CRITICAL ISSUES IN EDUCATION FOR STUDENTS WITH VISUAL IMPAIRMENTS: ACCESS TO MATHEMATICS AND THE IMPACT OF THE COVID-19 PANDEMIC

by

C. RETT MCBRIDE

(Under the Direction of Jaime Diamond)

ABSTRACT

In the United States, 0.05% of students aged 6 to 21 are visually impaired [about one in 2000 students] and 0.4% of students with disabilities served under the Individuals with Disabilities Education Act (IDEA, 2004) are visually impaired [about one in 250 students with disabilities] (McLeskey, Rosenberg, & Westling, 2018). In this paper, two manuscripts are presented, each addressing a critical issue for students with visual impairments: (1) the preparation of Teachers of Students with Visual Impairments for supporting students in high school mathematics; and (2) the impact of the COVID-19 pandemic on the educational experiences of students with visual impairments. Data were collected through surveys of TSVIs and parents of students with visual impairments. Analysis of data from these surveys indicates that TSVIs do not (generally) feel prepared to support students with visual impairments in high school mathematics; and issues of accommodation and accessibility were exacerbated by the COVID-19 pandemic.

INDEX WORDS: Visual Impairment, Blindness, Mathematics Education, Teachers of Students with Visual Impairments, COVID-19, Pandemic.

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DEDICATION

This dissertation is dedicated to mother, Shelley “Sunny” Weathers; and my brother, Heath McBride.

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CHAPTER 1

MOTIVATION

Defining Visual Impairment

A person with *visual impairment* (VI) is a child or an adult who is blind or has low vision. Definitions of *blind* and *low vision* vary throughout the world, and even within the United States. For many purposes, a person's level of vision is determined by a measure of their *visual acuity*; while in others, practical implications are considered. *Visual acuity* is a measure of the sharpness of a person's vision (an unimpaired person has an acuity measure of 20/20). Low vision is often defined as visual acuity of 20/70 or less (a person with 20/70 acuity can see from 20 feet away what an unimpaired person can see from 70 feet away). In the United States, *legally blind* means a person has either (1) visual acuity of 20/200 or less, in the better eye, with correction, or (2) a visual field of 20 degrees or less in the better eye (sometimes referred to as tunnel vision). It is estimated that more than a million Americans (in the U.S.) are legally blind (NIH, 2016); and according to a recent report from the American Printing House for the Blind (APH, 2017) there are approximately 63,657 children, youth, and adult students in educational settings who are legally blind. *Total blindness* means a person cannot perceive light or forms: approximately 15% of persons with VI are totally blind (AFB, 2020).

Educational Supports for Students with VI

For purposes of determining eligibility for special education services, a *VI* is defined by the U.S. Department of Education in the Individuals with Disabilities Education Act as "an impairment in vision that, even with correction, adversely affects a child's educational

performance" (IDEA, 2004). While visual acuity is considered in determining eligibility for special education services, it is not the single defining factor: a team of teachers and specialists consider practical limitations of a student's vision in their educational setting. Therefore, a student that does not meet the acuity standard for low vision may be eligible for special education services; and a student with acuity of 20/70 or less may be eligible, but not require special education services. Nationally, 0.05% of students aged 6 to 21 are visually impaired [about one in 2000 students] and 0.4% of students with disabilities served under IDEA are visually impaired [about one in 250 students with disabilities] (McLeskey, Rosenberg, & Westling, 2018).

Once eligibility for special education services has been established, the appropriate support for students with VI must be considered on a case-by-case basis. Teachers, parents, and VI professionals will collaborate to write an *Individualized Education Program (IEP)* for each student with VI. An IEP is a plan to provide specialized instruction, accommodations, and related services to a student with an identified disability. An IEP for a student with VI may include the required support of a *Teacher of Students with Visual Impairments (TSVI), a certified Orientation and Mobility (O&M) instructor*, or a paraprofessional or teachers' aide. A TSVI is a certified teacher with expertise in teaching students with VI. Many TSVIs start their career as a general or special education teacher and then add VI certification. As a member of an IEP development team, a TSVI will assess how a student uses their vision. A TSVI will then provide direct instruction in the Expanded Core Curriculum (ECC, i.e., a non-academic curriculum encompassing the skills necessary for students with VI to access the general education curriculum, prepare to live independently as adults, and participate fully in society. Instruction in the ECC may take place in a *Resource Classroom* (a special education classroom for teaching

ECC skills to students with visual impairments), in which case the TSVI may be referred to as a *Resource Teacher*. When a TSVI co-teaches an academic class with a general education teacher, the TSVI may be referred to as an *Inclusion Teacher*. An *O&M instructor* teaches people with VI how to safely, efficiently, and confidently travel (often teaching White Cane and other navigation skills).

