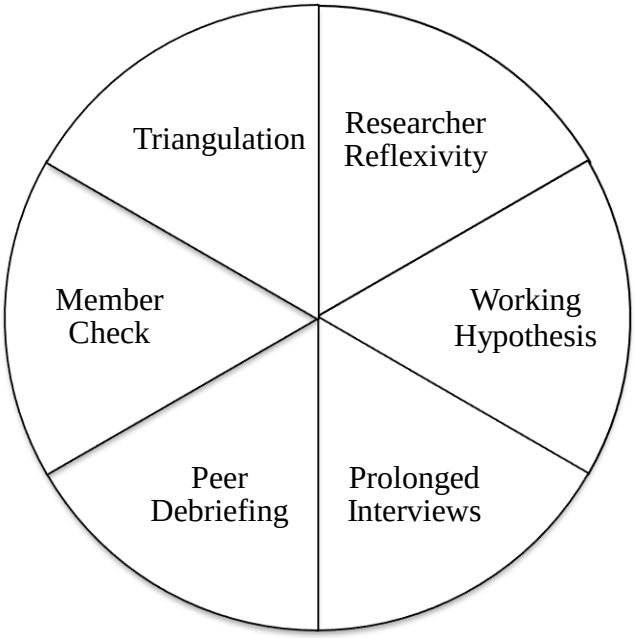

Figure 3. Elements of Trustworthiness

First, I needed to spend prolonged time in the field to develop an in-depth understanding of the phenomenon (Creswell, 2003). I used the observations in prolonged interviews and illustrated details about the ongoing problems in the narrative explanation. I conducted semi-structured interviews that lasted over an hour; prolonged interviews. During the interviews, the movements of participants, the environmental impacts, and the notes for further discussions were taken as the observation notes. The notes were useful for connecting the participants to the experiences and analyzing the context.

Second, peer-debriefing method was used to control the research process by reviewing the data analysis and asking questions for checking the similarity of outcomes (Creswell, 2003). Therefore, the peer-debriefer needed to be well-informed and experienced in the methodological issues (Lincoln & Guba, 1985). The chosen peer had the same experience as me and other relevant knowledge about conducting qualitative research, naturalistic inquiry and methodological issues. The peer-debriefer and I met once a week and discussed the methodological issues and discussed how I could improve the quality of analyses during the observations and interview process.

Third, the member check process increased the trustworthiness of the data and the outcomes (Erlandson, Harris, Skipper, & Allen, 1993). It increased the credibility of the research study by enhancing the opportunity to comment on the original data (Thomas, 2006). The original data were transcribed to computer files and analyzed according to the coding system. During and after the interviews, the participants clarified and confirmed their own answers to the interview questions and the outcomes that were shared after the analysis. The confirmation allowed the participants to make further explanations and reflections (Gonzales, 2004). Therefore, the outcomes of the study became more credible (reliable).

Fourth, my reflection created an open and honest perspective to draw a narrative description (Creswell, 2003). I kept a detailed reflective journal for the description of the teaching periods, observations, interviews, personal experiences, participant portrait, and different perspectives of visually impaired students.

Fifth, data were triangulated to obtain different resources and to construct a congruent justification (Creswell, 2003). The triangulation process was conducted with the gate-keepers with the information coming from my observations and tutoring sessions. I asked the gatekeepers to explain some information coming from the data and combined these comments with my observations. Therefore, gatekeepers helped me take multiple perspectives and understand the data deeply (Patton, 2002).

In addition to trustworthiness, the confidentiality of the participants was ensured. I explicitly explained the research objectives and data collection process, asked for the recorded permission to be a participant, informed the participants through a consent form about the data collection devices, and transcription, written interpretation, and final conclusions based on the data.

Working hypothesis

The current study explored the academic and social challenges of visually impaired students in learning high school mathematics. The working hypothesis was a unique context which could be generalized from the outcomes (Erlandson, Harris, Skipper, & Allen, 1993). The working hypothesis of the current study included the assumption that visually impaired and sighted students were not equal in inclusive mathematics classrooms.

CHAPTER 4: RESULTS

Introduction

In this study, I explored the academic and social problems of visually impaired students in learning high school mathematics during their inclusive education. There were two parts to the result section: the profiles of the participants and key findings, which were organized in themes. The first part included detailed profiles of the participants. The themes consisted of the findings from qualitative data. Direct quotes were given to enable the participants to communicate in their own words.

The profiles of the participants

The profiles in this section illustrate the background of the participants. This section was necessary to inform the readers and help them make sense of the information provided under the themes. This section starts with Umut's profile, followed by Rabia, Cem, and Emre. These names are all pseudonyms.

Umut (20): Umut had already graduated from high school when I was introduced to him. His aim was to get a decent university education and a nice job. He was blind from birth and had no visual sight at all. He was living with his parents and his two sisters. He was the only person with a disability in his family. During both elementary and middle school, he attended schools that were specialized in educating visually impaired students. However, afterwards, he transferred to a regular high school to continue his education in inclusive classrooms, together with sighted students. There was only one other visually impaired student at his school and he was the only one in his class. His loved learning mathematics and he was quite

successful in school exams. His expressed his views on mathematics as: “If you do not love mathematics, you cannot be successful”. Although his opinion on the inclusive education was generally positive, he expressed his concern about the way mathematics was taught at high school: “I could not benefit enough from my high school education in terms of learning mathematics. There were so many challenges for me”. After our initial correspondence, I helped Umut with his school mathematics and prepared him for university entrance examinations at the same time. I prepared several instructional materials to be more effective in my tutoring for the next six months. At the end, Umut turned out to be very successful in the university entrance examination and was accepted to the university he wanted to attend.

Rabia (24): She was a twelfth grade high school student when I first met her. She participated in the study right after she graduated. She was visually impaired from birth. She did not have direct sight although she could see around her. Her sight rate was very limited—5%. She looked to me as a young independent woman, who said: “I can handle everything; this sight is enough for me”. She actually did attend to neither an elementary nor a middle school. Instead, she was allowed to complete her education if she could pass examinations. She did so after a two-month long preparation period. I was amazed to hear that she learned the Braille alphabet in two weeks; however, she still did not seem to be very happy with her overall proficiency in Braille: “I cannot read or write fast enough in Braille alphabet. I have a problem with my hand: I cannot write in Braille for long periods of time”, referring to her chronic injury with her writing hand. She came to Ankara at the age of 20, just to be able to have inclusive high school education, because there were no such opportunity available in her home town. In Ankara, she was living in a dormitory with her peers.

There were 13 visually impaired students in her high school and she was the only one in her class. She expressed her dissatisfaction with the mathematics taught in high school:

> I was able to learn mathematics and solve problems before high school. I had several problems in high school and now I cannot learn or express my knowledge because of the problems I experienced in high school mathematics lessons…. learning mathematics is enjoyable, but a real challenge for visually impaired people.

She believed that

> Inclusive education is a wonderful thing. If a visually impaired student took all classes separated from sighted people, that person would have had a problem in connecting with the external world [socialization with other people]. We still have problems. If the teachers do not care about us, we sleep during the lesson.

Emre (18): He was a twelfth grade high school student when I first met him. Emre participated in the study right after he graduated. He was in inclusive education for all his school life. Emre was a successful student. He loved mathematics and was pretty good at it. Emre portrayed himself as follows:

> I did not know that I was visually impaired during my elementary school years. When I realized that I was visually impaired, I did not do much about it. I tried to read like the sighted people. I even wrote my notes by myself from first grade to fourth. I had to ask for help from my friends when I could not read my own hand writing. In middle school, I was not able to read at all.

> I was introduced to the Braille alphabet in eighth grade. …I still do not know the mathematical notations in the Braille alphabet. I make up my own mathematical notations in Braille.

Cem (18): He was a twelfth grade high school student when I first met him. Cem participated in the study right after he graduated. He was successful in mathematics and he loved it. He was in inclusive education for all his school life. Cem went to the United States as an exchange student in eleventh grade. He compared inclusive education in the US to Turkey and said practices in both countries shared common problems. When I asked him to describe his past experience, he responded insightfully:

> I was able to see and I had no physical problem [during elementary and middle school]. I spent eight years in my last school and I did not have much difficulty, thanks to the support I received from my teacher and my friends. …During those days, I was able to read and write by myself. …I have very limited vision since I was born. It was a huge disadvantage… and… it became really serious in high school. I did not want to accept my disability.

There were six themes in this study. They were *teachers for the best and the worse*, *unique learning styles*, *evaluation of the use of materials*, *the social aspect of inclusive education*, *evaluating the assessment system*, and *the perceptions on the equity*. Data were organized under themes in an order to provide a complete picture of the challenges of visually impaired students.

Teachers for the best or the worse

Teaching methods played a crucially important role for student success. Teachers' methods were shaped according to several variables, such as individual student needs, requirements of the mathematics topics (the use of technology, material, etc.), and class size. Students described the effects of different teaching methods on their learning. They also shared their experiences in the mathematics classroom and evaluated several teaching methods.

Teachers' limited knowledge in teaching mathematics to address individual needs of their students had negative consequences on visually impaired students. For example, Cem was sure that his teachers knew mathematics really well otherwise they would not have been in the classroom. However, there was a problem because they knew very little about the teaching of mathematics. Cem said that the "problem of not being able to transfer [mathematical] knowledge" was even more harmful for visually impaired students than it was for sighted students because he needed something more than a transfer of knowledge. Cem explained that "… There is already a problem for sighted students in [understanding] mathematics. The problem is even bigger for us [visually impaired students]".

Cem added that he needed a clear presentation of the mathematical information; he needed to be encouraged to be active in the classroom, and most importantly he needed clear instructions:

> I had serious problems in geometry lessons. The teacher would say things like *take this and put it here*, I did not understand what he meant. Teachers

should not use unclear directional cues while they teach visually impaired students.

Cem and Emre both stated that teachers did not have enough information about visually impaired learning materials and they were not interested in learning about them. Emre explained:

> [The reason for the use of inconvenient teaching methods might be] teachers' lack of pre-knowledge and experience in teaching us. They have some prejudice about how to give inclusive education in math lessons and how to deal with [the problems of] visually impaired students.

According to their experiences, teachers did not know about the Braille alphabet, writing style, or using the materials. Therefore, teachers had little effect on his learning. Emre explained

> Mathematics teachers do not know about the special abacus for us, Braille alphabet, or how to use these effectively [in mathematics lessons]. They do not help us in material use or ask to learn about the material.

Rabia agreed on the teacher prejudice by giving an example:

> I need to deal with serious problems in [learning] mathematics….one of my teachers said that visually impaired students cannot learn mathematics. I do not agree. I can learn mathematics. …Not all visually impaired students are similar to each other.

She believed in herself in learning mathematics. However, the attitude of her mathematics teacher ruined her hope. She explained that her teacher tried to ignore her and did not care about her success. Rabia explained that they really did not want to take on the responsibility and they were afraid to refresh their knowledge:

> Teachers are trying to get rid of us. They always complain about not having the skills. There were seminars about inclusive education or it is written in the regulation book. …they could share their experiences and talk about what could be done for us, but they do not prefer to discuss it. They [except two or three] do not want to learn about it or change their methods. This creates prejudice on both sides.

There was a vast difference between the teaching methods and learning styles of visually impaired students in the mathematics classes. Umut said that inappropriate teaching method was always the most important problem for him that some of his teachers tried to implement some effective teaching methods at first, but they gave up after a while:

> At first my teachers tried to explain everything to me after addressing the [crowded] class [on the white board]. However, since it was time consuming and caused some problems [related to the sighted students], they advised me to study with my classmates and take notes from them. But that did not work very well for me.

Umut admitted that he hesitated to talk about his problem with his mathematics teachers but they never asked, either. Rabia explained that in addition to the classical lecturing method and frequent use of white board for teaching, her teachers also used

uncertain directional cues; which created another problem. She already could not see the board and her teachers were pointing out the things on the board. She could not help but ask what she could do apart from asking clarification. She said:

> They use *this* and *that* to teach the lessons by using [only] the white board. But I cannot see what they are talking about. I tried to warn them that I do not understand because of my impairment. For a while, they listened to my warnings, but later they forgot not to use uncertain directional cues. I kept warning them for a while, but… How many times can you warn a person? …they could teach [geometry at least] by using [materials like] pencils and make us understand the content. …however, they do not want to care for my understanding. Since my classroom was so crowded [50 students], teachers continued with the classical method [lecturing on the board].

Cem and Emre added that experiencing the same type of issue resulted in a demotivating environment for learning mathematics. Cem highlighted the importance of teaching methods by giving an example:

> The teachers were teaching as if I were a sighted student [in my school]. The sighted students could see and write at the same time while they were learning in the classroom. However, I cannot. Therefore, I felt like I could not learn in this environment. The topics were getting harder and learning them created a more challenging problem. It was harder for me than the sighted students. My classmates' help with mathematical content was no longer enough. I felt like I was not able to learn. Visual impairment is a disadvantage in learning. We need to accept this… [For example,] in the complex numbers unit, I really could not understand what *i* is and why we

> need it. The content was completely new to me. The teacher could not explain it to me in the classroom. In my rehabilitation center, [when I attended tutoring,] I figured out that it was not that complicated. When the content is explained according to the student needs, the lessons become easier.

Rabia explained that, despite the teaching problems, one of her teachers could find a beneficial teaching method for her. However, this method also had a drawback both for visually impaired and sighted students:

> One of my mathematics teachers was teaching very fast. She was teaching the content very quickly and summarizing the lesson for me. The sighted students could not understand what she was teaching because she was too fast for them. But I could understand the content. She was explaining to me according to my learning style.

This time the other students in the class started to complain because the teacher was rushing the topic in order to spare some time for Rabia. Because it was not convenient again for all students in the classroom, instead of adjusting her method, the teacher gave up this method after a while.

All of the participants got tutoring sessions from volunteer teachers in different rehabilitation centers or foundations. Two of the participants, Umut and Rabia, explained that they got the most benefit from these centers because of the one-to-one education; just the teacher and the visually impaired student. Other participants,

Emre and Cem, explained that it was not a solution to their problems. Umut insisted on the necessity of some sort of separated education from the sighted students:

> The mathematics lesson in high school should definitely be given separately from the sighted students. It [learning] does not happen when we are together because they can see. Teachers write on the white board, they write in their notebook. They can ask about difficult questions. The teaching method is for them. They write quickly, but our writing style is different and we need to do this from our mind. We need the teacher to focus on us only. Then, we can start learning some serious mathematics.

Rabia agreed with Umut and added her own hesitations about asking questions during the lesson period:

> When a disabled person cannot express herself to the teacher, the other students can make fun of her. Therefore, a visually impaired student cannot feel comfortable asking her questions. It is important to have a one-to-one time with a mathematics teacher. [Moreover,] it is hard to concentrate on the topic when there is more than one visually impaired student in the class. The learning speed differs from person to person and you cannot ask your questions. Even when you do not understand the topic, you say that you do when it is asked. I did this a lot.

Rabia created some prejudice about learning mathematics. She hesitated to say so when she did not understand the content. Only a few of the mathematics teachers were interested in her success, she started not to care about her own success, either.

Emre and Cem disagreed that the tutoring session was definitely more beneficial than the inclusive education. Emre commented on this issue:

> Teachers mostly do not refer to the visually impaired students during class time. However, when they are trained about teaching us, they can handle some problems. … [For example,] I heard that inclusive students are not admitted to some schools. In the SBS (Student Placement Exam) examination, I experienced a similar problem. When I went to school registration (he was successful in the central exam), it was suggested to me that I go to another school with an inclusive education system for visually impaired students because they think that they will have difficulties in the future because of my disability. Perhaps teachers hesitated to give inclusive education and they thought that I would have better relationships with other visually impaired students there. Although I had problems in learning mathematics, that was an excuse. Now my teachers have enough knowledge and enough experience for giving inclusive education. [According to my experiences,] teacher attitudes and perceptions towards inclusive education [and teaching visually impaired students] have changed in time.

In conclusion, the participants complained about their problems related to the teaching methods and prejudices of their teachers. They emphasized that their teachers did not have enough information to provide inclusive education for visually impaired students. Therefore, the teachers could not use effective methods for them. Lastly, they compared tutorial sessions and inclusive education in terms of mathematics lessons. Two of the participants suggested the one-to-one education for mathematics lessons while other two were disagreed to that idea.

Unique learning styles

The participants agreed that the teaching methods were important for student learning. However, teaching methods should have been tailored to their needs and learning styles. They explained that because they had a disability and that they had different learning styles. In this chapter, the learning styles of participants were detailed according to participant experiences. The categories that construct the themes are memorizing, writing, reviewing, topics, and teaching style effect.

The learning styles of the visually impaired students were obviously different from the sighted students. Rabia explained the situation and concluded that it was a disadvantage:

> They are learning by looking at the board and writing in their notebook what they had seen. However, I always need a person to explain to me in detail what is going on. Therefore, I am one step behind from the other students in the classroom. Obviously, this is our learning difference.

She saw depending on a person as a disadvantage for her. Connecting with a person was time consuming and some points could be missed during this process. In this situation, Rabia had nothing to do on her own because the teaching method and class environment made her become depended on another person. Umut agreed on learning style difference and added:

> They are able to see the board and follow the lesson from the book, they have an advantage. Therefore, they were learning faster than me. Teachers are writing on the board and following the book; teaching according to the

> sighted students; they had a double advantage. My learning and writing style are different from them and teachers do not know about this. There were two options for me: I needed to make the teacher focus on me and give me advice or to stay quiet and solve the problem later.

Umut tried to solve the problem later but it was never solved. The negligence to his achievement and involuntary attitude to modify mathematics lessons prevented this problem from being solved. Moreover, Cem and Emre added:

> Visually impaired students needed to visualize the content while they are learning. The words that teachers use are important during the teaching period. …when teacher use uncertain directional cues, the visualization is eliminated….especially in geometry, the visualization of geometric shapes is already very a hard job for us. Teachers should be careful about it.

When teachers were not beneficial enough for student achievement, the participants decided to take action themselves. They started experimenting with the appropriate learning methods. Cem explained this process,

> You cannot learn during the lesson, you do not know the Braille alphabet; you do not have any resources for you. [Moreover] you do not have an ability to keep everything in your mind. I was desperate.

Then they tried to explore new methods that helped them learn. Umut, first tried to memorize everything, when it did not work he tried another method. He found that discussions were beneficial for his understanding. However, it also did not work due to having a lack of knowledge:

> Memorization [of the context] is so tiring and boring. [Then I found that] learning mathematics was about asking questions; in fact, learning the logic. Mathematical discussions are more beneficial for me in learning. You have to learn [the content] by discussing with a teacher or you have to accept without asking directly. In the classroom environment, the sighted students were discussing the content together, but I was excluded. I already do not know the content, what will I discuss? I preferred not to take notes in the Braille alphabet (The reasons are explained in the use of material section.). I preferred to solve the questions mentally. It worked for me and gave me an advantage against sighted students. I recommend it to all visually impaired students.

Umut started to learn the content in the tutoring sessions and tried to keep everything in his mind by repeating the content over and over again. He defined the sample questions for summarizing the content and he started to solve all of the questions without writing while he was repeating. Doing constant repetitions was challenging but worked for him. However, Rabia tried to apply the same method and it resulted in disappointment:

> I tried to do everything mentally all the time. Nobody warned me about its ineffectiveness. Now I cannot learn mathematics, I am faced with significant challenges….you cannot remember everything. You need to write and try to understand on your own.

Cem agreed with Rabia and he developed his own model; studying the mathematical content before, during and the after the content was taught. For example, Cem

believed that the mathematical content, even algebra, could be learned only by hard work. He said that the important point was starting to study before it was taught in the classroom and recover again what it was done. The other important point for Cem was starting to study mathematical topics long before school started. He had used this method since the first grade. He explained that

> I was able to do calculations before the first grade. …when I went to elementary school it was beneficial [like in high school]. The preparation is always important for us in learning.

Therefore, studying the content long before it was taught at school made Cem successful in mathematics lessons. He tried to learn the content before the lesson; he listened and took notes during the lesson, and he repeated everything over and over again after the lesson. It consumed a large amount of time for him to learn but the results were good.

Rabia had problems in individual study because she was not able to learn mathematics on her own; she needed someone to answer her questions all the time. Hence, she preferred to take notes during the lesson and ask her friends' questions. Moreover, she added that during the lesson giving the real life examples made her learning easier and that she never forgot these examples. She explained that:

> Whenever a teacher makes a connection between the questions and real life examples, the topics get visualized [concrete] and easier to remember. Therefore, I can understand [the content] and prefer them to the definitions or other meaningless parts…. [For example,] I am good at the topic permutation,

> combination, and probability. [Because] the content is directly related to real life.

Actually, Rabia was engaged in the lesson and illustrated topics in her mind through her own real life examples. Moreover, Rabia was comparatively good at learning mathematics when numbers instead of letters were used. When she could find the answers, she could easily understand the logic. However, when letters and other algebraic notations were used, she got confused. She explained that:

> It is better for me to try to understand the topic by using numbers. When I try to analyze or solve a problem by using letters, I get lost. Therefore, I really hate and cannot do algebra or trigonometry.