Not only will the make-up of a support-team vary from student-to-student, but so too does the level of involvement and frequency of services required of each team-member. For example, many high school students with VI who are attending academic classes in their local school are assigned an *itinerant TSVI* who meets with the student or consults with the student's academic teachers – the frequency of these meetings and consultations can range from once per academic term to multiple times each week. An itinerant TSVI travels from school to school within a district to provide consultative services and/or direct instruction in the ECC. O&M instructors also regularly serve itinerantly. Although rare, a school district may include a regional center for disability services – in which case a TSVI or O&M instructor may be stationed permanently in a Resource Classroom at their regional center and students with VI will travel to the Resource Classroom for instructional services. Since VI is a low-prevalence disability and students with VI are generally geographically disperse, regional centers are typically located in large metropolitan areas.

Other accommodations on a VI student's IEP will include tools and assistive technologies. These accommodations are also highly individualized and cannot be determined by visual acuity alone. In particular, a student's efficiency in reading and writing using regular and large print, low vision aids, or braille must be considered. Some low vision students use large print to access and produce written work, while many blind students use braille. However, just as

there is no strict definition of low vision or blindness, there is no strict correlation between level of usable vision and a student's reading/writing media. A student with low vision (according to their visual acuity) may use braille, and a student who is legally blind may have some usable vision and use both large print and braille (in which case the student may be referred to as a *dual-media reader*). Nonetheless, students with VI are often categorized as *low vision, print students,* or *blind, braille, or dual-media readers*.

The Genesis of My Interest in VI Education

My interests in the educational experiences of persons with VI developed progressively over the past three decades. In the early 1990's, I moved to within a few blocks of the Center for the Visually Impaired (CVI) in Atlanta, Georgia. The CVI is a non-profit organization that provides services to persons with VI and support to their families. Prior to this, I do not recall knowing any person with VI and my understanding of VI was limited to portrayals (by sighted actors) in television and movies. After moving to Atlanta, I regularly walked past the CVI building and saw people with VI on nearby streets working with O&M instructors to practice navigation skills. Something that was unfamiliar became novel, and then commonplace. I was intrigued by the courage and determination of the people with VI that I saw learning to navigate the busy walkways and intersections of midtown Atlanta. I was also curious about the specialists that I saw assisting people with VI. I wondered about the professions and training of these teachers.

More than twenty years later, I was looking online for a volunteer opportunity and was matched to a posting by the CVI advertising a position as a volunteer mathematics tutor. When I was confirmed as a volunteer (but before I knew what my role would be) I was terribly anxious, wondering: "What had I gotten myself in to?" and "How would I tutor a blind student in

mathematics?" At the time, I was teaching college mathematics classes and knew that I relied heavily, if not exclusively, on lectures, whiteboard notes, and whiteboard illustrations. I also had many hours of tutoring experience (with numerous high school and college mathematics students – all of whom were sighted students), and had always used drawings to illustrate concepts, pencil-and-paper to show examples of mathematical procedures, and observation of students' work to monitor progress and assess understanding. I fretted over adapting my instruction to accommodate students with VI (especially if a student was blind and used braille). I felt that I was good at explaining concepts and describing illustrations, but I wondered if my verbal instruction would be sufficient for helping students with VI to learn mathematics. I certainly did not know anything about the tools and assistive technologies used by students with VI in their mathematics studies. I accepted that I would have to improvise and learn "on the job" with help from the students and the program staff at the CVI.

My anxiety was temporarily assuaged when I realized that I would not be tutoring students in mathematics as a CVI volunteer, but instead I would be assisting middle and high school students attending the CVI's *Social, Therapeutic, Academic and Recreational Services* (STARS) weekend program. My experience as a STARS volunteer fostered confidence in my ability to support and advocate for students with VI. Mostly, I learned to relax (I was tense and intimidated, at first), but I also learned the basic techniques and etiquette for assisting students with VI (e.g., how to properly guide a blind student and how use acoustic signals – by tapping on a surface – to make my location in a room known to a blind student). By assisting students in a variety of activities, I was introduced to diverse accommodations for students with VI. For example, by sitting alongside blind students as they prepared resumes using word-processing software, I learned about screen reading software and using key-commands (rather than a mouse)

to navigate a screen. I marveled at the skills of these students: they were remarkably adept (to me, as a newcomer) in their use of computers and word-processing software. Only rarely did I intervene to help with technology – I mostly provided prompts and feedback on the content of their resumes. I couldn't help but wonder "When and where had these students learned these skills?" and "Who taught these skills?"