The participants agreed that the challenge of learning mathematical content became harder or easier to overcome mostly when the content became abstract or required a visual component. Therefore, some more challenging concepts were geometry, calculus (especially integral), and algebra (especially the polynomials). For example, Cem said that although he could have learned the basic geometric shapes in middle school, it got more complicated in high school. He compared himself to the visually impaired students from birth:

> At least, I can imagine immediately what a square is or what other shapes are. I can illustrate the properties quickly because I learned them by seeing. However, if you are visually impaired or blind from birth, you need to touch the shapes, and doing this in a typical classroom environment is really hard.

Umut agreed with him by adding that he did not know geometry apart from basic shapes. He learned basic shapes by folding the paper, he memorized their basic definitions:

> The geometric shapes were confusing to me. When the shapes changed or turned, it was hard for me to understand them … [Therefore] I could barely learn geometry content because I cannot illustrate it in my mind. I hate geometry. I would just sit in geometry lessons and do nothing. I really get bored.

In conclusion, the participants spoke about the problems and some solutions related to their learning styles and success in mathematics lessons. They concluded that their learning style was tactile and different from the sighted students'. Their disability was a disadvantage for them to learn mathematical content in the classroom environment due to the both challenges related to learning and teaching. They developed several methods to solve the problems and understand mathematical content; however, most of these developed methods did not work efficiently.

Evaluation of the use of materials

Material use is important for mathematical achievement of visually impaired students when they cannot benefit from the teaching and learning at school. Students use different materials to have a deeper understanding of mathematics, through assessing their own understanding, and seeking immediate support when they need to. The most useful materials for visually impaired students are the ones with no (or less) visual component or with voice support. The participants chose different types of materials according to their individual needs and material functionality. During the

interviews, they were quite explicit in expressing the advantages and disadvantages of these materials; including the Braille alphabet and its support, voice recorder, internet resources, JAWS screen reading software, etc. In this part, the materials are explained and evaluated according to their functionality, importance and benefits by the participants.

The first material that was commonly used was the *Braille Alphabet* and its support system. In order to keep notes, the visually impaired students wrote in Braille by using its special pen, paper, and tablet. Cem and Emre said that learning the Braille alphabet affected their life positively and increased their academic success in school. They said when they were in elementary and middle schools, they were able to read, write, and study by themselves, with minimal help, because they could see enough. They could read from books and write exams by themselves at the same time with their friends in the classroom. Whenever they had a reading problem, their friends or teacher were helpful to them. However, when they came to high school not only their needs, but also their impairments increased and they needed further help for their education. First, Cem and Emre tried to memorize every single piece of information that they had learned. Then they went to a rehabilitation center and they learned Braille to be able to write and it concluded with benefit and success. Cem said that it was beneficial for him but become even more beneficial with his modifications:

> I still did not come across the mathematical notations. In Braille I did not learn them [because of a time problem]; hence I made up my own notations. It got more complicated with more notations, but I got used to it.

Because time was limited to master content taught in the school, Cem needed to focus on his studies more than he did for learning Braille. Therefore, he could not complete his Braille education, but even his limited knowledge of Braille was beneficial for him. For Emre, the Braille alphabet gave him an opportunity for succeeding in mathematics:

> It is the first time that I got 90 [out of 100] on my mathematics exam. You do not need to keep all the questions in your mind anymore. You write whatever you want in Braille and you read it whenever you need to. You again need to keep something in your mind, but it is limited.

Umut learned Braille far before the other participants; however, he did not agree with its benefits. When he started to have inclusive education, he used Braille for keeping notes. However he said that it was not beneficial enough for him:

> Writing in Braille is so slow compared to normal writing. You need to continuously punch the paper with its special pen to write in Braille. You need to work continually and you need to check the correctness of what you have written all the time. If it is not correct, you need to change everything. [Lastly] its paper is big and you use just one piece of paper for writing. Carrying all of those papers is not easy.

The other problem related to writing in Braille was writing mathematical content. Writing in Braille was a linear process. Students needed to write everything in linear form and check if it was correct or not. There were some modifications for mathematical representations, the Nemeth codes, but the participants did not know anything about it. Therefore the use of Nemeth in mathematics lessons was limited.

The second material that was used by all participants was software called *JAWS*. Emre and Cem said that they were using JAWS for reading the online documents. However, there existed some problems with it. Emre said that the software saw some notations as an image; therefore, it does not read certain things like integral or matrices. It leaves those parts as a space while reading:

> It reads everything but only if there are in the text format. It was not designed for mathematics. … It does not read dots in the text. It reads *3·5* as *three dot five* not as *multiplication*. Therefore, it was not useful in mathematics. It confuses me.

The third material was the textbook which was translated into the Braille alphabet and was given to the visually impaired students by ministry for free. However, none of the participants benefitted much from it. Rabia said that it was not beneficial for her since there were too many errors and missing elements, when compared to the original textbook. The examples, connections, graphics, pictures, and charts were excluded in the Braille translated version. Therefore, she could use the book only to read definitions:

> … Since it was translated into the Braille alphabet, all of the tables, figures, and their explanations were gone. In some questions, the values were shown in the table but the question was asking something else. Since the table was gone, the question became meaningless. The remaining part in the book was just definitions and other narratives but not helpful enough. Therefore, I could not use the book and I needed someone to explain it to me. I also agree that a visually impaired student cannot do the questions with the visualized

> parts in the book, but a visually impaired student can be told what was asked. A narrative of the content should be added to the book.

Emre and Cem agreed that they needed extra help for the high school mathematics book. The page numbers, size of the book, the content of the book, and explanations were so problematic. Emre said:

> The page numbers never match with the normal books. When the teacher says to open to page 90, I need to check which page it is in my book. The index is given in the first volume of the book [therefore] I need to carry both of them. It is larger and heavier than the normal ones.

The fourth material that was used in the lessons was *voice recorder*. Although it was beneficial for students to review at home and recall the content, it had some problems. Emre and Cem made greater benefit from the voice recorder than others. They said that they used it actively in each lesson, even in the tutoring sessions; they could review the lesson by using their recordings. Umut regretfully admitted that he could not use it effectively. He said that he used it in some lessons; however, he gave up using it after a while because the class was so noisy for using the voice recorder. Rabia experienced the same problem and explained the reasons: "Voice recorder was not beneficial to use in the classrooms since the classroom was so crowded [50] and most of the teachers did not want [her] to record the lesson." She was very upset when she was not allowed to record the lessons; however, since the pressure on the teachers was high by the government, teachers might not want to face any problem related to their recorded lesson. She said that she accepted that fact. Therefore, she also preferred not to use it after a while.

The participants used other technological resources such as Internet lessons or videos, and CDs. Umut said that he had some problems in using these resources. Umut said:

> I used internet resources and CDs; however, finding high quality resources and using them effectively is very a hard job. You could learn from these resources but you cannot ask questions when you need to. How can you learn mathematics without asking questions?

Since Umut benefitted the most from discussing all details of the topic with his friends or teachers, he could not make enough use of technological resources. On the other hand, Rabia was a big fan of using technological resources since she said that they were extremely beneficial for her learning. She used her computer actively and tried to use Internet resources to revise the lessons. She studied the lessons from Internet videos, book CD's, and used resources of national and some university libraries with the help of her teachers for getting access. Rabia said that:

> In order to understand a topic, I need to read it in the Braille form. When I do not have the opportunity to read, I have difficulty and I am stressed. In this case, I am trying to use Internet resources. In the teaching videos, they give the content clearly and they also write on the board which is also beneficial for my learning.

Similar to Rabia, both Cem and Emre used other technological resources in addition to Internet resources and CDs. They used *CCTV* and other zooming programs in their laptop. However, they agreed that technological materials were not always of high

quality enough and they were very expensive. Technological tools and resources were produced mostly to be used in different areas but not always for mathematics lessons. Therefore, they were not beneficial enough to be used in mathematics lessons.

The participants chose different types of materials such as the Braille alphabet, JAWS software program, lesson books in Braille form, voice recorder, CD's of books, library resources, internet documents and videos, and CCTV. In this part, the materials were explained according to their functionality in mathematics topics, importance and efficiency by giving the examples of advantages and disadvantages.

The social aspect of the inclusive education

The aim of education is not just ensuring the academic success at school but also preparing students for their future lives. In the visually impaired students' case, there are more obstacles than anyone could assume. Some of the life obstacles are only for specific types of people; however, these problems are actually the problems of community. Therefore, the community needs to get together and solve problems. It can be said that inclusive education has benefits not only on the visually impaired students but also on the sighted students. Moreover, it is helpful for students in several areas in terms of academic success, social sensitivity and social awareness. There are two parts, the evaluation of social awareness and academic success of inclusive education on sighted and visually impaired students.

The first part was the evaluation of inclusive education for sighted students. Emre and Cem agreed that inclusive education had effects on both visually impaired students and sighted students. They reported that their friends appreciated that the

visually impaired students had a catalyzer effect on their academic success and social awareness in the classroom. Cem and Emre highlighted that inclusive education made their friends to become more sensitive to the problems which visually impaired students try to handle. Several sighted students became more successful because they were studying together. Cem added that

> My friends told me that since I was abroad in the USA last year, their mathematics grades decreased. The only reason for this is because we were always studying together, benefitting both sides.

This section was about the benefits of inclusive education for visually impaired students. Umut explained the importance and benefits of the inclusive education by comparing it to the special education. At elementary school, he suffered from not having any friends and not being able to interact with teachers as much as he would like to. He was afraid of making mistakes. He said:

> I was so scared of making mistakes because I might have gotten a harsh reaction. Because my teachers in the special education school were intolerant of little mistakes, it made me lose my self-confidence.

Therefore, he scared of making contact with others. About his friends, he said that "there was nearly no connection between them". Referring to the development of his personality and discovering the social aspect of life, he said:

> I found myself in high school. At first, I was afraid of the sighted people and I thought that they would exclude me from their environment. However, I made my real friendship. I felt social and self-confident for the first time at high school. Teachers were supportive and helpful to me all the time. It really

> took time for me to become easygoing but at the end, I found my real friends and more importantly, I found myself. I think I owe my life and my personality mostly to the high school education (inclusive education). Although they could not help me in learning mathematics, they showed me my true capacity to myself in the world of sighted people.

Rabia said that she benefitted from the inclusive education a lot, too. She had different types of friends who supported and helped her learn more. She elaborated:

> If a person gets all of his or her education separately from sighted people, then, this will be a problem for them in terms of communication and education. Even though we are doing inclusive education, we already experience many communication problems; however, we also learn how to tolerate and persevere through those problems. Therefore, inclusive education is important, at least, for our personality development.

To summarize, the inclusive education benefitted sighted and visually impaired students. It increased the social sensitivity and social awareness of all students. Moreover, the visually impaired students said they found themselves and their true capacity by inclusive education.

Evaluating the assessment system

The assessment of visually impaired students, both at school and centralized large scale examinations, differs from the sighted students. Because of their disability, visually impaired students need a reader who can read, interpret, and write the answers for the visually impaired students during the examinations. The reader is

sometimes one of the mathematics teachers, or any available teacher, counselor, or even at times, when there is nobody available, students. The *questions in the school examinations* can be the same or different from the ones asked to the sighted students. Sometimes the questions and the exams are modified for them. There was never any visual material included in these exams. *In large scale examinations,* the procedure involved approximately weighting questions with a consideration of the excluded visual questions. The remaining questions, which were visual material-free, were kept the same. Despite all to these modifications, the visually impaired students still experienced several problems during the examinations. Some of these problems were problems related to the high school mathematics examination, centralized large scale examination, and the reader.

The first problem was the content of the school examinations. During these examinations, visually impaired students were isolated and asked to sit the exam in another room. In these isolated rooms, although someone was needed to read the questions and visually impaired students could opt to write the questions by themselves on their own paper. This exam questions could be modified for visually impaired students according to the visual parts. Emre said that the examinations for visually impaired students were usually postponed and his teachers were not willing to prepare new examination for him because they were very busy:

> For example, in geometry lessons, the teacher needed to prepare different questions for me or modify the exam questions for me. They usually happen to forget to prepare questions for me. My exam is then postponed; a few days, but this was all the time.

Facing such problems was also demotivating for him. He added that another problem with mathematics examinations was the place, discipline, and time length. He said:

> The time is a serious problem. In mathematics examinations, while the reader reads the questions at loud, I write them on paper in a bigger format so that I can read. The teacher gives me extra time for this but it is never enough. [Moreover] this is mentally and physically tiring.

During the examination, other students were often causing interruptions, or creating a noisy environment that it becomes difficult to focus. Therefore, visually impaired students had problems in expressing their knowledge and got frustrated.

Umut had different problems in the evaluation of his learning. During exams, he was asked too simple questions; mostly word questions (definitions and fill in the blank questions) or basic knowledge questions. Rabia tried to deal with the same problem in high school. The scope of her exams was limited to basic definitions and calculations which were less than the actual lesson topics. Rabia was opposed to the way questions were written; easier and basic. Her teacher said that visually impaired students take this way. The teacher also added that visually impaired students could not learn mathematics in any other way; mixing learning and assessment. She argued with him and was given "… a real exam". But she was very frustrated and very disappointed with this attitude. She said that "it is just a prejudice for both sides. Visually impaired students can learn mathematics". Rabia said that the mathematics exams in school obviously did not assess her learning.

A second problem was in regards to the readers. This was a problem for both large scale assessments and high school examinations. When mathematics teachers were busy, other available teachers were needed to read the questions. This happened many times, and a common problem for all participants. Cem said that usually the available teachers were the ones who barely remember mathematical symbols or content; therefore, they could hardly transfer the questions correctly to him or writing his answers on the papers. It was a serious problem for the student, having doubts in whether understanding the questions correctly; the answers were written correctly, and trying not to worry about these throughout the exam:

> One, the reader should be knowledgeable about the subject. Otherwise, because we already cannot see the questions, the transferring knowledge process does not work well and the reader confuses the student. Because the reader cannot understand the questions and the questions should be transferred correctly and completely, there is chaos in my exams and it negatively affects the student. I think this is the most important point. There should be a fair system.

Umut said that it was very important mistake that the reader was expected to explain the questions and requirements with no prior knowledge in mathematics. It made him confused during the large scale examination and he suffered. Sometimes, there were other problems with the readers. Because it was very a hard job to be a reader to the visually impaired students, some teachers did not want to do again. Cem elaborated on this:

> Sometimes teachers say that they are not helpful enough for [him] in reading. They told me, they are very sorry about this but they cannot do it anymore. I

was recommended to find another reader; however, there are no more teachers around, to be a reader.

Rabia agreed with Cem, referring to her disappointment with the readers:

> As a reader it is very difficult job to read all of these questions, when I am anxious enough. Therefore, two readers are not enough for long examinations [in the YGS examination]. They are tired and that is demotivating during the exam.

If there were no teacher available to read the questions, the reader had to be a student. Cem said that if it were a student, it was better for him to understand the questions or answer the questions because the students had enough knowledge. The reader was usually a student in her exams and she suffered from this issue. But in this case, sometimes, she claimed the reader tried to solve some of the questions instead of just reading them:

> The reader cannot explain the question when he or she is a student. When I explain my solution, the reader cannot write it down accurately. While I am thinking about these issues, I cannot concentrate on the examination. After a while both of us get tired and the reader starts to solve the questions for me. It is really embarrassing but true that they solve the questions.

In large scale examinations, problems became more serious. In the YGS examination, Umut tried to deal with another problem:

> Last year, there was a reader who was speaking with a dialect. I was desperate when I solved the first problem with him because of his speaking

> style.The other reader was late; therefore, we started the examination later with him. When the other reader came, I was so happy, but when she started to read the questions, she read quietly and slowly. I did not know what to do in this condition.

All these troubles were enough a distraction for him. Rabia added her experience in a large scale examination (YGS):

> Before the examination started, one of my readers panicked and she said her son was also taking the exam and she did not want to be here. She said *I did not want to be a reader I may get nervous*…. The same reader put her head on the table [after a while into the exam time] and started to sing a song. The other reader warned her to stop; however, I still got very angry and my concentration was completely destroyed.

The selection and education of the readers were important issues that it could result in unprofessional, ignorant, and helpless situations during the examination. Then, the visually impaired students were victimized by these misfortunes. They devoted their time and money to get prepared for these examinations and it resulted in disappointment. In short, they were left with a lot of frustrations with the readers.

A third problem was specific to the large scale examinations (YGS or LYS). The questions in the large scale examinations must be clearly written for visually impaired students. Even though the visually impaired students were not supposed to solve questions with visual components, they were supposed to answer all other questions. Therefore, *the way questions were written* played a crucial role in

particular. Umut and Rabia agreed that there were unclear and abstract questions. According to Rabia the questions in both exams "… were long and abstract questions which were hard to follow". Umut said that the questions were very long and it resulted with confusion and disappointment: "I need to solve all of them in my mind. I cannot write them because it is really time consuming. I did it in the YGS, but in the LYS it is impossible" because in the LYS examination, the mathematics topics were harder than those in the YGS. Even more questions harder for Umut that were about geometriy. *Time management* was another issue. The extra time given to visually impaired students was 30 minutes in total for the two hours long examination; however, it was not enough for solving all of the questions. Therefore, he said that he would prefer to have the exam questions in the Braille form and to have professional help from specialized teachers when he needed it during the examination. Moreover, Rabia had an unfortunate experience that affected her exam result, in general. She told me that her first problem was bringing the lesson materials to the examination. She said that:

> Although I was prepared for that situation, it bothered me really deeply in the exam day. Before examination, I called OSYM [examination center] and asked if we were allowed to bring our materials such as a Braille tablet, special pen for writing, and Braille papers. They confirmed that we were allowed to. I also took a print out of my request letter in case the staff was unaware of this issue. However, the staff did not know the regulation and they took my materials rudely before the examination. They brought them back after one hour. This situation disturbed me deeply. They gave it back during the examination after I lost an hour. Nothing changed positively after that.

To conclude, the visually impaired students suffered from the assessment system in general. They believed that the exam questions in the high school examinations did not directly assess their understanding. Location order, exam discipline, time were some of the most important problems.

Perceptions on equality

The participants indicated that they could not get enough out of the teaching styles in the classroom, their learning style was different from the sighted students and teachers had limited knowledge. The participants added that they could not use the materials effectively in mathematics lessons. Therefore, the participants concluded that they could not benefit from their high school mathematics lessons because they were dealing with more problems compared to the sighted students. In this part, only the participants' views on equity in the mathematics education were presented.

Cem said that:

> It is not fair. For example, I am getting an equal education; the curriculum, the classrooms are the same. However, because my disability and abilities are different from the others', it is unfair. The education should also be shaped according to my needs.

Emre added that:

> We are using a different writing style and different alphabet. Teachers do not know how to refer to us. We are separated from the sighted friends in this regard at least. Therefore, the education becomes unequal at that point.

Umut thought that the education system was not fair because it was equal. He asked:

> In regards to equality, we need to think about for whom the education system was designed and who could benefit from it. If it was designed for visually impaired students, yes, we are equal with sighted ones; but if not, then we are not equal.

Rabia answered:

> Teachers do not care about our learning in the classroom. We do not have a teacher who teaches the class and me at the same time. I do not think there is equality. Teachers always give the same excuse; *the class is so crowded, how can I give you special attention at the same time?* I felt like I was abandoned in the classroom.

CHAPTER 5: DISCUSSION

Introduction

The findings of the study indicated that the visually impaired students thought they were not equal with the sighted students. The social needs of visually impaired students have been successfully met through inclusive education while their academic problems have been far away from being resolved. In this chapter, the main findings will be discussed in reference to the literature.

Overview of the study

The main purpose of this study was to explore the academic and social challenges of visually impaired students in learning high school mathematics. The study was based on the equality principle in mathematics education. The sample consisted of four visually impaired students who took mathematics education in the inclusive classrooms. The sample selection was convenient due to the limitations on reaching participants. I conducted five prolonged-interviews, observations, and tutoring periods for each participant to collect the data and witness their problems. The human instrument was used for data collection. The data was analyzed by the constant comparison method by referring to qualitative analysis. As a result of analysis, the themes and categories emerged, which supplied the research questions and suggestions for further studies. As a result of the study, the social benefits and academic challenges were explored.

Major findings

There were three major findings in this study.

1. Inclusive education is beneficial for increasing the social awareness of visually impaired students as well as that of sighted students.
2. Inclusive education is not successfully addressing the academic needs of the visually impaired students.
3. The assessment system is not appropriate for assessing visually impaired student knowledge and skills in high school mathematics.

Discussion of the major findings

Inclusive education is beneficial for increasing the social level and awareness of the visually impaired students and sighted students

The finding with respect to participants' positive evaluation of inclusive education can be explained with their satisfaction with the quality of the interaction between sighted and visually impaired students (Buhagiar & Tanti, 2013). Inclusive education creates an environment that increases social awareness of visually impaired and sighted students and allows them to share their experiences (Sucuoğlu & Özokçu, 2005). In this environment, both sides realize their own personality, skills, needs, and potential; increasing their self-esteem (Freeland, Emerson, Curtis, & Fogarty, 2010). In inclusive education, visually impaired students may understand the importance of being explicit in describing their needs and problems and the ways of socializing and constructing a network with their peers (Kef, 2002). The sighted students may observe the problems that visually impaired students are faced with and create solutions for these problems; therefore, they increase their social awareness. Moreover, they may share experiences by doing group work or study lessons

together for more insightful experiences. Peer-teaching can be beneficial for both sides from studying together (Buhagiar & Tanti, 2011). By increasing social awareness, inclusive education may be beneficial for both sides in preparing them for a social life.