Around the same time, I started the doctoral program in mathematics education at the University of Georgia. A requirement of one of my first classes was to propose a research study and to submit a relevant annotated bibliography. I decided to investigate the intersection of mathematics education and VI. I wondered whether and how my own reactions (feelings of trepidation, unpreparedness, and isolation - given the prospect of teaching mathematics to students with VI) related to those of other mathematics teachers. I began looking into any and every opportunity to learn about VI (by reading existing research, taking courses in VI and Special Education, attending conferences, and building a network with researchers and specialists in these fields).

Coursework that Impacted My Understanding of VI Education

VI Education programs. Several courses in my doctoral program were especially impactful of my understanding of VI education and subsequently influenced my research. Once I decided on a general area of research (mathematics education and VI education), I knew I wanted to take at least one course in VI Education to supplement my Mathematics Education coursework. I was dismayed to find there were no undergraduate or graduate programs in VI Education in my home state of Georgia, and only a small number of VI Education programs in the Southeastern United States: the programs at The University of South Carolina Upstate, Florida State University, Louisiana Tech, Mississippi State, and North Carolina Central. It

should be noted that special education teachers in Georgia can take continuing education courses leading to a "VI Endorsement" through the Middle Georgia Regional Educational Service Agency.

I wrote to the program directors of Florida State Univeristy (FSU) and the University of South Carolina Upstate (USC Upstate) to inquire about their VI Education programs; and discovered the foundational courses in VI Education at FSU were taught (exclusively) in-person [it should be noted that FSU now offers a completely online Masters program in VI Education]; while the VI Education classes at USC Upstate were taught in a hybrid format (mostly online – with limited in-person instruction). Besides these differences in delivery, the programs at FSU and USC Upstate were very similar in terms of their required sequence of courses. Both programs required 10 courses (30 semester credit hours) in VI Education which included: a foundations course, courses in literary and Nemeth braille, a course in the anatomy and physiology of VI disorders, a course addressing the needs of students with VI and additional disabilities and courses with focus on access and assessment The VI program at USC Upstate required three additional courses (9 semester credit hours) in education research, literacy, and the K-12 curriculum.

USC Upstate. I also wrote to several other VI program directors to ask which course or courses would be most beneficial given my research interest in how students with VI are included in general education high school mathematics classes. I decided to take *SVIP 610: The Nature and Needs of Learners with Visual Impairment* at USC Upstate, which is the introductory course in USC Upstate's VI Education program and focuses on the history of VI education and the ECC. SVIP 610 required a field experience and so I volunteered two days at the summer camp administered by the South Carolina School for the Deaf and Blind and wrote a case study

of one of the campers. The camper I worked with was an outgoing and fun-loving middle school student with a degenerative visual impairment. I accompanied this student throughout the days' activities which included diverse recreational activities and a field trip to a nearby zoo. I took note of how the student's VI impacted his engagement in each activity. Through this field experience I learned about the process of assessing and documenting the needs of a student with VI and the possible impact of VI on the student's development. SVIP 610 also provided insight into the rigor of a VI Education program. This course was one of the most demanding of all my graduate coursework – and it was just the introductory course of the VI program!

Through conversations with the director of the VI program at USC Upstate (Dr. Tina Herzberg, who also served on my graduate committee), I learned that three courses in the VI Education program at USC Upstate address supporting students with VI in mathematics: *Advanced Braille, Assessment and Education Methods for Learners with VI,* and *Assistive and Instructional Technology for Learners with VI.* In the Advanced Braille course, prospective TSVIs are taught Nemeth Code within UEB Contexts (hereafter referred to as Nemeth) and how to create tactile graphics. Nemeth is used by persons with VI to access and produce mathematical and scientific content in braille. Research shows that 20% of VI programs in the U.S. and Canada do not include training in Nemeth in their programs (Amato, 2002). The Assessment and Methods course at USC Upstate includes training in the abacus and other mathematics manipulatives, and tactile graphics (which are used by students with VI to access mathematics content). Training in tools and technologies that are used more broadly across the curriculum are taught in the Assistive Technologies course. While the course descriptions show these topics are addressed in USC Upstate's VI program, I did not take these courses, and so I was left to wonder about the scope of the mathematical contexts in which these skills were taught (elementary,