Inclusive education is not addressing the individual academic needs of the visually impaired students

The finding with respect to participants' poor evaluation of their teachers' instructional techniques can be explained with the limited teaching knowledge of the practitioners (Kargın, Acarlar, & Sucuoğlu, 2004). Mathematics teachers may not be qualified enough to teach visually impaired students, or knowledgeable enough about the use of materials for inclusive education (Rosenblum & Herzberg, 2011; Spindler, 2006). Mathematics teachers may show resistance for learning methods which they are not used to (Spindler, 2006), and may rely too much on a *trial and error* method while teaching visually impaired students (Kohanova, 2008). They may not have enough experience or pedagogical content knowledge for teaching visually impaired students (Ball, Simons, Wu, Simon, Whitehurst, & Yun, 2008). Also, it may be speculated that teachers cannot resist the urge to find a method that works for all students in the same classroom (Hill, Rowan, & Ball, 2005).

Another reason that explains this finding is the use of inappropriate materials in mathematics classrooms (Spindler, 2006). When the lesson materials are not selected correctly, the visually impaired students may not fulfill their potential in mathematics lessons (Buhagiar & Tanti, 2013). Many materials that visually impaired students use for learning mathematics are not specifically designed for mathematical content

(Karshmer & Bledsoe, 2002). The materials that visually impaired students use needs to be tactile or to have voice supported (Rozenblum & Herzberg, 2011).

Although the most common material is the Braille alphabet, it also consisted of some problems related to its linearity and complexity (Karshmer, Gupta, Pontelli, 2007). The long length of representation of mathematical notations because of its linearity (Karshmer, Gupta, & Pontelli, 2007), the bigger size of the text-books, and the reading proficiency errors because of the translation to Braille alphabet (Rosenblum, Lewis, & D'Andrea, 2010) are likely to create problems such as wasting of time, in accuracy, and moving heavy materials (Smith & Amato, 2012). The problems that are caused from the use of Braille in mathematics lessons may be due to the design of the Braille alphabet which is for writing linear texts (Karshmer, Gupta, & Pontelli, 2007). Moreover, the use of technology is important for visually impaired students' success in mathematics because they have problems with other materials; books and Braille (Cooper & Nichols, 2007). However, they are not designed for mathematics lessons, either. The voice recorder and screen reader programs may be beneficial for their learning mathematical topics and using the web-resources (Gürel, 2011). However, the screen reading programs (JAWS) also have problems with reading mathematical notations and calculations, because it is not designed for mathematical content and it consisted of several reading problems (Cliffe, 2009).

The frequent use of the whiteboard, the use of uncertain directional cues (this, that), the limited use of available lesson materials (Rowlett, 2010), use of assistive technology in the lesson create problems for visually impaired students' academic success (Quek & Mcneill, 2006). In this case, students may be redirected too much to

self-learning which can be only a temporary solution (Zhou, Parker, Smith, & Griffin-Shirley, 2011).

The finding with respect to the participants' poor evaluation of their academic levels can be explained with the time consuming nature of their learning process (Gün, 2013). Visually impaired students are tactile and kinesthetic learners that cannot learn when instruction is loaded with visual elements. When instruction focuses on abstract knowledge and visual content (especially geometrical parts), this presents a challenge for visually impaired students (Rosenblum & Herzberg, 2011; RNIB, 2011). Especially when multi-representations are used as effective strategies, and visualization takes the important part, the visually impaired students can see themselves in a disadvantage (Buhagiar & Tanti, 2013).

Teaching a visually impaired student can be a time consuming process where giving explicit explanations, avoiding the uncertain directional cue use, allowing enough time for students to take notes, teaching with simple instructions, explicitly defining the guiding problems, allowing for repetition, encouraging students to review the content regularly, and using the appropriate materials during the classroom are essential (Spindler, 2006). In learning the visual content, visually impaired students feel like they need to complete a puzzle that they have never seen before (Levy, 2009). Visually impaired students lose valuable time in developing basic cognitive levels; understanding the definitions, demonstrating what they have learned, and applying their mathematical knowledge (Bülbül, Graip, Cansu, & Demirtaş, 2012). Instead of mastering the basic knowledge quickly, they have to be guess the given knowledge, confirm it with the students to determine if they understand it correctly,

and use their understanding by illustrating it in their own way. Because the visual content contradicts the learning style of visually impaired students, it may be speculated that they will always have serious problems in learning high school mathematics (Klingenberg, Fosse, & Augestad, 2012; Quek & Mcneill, 2006; Rozenblum & Herzberg, 2011).

Another explanation of the low mathematic performance can be due to their lack of motivation for learning certain topics in mathematics. The visually impaired students are exempt from the visual based questions in the mathematics examinations; therefore, they miss most of the visual based questions in the examinations (Bülbül, 2009). Since the exams are an important motivation for students (Ryan & Deci, 2000), during the high school mathematics lessons, the visually impaired students may be demotivated in learning certain mathematical content such as geometry or functions even the content is presented in the classroom without visual elements (Hannan, 2007). Therefore, students can feel demotivated and become reluctant to learn such content (Meece, Anderman, & Anderman, 2006).

The assessment system is not appropriate for assessing visually impaired student knowledge and skills in high school mathematics

The finding with respect to participants' poor evaluation of assessment tasks used in mathematics classrooms or large scale assessment can be explained with the limited use of the effective methods to prepare students for these tests (Zebehazy, Zigmond, & Zimmerman, 2012). Differentiated assessment is as important as the differentiated instruction that gives students the opportunity for displaying their understanding of the subject-matter (Anthony & Walshaw, 2009). The existing system emphasizes

assessing student performance in factual, conceptual, and process knowledge (Kulm, 1994). In Turkey, after the 2005 curriculum reforms, the assessment system was planned to be improved for efficiency and the specific learning objectives and outcomes were replaced by the skills and abilities for increasing the academic success of students. However, in practice, these effective assessment methods are not widely used in Turkish mathematics classrooms (Ayas, Aydın, & Corlu, 2013). In high school exams, the same written examination is given to all students in a classroom for assessing their performances, and in large-scale exams, the questions are also given in the written form and are not appropriately presented for visually impaired students (Bülbül, 2009; Hannan, 2007). When students are given a written examination for auditory learners, visually impaired learners may have problems in answering the questions and expressing their knowledge (Klingenberg Fosse, & Augestad, 2012). In this case, the reader is needed to bridge the gap and be the eyes of visually impaired students (Ay, 2009). Thus, visually impaired students may lose time and have a reader problem; and they may be in the disadvantage (Buhagiar & Tanti, 2013; Hansen, Shute, & Landau, 2010). However, because there are no criteria for being a reader, the readers may be ignorant, unprofessional just unknowledgeable about how to read the questions; or their good intentions to help the visually impaired students may cause more problems (Ay, 2009; Bülbül, 2009). Visually impaired students have to tackle more challenges in exams compared to sighted students (Ay, 2009; Hannan, 2007). To conclude, the problems related with the assessment of student performance in mathematics can be best explained with the limited use of differentiated assessment.

Another explanation for poor evaluation of the mathematics assessment can be explained with the unprofessional attitudes of mathematics teachers towards the examination of visually impaired students' learning performance (Durna, 2012). The national curriculum in mathematical context is extended in that it puts pressure on mathematics teachers to cover Turkish curriculum makes mathematics teachers busy enough (Yenilmez & Bozkurt, 2006). Preparing additional questions or even just modifying the exam questions or reading these questions for visually impaired students increase the workload of the teachers. Teachers can postpone exams or just be reluctant to deal with visually impaired students (Gün, 2013). In conclusion, teachers may take the evaluation of visually impaired students' mathematical performance without much consideration of their true ability (Ay, 2009).

Implications for practice

In this study, the social and academic challenges of visually impaired students in learning mathematics are explored. The discussions of the findings shows that the social needs of visually impaired students have been successfully met through inclusive education while their academic needs have not.

In order to address the gap between the laws and practice, the most important responsibility belongs to teachers. According to the results, I believe that teachers should be more informed about the differentiated education for visually impaired students. The teachers can increase their pedagogical content knowledge in teaching mathematics to visually impaired students. Moreover, the large scale assessment system is another issue that visually impaired students has challenges with.

Therefore, the large scale assessment system should be re-modified according to the problems presented in the study and innovative solutions should be developed.

The results may be informative for mathematics teachers so that they can learn the needs and challenges of visually impaired students. Teachers can differentiate their teaching methods and assess student learning in mathematics lessons. The lessons can be enriched by appropriate materials and technological support. Moreover, teachers should also need to be informed about the useful for assistive technologies and how these technologies can be used. In short, teachers should have enough technological pedagogical knowledge for assisting visually impaired students during mathematics lessons. In fact, the teachers who have pedagogical content knowledge in teaching mathematics to visually impaired students should be selected.

Parents of visually impaired students can look deep into the challenges presented in this study and support their children. Parents can work collaboratively with teachers and give the required help for their children at home. However, parents should be informed about the details of inclusive education and its positive effect on their children.

Lastly, the current materials of visually impaired students use can be developed for mathematical content. There can be new designs for mathematical content or new materials can be developed by referring to their challenges, and students can be informed about the effective use of some new designs in mathematics lessons. Moreover, some projects can be extended to address the challenges of visually impaired students. For example, the FATIH Project which enriches the mathematics

lessons with advanced technologies can be instrumental, if the project can also focus on the learning needs of visually impaired students.

Implications for further research

This study explored the academic and social challenges of visually impaired students in learning high school mathematics. The study only focused on the experiences and reflections of visually impaired students about their academic and social achievement in high school mathematics classrooms. However, inclusive education is a team effort between the students, teachers, parents, and other policy makers. Therefore, for future researchers, it can be suggested to focus on the other parts of this team effort and their dependence to each other. Moreover, the classroom observations and teacher perspectives, and parent guidance are other ways to extend what is established at the end of the current study.

Limitations

This section explains the limitations of this study. There were two limitations: observation of regular school environment, and sampling and budget.

First, I could not observe how inclusive education is implemented in the regular school environment. Because of the sensitivity of the subject, the participants specifically asked me not to observe them in their regular classroom environment.

Second, there were few visually impaired students who agreed to attend the research study. The inclusive education was a controversial issue and the participants belonged to an isolated group. It was attempted to eliminate this limitation by

collecting other artifacts. Although reaching the information rich participants was a problem, the data were enriched by observations and tutoring sessions. The findings could not be generalized to the whole of visually impaired students in Turkey. However, a larger budget was required to reach participants across Turkey.

Conclusion

The working hypothesis was formed at the beginning of the study and until the end, it changed and evolved. In the end, the conclusion holds that visually impaired and sighted students are not equal in inclusive mathematics classrooms. Students have important academic and social problems in mathematics lessons; moreover, they cannot reach the materials that are definitely beneficial for them in mathematics lessons. The evaluation system also creates new challenges for them; therefore, visually impaired students do not think that they are equal to sighted students.