middle, or high school mathematics), and the requisite understanding of mathematics for learning to effectively teach these skills to mathematics students with VI. Amato, Hong, and Rosenblum (2013) report that nearly a third (31.3%) of TSVIs do not teach the abacus because "[They] do not have the knowledge or skills to be an effective abacus instructor for [their] students" (p. 5).

In addition to teaching tools and technologies to students, TSVIs are often called upon to pre-teach concepts and to provide supplemental instruction in the academic curriculum (including mathematics). There is a gap in the literature regarding preparation among TSVIs (specifically) for supporting students in mathematics. However, a study by Rosas & Campbell (2010) of 26 students enrolled in a graduate-level special education program (not a VI Education program) found that only a third of participants indicated their undergraduate program provided a solid foundation in mathematics, and just a quarter reported they had sufficient content knowledge to teach secondary (Grades 9 through 12) mathematics content. While I was convinced of the rigor of VI Education programs through my experience at USC Upstate, I remained curious about TSVI preparation in mathematics and mathematics education, and how this impacts their ability to effectively (1) teach tools and technologies in the mathematical contexts, and (2) pre-teach and provide supplemental instruction in mathematics content.

UGA: Qualitative Methods Course. A requirement of the doctoral program in mathematics education at the University of Georgia is a three-course sequence of courses in Qualitative Research. In partial fulfillment of these courses, I conducted one-hour interviews with five people with VI education and mathematics education experience: a college mathematics instructor with experience teaching a blind student, two TSVIs, a college student with VI, and a special education teacher. The interviews with the two TSVIs suggested to me that TSVIs interpret their role in mathematics education along a spectrum. While some TSVIs

draw a clear line between their responsibility as a TSVI (which include providing adapted materials and instruction in tools and technology) and the responsibilities of the mathematics teacher (which include content instruction), other TSVIs see a "grey" area where their responsibilities as a TSVI overlap with the those of the mathematics teacher. My interviews with the two TSVIs led me to believe their different perspectives on their roles as TSVIs were impacted by their self-perceived proficiency and confidence in mathematics. In the following section, I summarize my findings from this pilot research with profiles of these two TSVIs. Pseudonyms are used to protect the privacy of the participants. These profiles are based on limited data (one-hour interviews) and my interpretation of the data. I do not presume that my interpretations of these data give a fully accurate representation of the beliefs and experiences of the participants. Rather, I am including this analysis to show the impact of these interviews on my understanding of the role of TSVIs and how this pilot research informed my dissertation research.

Profile of Isabelle

In the summer of 2016, I conducted a one-hour phone interview with Isabelle. The goal of my interview was to understand the role of the TSVI in mathematics education for students with VI. Overall, I was impressed by Isabelle's candor, humor, and expertise in VI education. At the time of our interview, Isabelle served as an itinerant TSVI in a suburban county within a large metropolitan region. As an itinerant TSVI, Isabelle traveled from school to school in her county to provide direct instruction in the ECC and consultative services to students and their classroom teachers. For her academic high school students, Isabelle met with the students' teachers at the start of the school year to review IEPs – after which she would leave it up to the teachers and students to contact her if or when an issue arose. At the time of our interview,

Isabelle's caseload included elementary, middle, and high school students; students with low vision (but not blindness) and students with multiple disabilities. Isabelle pointed out that she did not have any experience working with a blind student who used braille and was on grade level in the academic curriculum. Otherwise, Isabelle had experience working with diverse students with VI: blind students, low vision students, students with multiple disabilities; preschoolers through high school students; gifted students and students with cognitive or intellectual disabilities. Isabelle embraced the challenge of supporting students with a range of abilities and made lite of any lack of specific preparation. She viewed her TSVI education as necessary and beneficial, but insufficient given the complexities of VI education and the diversity among students with VI. She found it necessary to learn many skills "on the job," sometimes through trial-and-error.

Isabelle held a bachelor's degree in Elementary Education with two add-on certificates: one in Infant through Pre-K Education and another in VI Education. Her VI certification required 16 credit hours of coursework and included training in the abacus and Nemeth. However, mathematics content and pedagogy were not otherwise a significant part of Isabelle's undergraduate education or VI certification program. Isabelle described herself as "mathematically challenged" and jokingly compared mathematics teachers' instruction to that of the teacher in the Peanuts cartoons ["wah-wah, wah wah wah wah…"]. Isabelle repeatedly expressed the opinion that TSVIs do not teach mathematics, but rather the tools to access mathematics. Consequently, in the contexts of supporting students with VI in mathematics, Isabelle focused on adapting materials, making sure that accommodations were implemented, and providing instruction in the use of tools and assistive technologies. She consulted with her students' mathematics teachers to find out what content was on the horizon and what tools could be used to make the content accessible.

Planning did not render Isabelle rigid in her strategies: several times she mentioned the need to be spontaneous, innovative, and flexible. She was open to brainstorming with teachers and students to find appropriate accommodations that minimized adaptation. An *accommodation* makes the content of a class accessible to a student with disabilities, while an *adaptation* alters the content (most commonly by reducing homework assignments and the scope of tests). Isabelle preferred tools that were unobtrusive and that would be useful in the long-term (in college, for example). Isabelle did not regularly attend academic classes with her students; since she felt doing so would draw unwanted attention to her students and cause them embarrassment. Instead, Isabelle encouraged her students to advocate for themselves and to resolve accessibility issues directly with their classroom teachers: she intervened only as a last resort.

Profile of Susan

In the fall of 2017, I conducted a one-hour phone interview with Susan. The goal of my interview was to expand my understanding of the role of TSVIs in mathematics education. At the time of our interview, Susan spent half of her professional time as a Resource Teacher and the other half as an Inclusion Teacher. In her half-time role as a Resource Room teacher, Susan hosted students in a Resource Classroom and provided direct instruction in the ECC. As an Inclusion Teacher, Susan attended academic classes with her students to make sure that academic content, including mathematics, was accessible to students with VI.

Susan's expertise is likely attributed to the combination of her specialization in VI education, many years of experience as a TSVI, an understanding of mathematics, and an innate positive disposition towards mathematics. Susan held an undergraduate and Masters' degree in VI Education and at the time of our interview, Susan had accumulated nearly 40 years of experience working with students with VI. Susan's college education did not include advanced

mathematics coursework nor courses specific to mathematics education, but she did have training in Nemeth. Susan characterized her training in mathematics and mathematics education as “on-the-job” training: she had repeatedly taken (by attending these classes with her students) many high school mathematics classes.

Susan’s caseload of students included blind and low-vision students with and without additional disabilities. Her current and past students’ intellectual abilities ranged from profoundly disabled to gifted. Many of Susan’s students required intensive instruction in the ECC, and therefore had multiple sessions each week in the Resource classroom.

Susan’s proficiency and confidence in mathematics facilitated, or even defined, her role as an inclusion teacher. Several times in the interview, Susan recalled instances where she would “teach the teacher,” for example how to articulate things the teacher was writing so that it was accessible to a student with VI. Susan frequently asked the mathematics teacher for additional explanation so that she could provide supplemental instruction to her students: a practice which Susan viewed as an opportunity to model, for her students with VI, how to advocate for themselves when they did not understand what the teacher was doing.

I believe that Susan understood her roles and responsibilities as a Resource Teacher and Inclusion Teacher as distinct from one-another and that of a mathematics teacher; but she was willing to cross lines when she felt that she could accommodate a need that would otherwise go unaddressed. More than once Susan mentioned using one-on-one time in the Resource Classroom to discuss mathematics content: she even described some of her time with students as “tutoring”. Susan revealed that if a student came to her Resource Classroom for instruction in the ECC, but asked for help with mathematics, and if time-permitted, she would not deny instruction (a.k.a “tutoring”). Susan was hesitant to divulge this information since TSVIs regularly, and

understandably, cringe at the inclusion of "tutor" among their job descriptions. TSVIs have many duties and are spread-thin, so they cannot universally be expected to provide tutoring across the academic curriculum. Susan may not have been the official content expert and teacher, but she was almost certainly qualified to provide content instruction in mathematics. In fact, I believe that Susan was quite skilled in mathematics: during our interview, Susan provided several examples of specific mathematical concepts that revealed an advanced level of understanding of mathematics. For example, Susan described a recent lesson on using the complex conjugate to simplify a complex quotient. She stumbled a bit with terminology but explained the procedure accurately.