The outcomes of the study show that visually impaired students are not equal with sighted students in inclusive mathematics classrooms. Therefore, they must overcome several challenges to be successful in mathematics. Visually impaired students illustrate the major problems in areas, such as teaching methods, learning strategies, use of material, assessment types, and use of technology. According to the problems, we are expected to emerge solutions immediately and make the classrooms equal for all students no matter they are with or without disability.

REFERENCES

Abner, G. H., & Lahm, E. A. (2002). Implementation of assistive technology with students who are visually impaired: Teachers' readiness. *Journal of Visual Impairment & Blindness, 96(2),* 98-105.

Agbeko, F. B. (2012). *Teaching of mathematical concepts to children with low vision in some selected schools in Hohoe municipality in Ghana* (Unpublished doctoral dissertation). University of Education, Winneba, Ghana.

Akçamete, A. G., Kayhan, N., & Sen, M. (2012). Pre-school special education practices in European Union Countries and Turkey. *Procedia-Social and Behavioral Sciences, 46,* 1510-1516.

Akçamete, G. (1998). *Türkiye'de özel eğitim [Special education in Turkey].* [Online textbook]. Retrieved from http://w2.anadolu.edu.tr/aos/kitap/IOLTP/1267/unite12.pdf.

Allen, E., & Cowdery, G. (2011). *The exceptional child: Inclusion in early childhood education.* New York: Cengage Learning.

Allexsaht-Snider, M., & Hart, L. E. (2001). "Mathematics for all": How do we get there? *Theory into Practice, 40(2),* 93-101.

Alsmeyer, A. M. (1994). *An analysis of institutional commitment among older alumni of Texas A&M University* (Unpublished doctoral dissertation). Texas A&M University, College Station.

Amato, S., & Rosenblum, L. P. (2004). Preparation in and use of the Nemeth braille code for mathematics by teachers of students with visual impairments. *Journal of Visual Impairment & Blindness, 98(8),* 484-495.

American Foundation for the Blind (2005). *Educating students with visual impairments for inclusion in society: A paper on the inclusion of students with visual impairments.* [online report] Retrieved from: http://www.afb.org/info/programs-and-services/professional-development/teachers/inclusive-education/1235.

Anthony, G., & Walshaw, M. (2009). *Effective pedagogy in mathematics (Vol. 19).* Geneva, Switzerland: International Bureau of Education.

Aron, L., & Loprest, P. (2012). Disability and the education system. *The Future of Children, 22(*1*),* 97-122.

Augestad, L. B., Klingenberg, O., & Fosse, P. (2012). Braille use among Norwegian children from 1967 to 2007: Trends in the underlying causes. *Acta Ophthalmologica, 90(*5*),* 428-434.

Ay, S. (2009). *Görme engelliler için yeni bir arayüz tasarımı* (Unpublished master thesis). Fırat University, Elazığ, Turkey.

Ayas, A., Aydın, E., & Çorlu, M. S. (2013). Mathematics and science assessment in the Turkish educational system: An overview. *Middle Grades Research Journal, 8(*2*),* 11-23.

Baki, A., & Çakıroğlu, Ü. (2010). Learning objects in high school mathematics classrooms: Implementation and evaluation. *Computers & Education, 55(*4*),* 1459-1469.

Ball, D. L., Simons, J., Wu, H. H., Simon, R., Whitehurst, G. J., & Yun, J. (2008). *Report of the task group on teachers and teacher education*. The National Mathematics Advisory Panel Report of the Task Groups and Sub-Committees. Department of Education, USA. Retrieved from http://www2.ed.gov/about/bdscomm/list/mathpanel/reports.html.

Barbe, W. B., Swassing, R. H., & Milone, M. N. (1979). *Teaching through modality strengths: Concepts and practices*. Columbus, OH: Zaner-Bloser..

Bartel T. G., & Meyer, M. Y. (2008). Addressing the equity principle in the mathematics classroom. *Mathematics Teacher, 101(*8*),* 604-608.

Batu, S. (2008). Kaynaştırma ve destek özel eğitim hizmetleri [Inclusion and special education support services]. *Özel Eğitim, 2(*4*),* 89-107.

Bogdan, R. C., & Biklen, S. K. (1982). *Qualitative research for education: An introduction to theory and methods.* Boston, MA: Allyn and Bacon.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn?* Washington, DC: National Academy Press.

Buhagiar, M. B., & Tanti, M. B. (2013). Working toward the inclusion of blind students in Malta: The case of mathematics classrooms. *Eğitimde Kuram ve Uygulama*, *7*(1), 59-78.

Bülbül, M. Ş. (2009). Doğuştan görme engellinin Türkiye'de fizikçi olabilme ihtimali. *Eleştirel Pedagoji*, *2(7),* 52-59.

Bülbül, M. Ş. (2009). *Görme engelliler ve fizik öğretimi. Türkiye'de fizik eğitimi alanındaki tecrübeler, sorunlar, çözümler ve öneriler [Visually impairers and physics teaching. Experiences, problems, solutions and recommendations in the field of physical education in Turkey*]. Ankara : Murat Kitabevi.

Bülbül, M. Ş., Garip, B., Cansu, Ü., & Demirtaş, D. (2012). Mathematics instructional materials designed for visually impaired students: Needle page. *Elementary Education Online, 11(*4*),* 1–9. Retrieved from http://ilkogretim-online.org.tr/vol11say4/v11s4ou1.pdf.

Chronaki, A. (2011). Disrupting 'development' as the quality/equity discourse: Cyborgs and subalterns in school technoscience. In *Mapping equity and quality in mathematics education* (pp. 3-19). Springer Netherlands.

Cliffe, E. (2009). Accessibility of mathematical resources: The technology gap. *MSOR Connections, 9*(4), 37-42.

Cooper, H. L., & Nichols, S. K. (2007). Technology and early Braille literacy: Using the mountbatten pro brailler in primary-grade classrooms. *Journal of Visual Impairment & Blindness, 101*(1), 22-31.

Cox, P. R., & Dykes, M. K. (2001). Effective classroom adaptations for students with visual impairments. *Teaching Exceptional Children, 33(*6*)*, 68-74.

Creswell, J. W. (2002). *Educational Research: Planning, conducting, and evaluating quantitative and qualitative research.* Saddle River, NJ: Prentice Hall.

Crockett, J. B., & Kauffman, J. M. (1999). *The least restrictive environment: Its origins and interpretations in special education*. Matwah, NJ: Lawrance Erlbaum Associations.

Demir, M. K., & Açar, S. (2011). Kaynaştırma eğitimi konusunda tecrübeli sinif öğretmenlerinin görüşleri [Experienced class teachers' views on inclusive education]. *Kastamonu Eğitim Dergisi, 19(*3*)*, 719-732.

Dunn, R., Honigsfeld, A., Doolan, L. S., Bostrom, L., Russo, K., Schiering, M. S., Suh, B., & Tenedero, H. (2009). Impact of learning-style instructional strategies on students' achievement and attitudes: Perceptions of educators in diverse institutions. *A Journal of Educational Strategies, Issues and Ideas, 82*(3), 135-140.

Durna, G. (2012). The impact of an integrated education upon visually disabled students (Unpublished master thesis). Fatih University, Istanbul, Turkey.

Emanuelsson, I. (2003) Differentiation, special education and equality: A longitudinal study of self-concepts and school careers of students in difficulties and with or without special education support experiences, *European Educational Research Journal*, *2(2)*, 245-261.

Erlandson, D., Harris, E. L., Skipper, B. L., & Allen, D. S. (1993). Quality criteria for a naturalistic study. *Doing Naturalistic Inquiry* (pp. 131-162). Newbury Park, CA: Sage.

Ernest, P. (2002). Empowerment in Mathematics Education. *Philosophy of Mathematics Education Journal*, *15*, 1-16.

Ersoy, Y. (2003). Matematik okur yazarlığı-II: Hedefler, geliştirilecek yetiler ve beceriler [Mathematical literacy-II: Objectives, ability and skills to be developed]. *Matematikçiler Derneği*. Retrieved from http://www.matder.org.tr.

Freeland, A. L., Emerson, R. W., Curtis, A. B., & Fogarty, K. (2010). Exploring the relationship between access technology and standardized test scores for youths with visual impairments: Secondary analysis of the national longitudinal transition study. *Journal of Visual Impairment & Blindness, 104(*3*)*, 170-182.

Freire, A. P., Linhalis, F., Bianchini, S. L., Fortes, R. P., & Pimentel, M. D. G. C. (2010). Revealing the whiteboard to blind students: An inclusive approach to provide mediation in synchronous e-learning activities. *Computers & Education*, *54(*4*)*, 866-876.

Goldin, G.A. (2003). Representation in school mathematics: A unifying research perspective. In J. Kilpatrick, M. G. Martin, & S. Schifter (Eds.), *A research*

companion to principles and standards for school mathematics (pp. 275-286). Reston, VA: National Council of Teachers of Mathematics.

Gonzalez Gonzalez, E. M. (2004). *Perceptions of selected senior administrators of higher education institutions in Mexico regarding needed administrative competencies.* (Unpublished doctoral dissertation). Texas A&M University, Texas College Station.

Gözün, Ö., & Yıkmış, A. (2004). Öğretmen adaylarının kaynaştırma konusunda bilgilendirilmelerinin kaynaştırmaya yönelik tutumlarının değişimindeki etkililiği [The change in the efficiency of the attitudes of pre-service teachers in inclusive education]. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi, 5(*2*),* 65-77.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods, 18(*1*),* 59-82.

Gün, Z. (2013). *Ülkemizdeki kaynaştırma eğitiminin matematik eğitiminde yeri ve önemi [The place and importance of inclusive education in mathematics education in our country]* (Unpublished master dissertation). Fırat University, Elazığ, Turkey.

Gurel, O. (2011). Görme engelli çocuklar için eğitim ortamlarının düzenlenmesi [Regulation in education environment for visually impaired students]. *Eğitimci Dergisi, 1(*8*),* 18-21.

Hall, T. (2002). Differentiated instruction. *National Center on Accessing the General Curriculum*. Wakefield, MA: National Center on Accessing the General Curriculum. Retrieved from http://www.cast.org/publications/ncac/ncac_diffinstruc.html.

Hannan, C. K. (2007). Exploring assessment processes in specialized schools for students who are visually impaired. *Journal of Visual Impairment & Blindness, 101(*2*),* 69-79.

Hansen, E. G., Shute, V. J., & Landau, S. (2010). An assessment-for-learning system in mathematics for individuals with visual impairments. *Journal of Visual Impairment & Blindness*, *104(*5*),* 275-286.