Ultimately, I believe that Susan had her students' best interests at heart and was willing to use her capabilities for the benefit of her students. Susan recognized that the system was flawed and that students with VI were systemically disadvantaged. In my interview, Susan mentioned several examples of systemic disadvantages. First, there is a trend away from textbooks and towards handouts – which precludes a TSVI from ordering a braille or large print copy of materials and requires the TSVI to transcribe materials ad hoc; and if the general education teacher does not provide these materials in a timely manner, the TSVI cannot transcribe them and the student will not have access to the materials. Second, online technology is increasingly used to supplement instruction in general education mathematics classes (e.g., applications such as Geogebra and videos on Khan Academy, which may not be accessible to students with VI). A brief demonstration of a concept such as translating a function can be done quickly and efficiently (for sighted students) using Geogebra or a similar app, but the limited scope and brief time devoted to each activity means that adapting all of them for students with VI, is, for all intents and purposes, impossible. While exempting a student with VI from participating in a

single activity may seem negligible, one must consider the cumulative effect of depriving students with VI of these learning activities in their totality. Increasingly, mathematics teachers are choosing to flip their classrooms (Patterson, B., McBride, C.R., & Gieger, J.L., 2018) and students with VI are electing to attend virtual charter schools. In both scenarios, issues of accessibility for students with VI becomes an issue since printed texts, online videos, and instructional apps are not universally available or accessible to students with VI.

Comparing Isabelle and Susan

Isabelle and Susan were both highly qualified TSVIs. Yet their interview responses reveal different educational experiences and disparate views of the role of TSVIs in supporting students' learning of mathematics. Isabelle earned an undergraduate degree in Elementary Education and an add on certification in VI, while Susan earned an undergraduate and master's degree in VI Education. Neither Isabelle nor Susan reported taking courses in advanced mathematics or mathematics education. The two TVSIs had different professional experiences in terms of the grade levels of the students they taught. Isabelle began her TSVI career working exclusively with Pre-K students, but later transitioned to positions that required her to work with students from Pre-K through high school. Susan, on the other hand, reported working exclusively with high school students throughout her career as a TSVI. Consequently, Isabelle has a broad perspective on how students with VI can be included (or excluded) at any grade level. This wide lens allowed Isabelle to make connections across the curriculum: for example, as to how inclusion in middle school mathematics impacts participation in advanced mathematics. Both TSVIs expressed interests in preparing their students for college: Isabelle's strategy was to promote independence, self-advocacy, and competence in the tools and technologies that were

likely to be available to college students. Susan promoted independence but was also willing to intervene and provide instruction in mathematics content.

Isabelle and Susan had different professional roles: Isabelle worked as an itinerant TVSI and travelled to meet with students and their teachers, whereas Susan split her time as a Resource Teacher and an Inclusion Teacher. Isabelle did not regularly attend mathematics classes with her students because she felt it would be an embarrassment to her students and preferred to collaborate and brainstorm with students and teachers outside of class. Susan regularly engaged with students in their academic classes and even co-taught some of their academic classes even modeling ways the students could advocate for themselves in the mathematics classroom.

I believe it would be an oversight to ignore the disparate dispositions towards mathematics of these two teachers. Isabelle readily admitted that she was not inclined towards mathematics and she joked about her indifference to the subject; whereas Susan expressed enjoyment and confidence in mathematics. TSVIs provide support to students with VI across the academic curriculum, and it should not be expected that all TSVIs would be equally and uniformly interested in mathematics or mathematics education. Nonetheless and regardless of personal interests in mathematics, all TSVIs must be prepared to support students with VI in learning mathematics. As part of my research, I aim to understand how TSVI generally view their proficiency in mathematics and how they see their proficiency in mathematics as impactful of their ability support students in mathematics.

UGA: Diversity Course.

For many undergraduate Mathematics Education majors at UGA, *EDUC 2120: Exploring Socio-Cultural Perspectives on Diversity,* satisfies the major's "Cultural Diversity" requirement. This course requires a field experience. Students are expected to volunteer in an educational

setting that includes students with disabilities and to write about their experiences. I took this course to better understand the preparation of mathematics teachers for including diverse students (including those with sensory impairments, and more specifically students with VI). For me, the field experience was the most impactful part of the course: I elected to sit-in on the high school mathematics classes at the South Carolina School for the Deaf and Blind (SCSDB). This was an eye-opening experience, which profoundly affected my understanding of mathematics education for students with VI. The high school mathematics teacher at SCSDB was a newly qualified mathematics teacher with no formal TSVI training. In the following section, I summarize my observation notes from this experience.