Heacox, D. (2002). *Differentiating instruction in the regular classroom: How to reach and teach all learners, grades 3-12.* Minneapolis, MN: Free Spirit Publishing.

Herbel-Eisenmann, B., Choppin, J., Wagner, D., & Pimm, D. (2012). *Equity in discourse for mathematics education: Theories, practices, and policies.* New York, NY: Springer.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42(*2*),* 371-406.

Jonassen, D.H., & Grabowski, B.L. (1993). *Handbook of individual differences, learning, and instruction*. Hillsdale, NJ: Lawrence Erlbaum.

Kane, M., Berryman, S., Goslin, D., & Meltzer, A. (1990). *Identifying and describing the skills required by work.* The Secretary's Commission on Achieving Necessary Skills. Washington, DC: Author.

Kapperman, G., Sticken, J., & Smith, T. J. (2011). The effectiveness of the Nemeth code tutorial for the Braille note. *Insight: Research & Practice in Visual Impairment & Blindness*, *4(*1*),* 22-28.

Kargın, T. (2004). Baş Makale: Kaynaştırma: Tanımı, gelişimi ve ilkeleri [Leading article: Inclusion: Definition, development and policy]. *Özel Eğitim Dergisi, 5(*2*),* 1-13.

Kargın, T., Acarlar, F., & Sucuoğlu, B. (2005). Öğretmen, yönetici ve anne babaların kaynaştırma uygulamalarına ilişkin görüşlerinin belirlenmesi [Teacher, administer, and parent perspectives according to the implications of inclusive education]. *Özel Eğitim Dergisi, 4(*2*),* 55-76.

Karshmer, A. I., & Bledsoe, C. (2002). *Access to mathematics by blind students.* ICCHP '02 proceedings of the 8th international conference on computers helping people with special needs. Springer, Verlag Berlin Heidelberg London: UK. Retrieved from http://www.catea.gatech.edu/scitrain/kb/FullText_Articles/Access2MathByBlindStudents.pdf.

Karshmer, A., Gupta, G., & Pontelli, E. (2007). Mathematics and accessibility: A survey. *9th International Conference on Computers Helping People with Special Needs, 3118*, 664-669.

Kef, S. (2002). Psychosocial adjustment and the meaning of social support for visually impaired adolescents. *Journal of Visual Impairment & Blindness, 96(*1*),* 22-37.

Kilpatrick, J. (2000). Scientific solidarity today and tomorrow. *One Hundred Years of L'Enseignement Mathématique, 20*, 317.

Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. National Academy Press, Washington: DC.

Kohanova, I. (2008). *The ways of teaching mathematics to visually impaired students*. Bratislava, Slovakia: Comenius University.

Kolb, D. (1984). *Experiential learning: Experience as the source of learning and development.* Englewood Cliffs, NJ: Prentice Hall.

Kulm, G. (1994). *Mathematics assessment: What works in the classroom*? San Francisco, CA: Jossey-Bass Publication.

Kurz, A., Elliott, S. N., Lemons, C. J., Zigmond, N., Kloo, A., & Kettler, R. J. (2014). Assessing opportunity-to-learn for students with disabilities in general and special education classes. *Assessment for Effective Intervention*. Tempe, AZ: Arizona State University.

Levy, H. M. (2008). Meeting the needs of all students through differentiated instruction: Helping every child reach and exceed standards. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *81(*4*),* 161-164.

Lincoln, Y.S., & Guba, E.G. (1985). Naturalistic inquiry. Newbury Park, CA: Sage.

Loewenberg Ball, D. (2003). *Mathematical proficiency for all students: toward a strategic research and development program in mathematics education.* Mathematics Study Panel, Santa Monica, CA: RAND.

Mamona-Downs, J., & Downs, M. (2002). Advanced mathematical thinking with a special reference to reflection on mathematical structure. In L. D. English (Ed.), *Handbook of international research in mathematics education* (pp. 165-195). Mahwah, NJ: Erlbaum.

Marshall, C., & Rossman, G. B. (2010). *Designing qualitative research* (5th ed). Thousand Oaks, CA: Sage.

Martin, T. S., & Herrera, T. (2007). *Mathematics teaching today: Improving practice, improving student learning*. Reston, VA : National Council of Teachers of Mathematics.

Meece, J. L., Anderman, E. M., & Anderman, L. H. (2006). Classroom goal structure, student motivation, and academic achievement. *Annual Reviews Psychology, 57,* 487-503.

Merriam, S. B. (1988). *Case study research in education: A qualitative approach*. San Francisco: Jossey-Bass.

Ministary of National Education (2006). *Özel eğitim hizmetler yönetmeliği regulation [Education regulations of the disabled students]*. Ankara, Turkey: Milli Eğitim Basımevi.

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2008). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods, 1(*2*),* 13-22.

National Council of Teachers of Mathematics (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics (2000). *A vision for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Retrieved from http://www.nctm.org/standards/content.aspx?id=26805.

National Council of Teachers of Mathematics. (2007). *Mathematics teaching today: Improving practice, improving student learning* (2nd ed.). Reston, VA: Author.

National Council on Education and the Disciplines. (2001). *Mathematics and democracy: The case for quantitative literacy.* Princeton, NJ: Author.

Organisation for Economic Co-Operation and Development. (1995). *Integrating students with special needs into mainstream schools*. Washington, DC: OECD Publications and Information Centre.

Özaydın, L., & Çolak, A. (2011). Okul öncesi öğretmenlerinin kaynaştırma eğitimine ve "okul öncesi eğitimde kaynaştırma eğitimi hizmet içi eğitim programı" na ilişkin görüşleri [The views of preschool teachers on inclusive education and "inclusive education in preschool education in-service training program"]. *Kalem Eğitim ve İnsan Bilimleri Dergisi*, *1(*1*)*, 189-226.

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles concepts and evidence. *Psychological Science in the Public Interest*, *9(*3*)*, 105-119.

Patton, M. Q. (2002). *Qualitative evaluation and research methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Patton, M. Q. (2005). *Qualitative research*. Thousand Oaks, CA: Sage Publications.

Phinias, T., Jeriphanos, M., & Kudakwashe, M. (2013). Inclusion and the world of disability: A case study of Zaka Central Cluster, Masvingo, Zimbabwe. *Journal of African Studies and Development*, *5(*8*)*, 241-249.

Povey, H. (2010). Teaching for equity, teaching for mathematical engagement. *Philosophy of Mathematics Education Journal*, *25*. Retrieved from http://people.exeter.ac.uk/PErnest/pome25/Hilary%20Povey%20%20Teaching%20fo.

Prime Minister Administration for Disabled People (2005). Turkish disability act. Retrieved from http://www.ozida.gov.tr/ENG/?menu=legislation&sayfa=act

Quek, F., & McNeill, D. (2006). Embodiment awareness, mathematics discourse, and the blind. *Annuals of the New York Academy of Sciences*, *1093(*1*)*, 266-279.

Rosenblum, L. P., & Herzberg, T. (2011). Accuracy and techniques in the preparation of mathematics worksheets for tactile learners. *Journal of Visual Impairment & Blindness, 105(*7*),* 402-413.

Rosenblum, L. P., Lewis, S., & Mary D'Andrea, F. (2010). Current practices in instruction in the literary Braille code university personnel preparation programs. *Journal of Visual Impairment & Blindness, 104(*9*),* 523-532.

Rowlett, P. (2010). Visual impairment in maths, stats and operational research. *MSOR Connections, 10(*2*),* 45-48.

Royal National Institute of Blind People (2011). *Teaching maths to pupils with vision impairment*. [Online report] Retrieved from http://www.pathstoliteracy.org/math-literacy/content/resources/teaching-maths-pupils-vision-impairment.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55(*1*),* 68.

Sadioğlu, Ö., Batu, S., Bilgin, A., & Oksal, A. (2013). Problems, expectations, and suggestions of elementary teachers regarding inclusion. *Educational Sciences: Theory & Practice, 13(*3*),* 1760-1765.

Sahin, M., & Yorek, N. (2009). Teaching Science to Visually Impaired Students: A Small-Scale Qualitative Study. *Online Submission, 6(*4*),* 19-26.

Sampson, D., Karagiannidis, C., & Kinshuk, D. (2010). Personalized learning: Educational, technological and standardization perspective. *Digital Education Review, 4,* 24-39.

Sart, H., Ala H., Yazlık, Ö. & Yılmaz, F.K. (2004). Türkiye kaynaştırma eğitiminde nerede?: Eğitimciye öneriler [What is the place of inclusive education in

Turkey?: Suggestions for educator]. *XIII. Ulusal Eğitim Bilimleri Kurultayı*, Malatya, Turkey.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334-370). New York, NY: Macmillan.

Schoenfeld, A. H. (2002). Making mathematics work for all children: Issues of standards, testing, and equity. *Educational Researcher, 31(*1*),* 13-25.

Secretary's Commission on Achieving Necessary Skills. (1991). *What work requires of schools: A SCANS report for America 2000.* Washington, DC: U.S. Department of Labor. [Online report] Retrieved from http://wdr.doleta.gov/SCANS/whatwork/whatwork.pdf.

Seidman, I. (2012). *Interviewing as qualitative research: A guide for researchers in education and the social sciences*. Teachers college press. [Online book] Retrieved from http://www.worldcat.org/title/interviewing-as-qualitative-research-a-guide-for-researchers-in-education-and-the-social-sciences/oclc/812791743/viewport.

Smith, D. W., Kelley, P., Maushak, N. J., Griffin-Shirley, N., & Lan, W. Y. (2009). Assistive technology competencies for teachers of students with visual impairments. *Journal of Visual Impairment & Blindness*, *103(*8*),* 457-469.

Spence, P. R. (2009). Collaborative information use: Knowledge creation in teams. *International Conference on Computer and Information Science, 45(*1*),* 142-158.

Spindler, R. (2006). Teaching mathematics to a student who is blind. *Teaching Mathematics and Its Applications*, *25(*3*),* 120-126.

Spradley, J. P. (1980). *Participant observation*. New York, NY: Holt, Rinehart and Winston.

Steen, L. A. (2001). Mathematics and numeracy: Two literacies, one language. *The Mathematics Educator, 6(*1*),* 10-16.

Sucuoğlu, B. (2004). Türkiye'de kaynaştırma uygulamaları: Yayınlar/araştırmalar [Inclusion applications in Turkey] (1980-2005). *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi, 5(*2*),* 15-23.

Tanti, M. (2006). *Teaching mathematics to a blind student: A case study* (Unpublished master thesis). University of Exeter, Exeter, UK.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27(*2*),* 237-246.

Tomlinson, C. A. (1999). *Differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tortop, H. S. (2012). Olağanüstü üstün yetenekli öğrencilerin eğitim sürecinde radikal hızlandırma ve Türkiye'nin durumu [The radical acceleration in the educational process of extraordinary gifted students and the situation in Turkey]. *Journal of Higher Education and Science, 2(*2*),* 106-113.

Wang, H. L. (2009). Should all students with special educational needs (SEN) be included in mainstream education provision?-A critical analysis. *International Education Studies, 2(*4*),* 154.

World Bank (2012). *World development report 2013: Jobs*. New challenges for tertiary education, World Bank: Washington. Retrieved from http://www.worldbank.org/wdr2013.

World Health Organization (2004). *International statistical classification of diseases, injuries and causes of death: Tenth revision*. Geneva: WHO. [Online report] Retrieved from http://apps.who.int/iris/bitstream/10665/42980/1/9241546530_eng.pdf.

Yenilmez, K., & Bozkurt, E. (2006). Matematik eğitiminde çoklu zeka kuramına yönelik öğretmen düşünceleri [The perceptions of teachers according to the multiple intelligence theory in mathematics education]. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi, 12*, 90-103.

Zebehazy, K. T., Zigmond, N., & Zimmerman, G. J. (2012). Performance measurement and accommodation: students with visual impairments on Pennsylvania's alternate assessment. *Journal of Visual Impairment & Blindness, 106(*1*)*, 17-30.

Zhou, L., Parker, A. T., Smith, D. W., & Griffin-Shirley, N. (2011). Assistive technology for students with visual impairments: Challenges and needs in teachers' preparation programs and practice. *Journal of Visual Impairment & Blindness, 105(*4*)*, 197-210.

APPENDICES

APPENDIX A: Interview questions

Interviewee Background

How long have you been visually impaired?

How long have you been studying mathematics?

What is your education background? Briefly explain.

When did you learn Braille alphabet? Do you use Nemeth code?

How long have you been prepared for the LGS/LYS?

Why did you choose studying mathematics (TM) instead of social science (TS) or language?

What is your highest degree in high school?

What is your highest degree in LGS/LYS in mathematics parts?

Which field do you want to study in university?

Learning Perspective

1. What do you think when you compare your learning of mathematics with other lessons?

What are your feelings about your learning process?

2. What resources do you use in studying mathematics? Tape record or Braille alphabet?

What about the books you use and available? What about CD?

3. When you compare the learning in mathematics and other lessons, which one is hard to understand? Which lesson is hard at secondly? Why?

4. How do you study geometry lessons?

5. Which questions do you solve in exams? Which are out of case?

Equity Principle

1. How do you compare yourself with sighted students in learning mathematics? What are the advantages and disadvantages of this situation?

2. Is there any different attitude towards to you from the sighted students? What kinds of attitudes is it? Are they positive or negative? From readers? Making easier or harder?

3. What do you think about the equity in classes? In the entrance of universities is there equal situation? Please give examples.

4. How was the exams in schools, what do you think about readers and what do you think in assessment process?

5. Where do you use mathematics in your real life? Do you have problems in your life?

Teaching and Learning Principle

1. What do you think about your mathematics teachers? According to their knowledge and teaching, what should be done? Are they qualified enough in special teaching methods to satisfy your needs about this special situation?

2. What are the challenges that you face with as a result? What are the major opportunities that you have?

3. Does your mathematics teachers give you challenge questions? Are the challenges hard enough for your learning?

4. How do your teachers prepare materials for your understanding? Do these materials helpful for you? Which activities are chosen and how they are helpful for your learning?

5. Do you have extra time for your learning or completing process in exams?

6. Did you have special teaching teacher in your school? Did they make tutoring in mathematics?

7. What do you think about reading and teaching the mathematical symbols? How do you give answers to the exams? How do you solve the mathematical problems?

Technology Principle

1. Describe which technology do you use for your learning process? How is it affective for your learning and answering mathematical questions?

2. Do you use web-based learning? How do you take an advantage of the internet or other software systems?

3. How frequently you use technology or other programs? Should the teaching learning process be combined with the technological resources?

4. Do you use any technological sources? Calculations, JAWS or any other rograms? Is there any source which is specified with mathematical concepts that you use?

APPENDIX B: Interview protocol

I. Preface

a. The interview date and place will be pre-arranged according to participants because they need to feel relax and safe. The expected interview conditions and the planned interview process will be explained for the best place.

b. I will explain the participants how much they are appreciated for attending volunteer interviews. I will explain the purpose of the interview, their rights for answering or not answering questions, asking other or clarification questions, and continuing or stopping the interview.

c. I will read the Informed Consent Documents to the participant and take verbal permission for taping the interview.

d. I will give information about recording; I will use it as a recall for the interview information; only I will listen what is recorded, others do not have permission; just the voice recorder will be used.

II. Ask descriptive information

Name:

School:

Date:

Descriptive Information:

-Age

-Gender

-Disability degree

-Years in inclusive education

III. Semi-structured Questions

Some of the questions that will guide the interviews are:

Learning Perspective

1. What do you think when you compare your learning of mathematics with other lessons?

What are your feelings about your learning process?

2. What resources do you use in studying mathematics? Tape record or Braille alphabet?

What about the books you use and available? What about CD?

3. When you compare the learning in mathematics and other lessons, which one is hard to understand? Which lesson is hard at secondly? Why?

4. How do you study geometry lessons?

5. Which questions do you solve in exams? Which are out of case?

Equity Principle

1. How do you compare yourself with sighted students in learning mathematics? What are the advantages and disadvantages of this situation?

2. Is there any different attitude towards to you from the sighted students? What kinds of attitudes is it? Are they positive or negative? From readers? Making easier or harder?

3. What do you think about the equity in classes? In the entrance of universities is there equal situation? Please give examples.

4. How was the exams in schools, what do you think about readers and what do you think in assessment process?

5. Where do you use mathematics in your real life? Do you have problems in your life?

Teaching and Learning Principle

1. What do you think about your mathematics teachers? According to their knowledge and teaching, what should be done? Are they qualified enough in special teaching methods to satisfy your needs about this special situation?

2. What are the challenges that you face with as a result? What are the major opportunities that you have?

3. Does your mathematics teachers give you challenge questions? Are the challenges hard enough for your learning?

4. How do your teachers prepare materials for your understanding? Do these materials helpful for you? Which activities are chosen and how they are helpful for your learning?

5. Do you have extra time for your learning or completing process in exams?

6. Did you have special teaching teacher in your school? Did they make tutoring in mathematics?

7. What do you think about reading and teaching the mathematical symbols? How do you give answers to the exams? How do you solve the mathematical problems?

Technology Principle

1. Describe which technology do you use for your learning process? How is it affective for your learning and answering mathematical questions?

2. Do you use web-based learning? How do you take an advantage of the internet or other software systems?

3. How frequently you use technology or other programs? Should the teaching learning process be combined with the technological resources?

4. Do you use any technological sources? Calculators, JAWS or any other programs? Is there any source which is specified with mathematical concepts that you use?

IV. Closure

a. Member check process

b. Any questions about the interview

c. What else that he/she would like to add

d. Reiteration of the confidentiality aspect of the interview

e. Thank them for their participation and their time to this study

APPENDIX C: Informed consent form

Informed Consent Document

The study, conducted by Gözde Irem Bayram; a graduate student in Bilkent University, is about exploring the academic and social challenges of visually impaired students in learning high school mathematics. The interviews are the major part of this study and I accept to be one of the participants to be conducted these interviews. I will help the researcher to collect information, to complete the requirements, and respond the interview questions for her thesis voluntarily. I understand that there will be no sanctions for my answers positively or negatively. The researcher will reserve my rights including my name, my answers, and my suggestions by keeping the content confidential.

The interviews will be conducted face-to-face and they will be lasted at least 90 minutes. A tape recorder will be used during the interviews for a recall for the interview information, and only the researcher will have a right to access this information. I have a choice to stop the interviews, to ask questions during and after interviews, refuse to answer questions, and there will be no sanction in the end.

I give my permission to be quoted in Gözde Irem Bayram's research publication.

_____ _____

Signature of Subject Date

The informed consent document is read to me and I asked my related concerns. I have had all my questions answered, and I voluntary agree to participate in this study. I have been given a copy of this consent form.

Signature of Subject	Date
Gözde İrem Bayram Bilkent University	Date
Assistant Professor Doctor M. Sencer Çorlu Bilkent University, Commitee Co-Chair	Date

APPENDIX D: Consent to be audio-taped

Audio-Tape Release Forms

I voluntarily permit to the researcher; Gözde İrem Bayram; to record the interviews by an audio-tape recorder. I understand the tapes will be kept for the transcription for data and the only access will be on the researcher; Gözde İrem Bayram. The tapes will be kept confidential and only kept in the computer of the researcher. The tapes will be erased, and the transcriptions will also be destroyed after the study was completed.

_____ _____

Signature of Subject Date

_____ _____

Signature of the Investigator Date

Refusal to be Audio-Taped

I do not want to be audio-taped during the interviews for the study conducted by Gözde İrem Bayram. I understand I will not receive compensation by such a refusal and I can continue to participate in the study.

_____ _____

Signature of Subject Date

_____ _____

Signature of the Investigator Date

APPENDIX E: Invitation letter to participants

<<Date>>

<<First>><<Last>>
<<Address>>
<<City>>, <<Zip>>

Dear <<First>> <<Last>>;

I am writing you for inviting to my thesis research study, which aims to explore the problems of visually impaired students in learning high school mathematics during their inclusive education.

I am a graduate student in Bilkent University and I am in the Mathematics education department. I am training to be a teacher in high school and I am interested in inclusive education and differentiated instructions. By the new regulations, the visually impaired students have inclusive education in high school and they may face with some problems. In this study, I will explore the possible problems and try to explain the reasons of these problems.

Four visually impaired students from different backgrounds in inclusive education will be involved in this study. I would like to have the opportunity to face-to-face interview you if you agree. These interviews usually last about 90 minutes. Before conducting the interview, I will first call you in order to arrange the date, the place, and the time for the interview.

If you have any questions about this study or interviews, please feel free to contact me by telephone or by email. Otherwise, I will call you in the next few days to schedule the interview.

Thank you for your time in advance. I am looking forward to talking you.

Sincerely,
Gözde İrem Bayram
Researcher, Bilkent University

APPENDIX F: Thank you letter to participants

<<Date>>

<<First>><<Last>>
<<Address>>
<<City>>, <<Zip>>

Dear <<First>> <<Last>>;

I am writing you to tell you how much I appreciate your volunteer participation to the interviews and I am writing to convey my thanks.

By your volunteer participation and honest sharing about your experiences in learning high school mathematics, I have collected rich information and I have reached significant data. Your response let me reach the results of my study and explore the problems of visually impaired students.

I appreciate your participation and thank you for your interoperability for the research study. If you have any further questions about this study or interviews, please feel free to contact me by telephone or by email anytime.

Thank you for your time and support during the research study.

Sincerely,
Gözde İrem Bayram
Researcher, Bilkent University