Field Experience at SCSDB

During my observation of mathematics classes at SCSDB, I mostly sat at the back of the classroom or along a sidewall. I tried to be unobtrusive, but two factors eventually necessitated making myself known. First, I realized that when blind students or aides were in the classroom it was awkward, if not rude, to not make myself known – especially as a visitor. When I sat along the sidewall, students routinely navigated near me to retrieve a calculator from a bin. At first, I was unsure of what to do as students approached the bin: my initial reaction was to freeze (even to hold my breath); then to intervene and help the student find and unplug a calculator from its charging cable; or to just hand the student a calculator. I eventually realized the better option was to announce myself with a friendly greeting and let the student go about retrieving a calculator on their own. Second, the environment of the classroom was very casual: the teacher, aide, and students moved about the room freely and regularly engaged in conversations (sometimes about mathematics content and sometimes not): so I felt free to ask questions, and to move about the classroom to get a closer look at the materials and devices that were being used by students.

Prior to this experience at SCSDB, I assumed that teachers and students at a residential school for the blind would have full access to materials (in large- and braille-print), and to a wide-range of tools and cutting-edge assistive technologies. However, the students at SCSDB mostly used materials produced by the mathematics teacher (since the large- and braille-print materials were mostly incomplete or out-of-date) such as talking calculators, braille writers, electronic braille displays, hand-held magnifiers, and screen enlargers.

There was a great deal of collaboration in each of the classes that I observed – students often worked in groups or pairs. However, when a student was not working with a teacher or peer, it was hard for me to tell if they were focused on a mathematical task, and whether they needed or wanted help. In one observation session, I noticed a braille-reading student sitting quietly at her desk and I assumed she was not engaged in the lesson, but when I moved closer I could see that she was actively working on an assignment using a hand-held electronic braille display. After this class session, I asked the teacher and aid how a teacher can know when a braille student is on task. The aid said that he regularly checks students' work (he reads braille); and the teacher (who knows minimal braille) said that she does verbal checks.

In an out-of-class conversation, the teacher and aid jointly emphasized the importance of cultivating personal relationships with and among students. In my observation, it was not unusual for teachers and students to have conversations about plans outside of class, and to joke with one another. There was a light heartedness to the classroom talk, but that did not seem to impede the pedagogical purpose of the class – students were there to learn and do mathematics. The mathematics teacher explained that students have to learn to communicate and work with others as a life skill.

The casual atmosphere of the classroom was also evidenced by the teachers' and students' freedom of movement. At times, the teacher's movements seemed choreographed – she moved about the classroom anticipating the needs of students (handing them materials or supplies, without having been asked). The teacher sometimes sat at her desk at the front of the classroom but was just as likely to sit at a desk among the students. Students moved about the classroom – to retrieve a talking calculator, to sharpen a pencil, to move to another student's table to talk, or to pace the room – without asking permission from the teacher. In a conversation with the teacher outside of class, I remarked on this observation and the teacher told me this "norm" was something she also had to get used to but learned to accept and then value.

In the mathematics classroom at SCSDB, noise was the norm, to the point the mathematics teacher kept earplugs on-hand for her students. Some of the noise, I would say is inherent to the VI classroom (e.g., a mechanical braille writer sounds similar to manual typewriter), but there was other noise generated from multiple conversations among students, the moving about of students, and exterior sources such as a nearby music education classroom with near-constant piano playing. The extraneous noise was disconcerting to me as a visitor but did not seem to be an issue for the mathematics teacher or students with VI.

Through this field experience, I learned about not only about delivery of instruction (which was highly individualized within small classes), but also about classroom management and classroom norms in high school mathematics classes at one school for the blind. It was surprising to me that the mathematics teacher at a school for the blind might not have formal education in VI, but I was amazed at the skills the mathematics teacher at SCSDB had developed in a short period of time through on-the-job experience. In this situation, the mathematics teacher determined the accommodations for her students and was responsible for implementing those

accommodations. If the teacher wanted to use a handout in class, she had to produce the handout in large-print and braille. When the teacher devised an activity for students, she was thinking only of students with VI, and how every part of the activity had to be accessible to low vision and blind students. A common problem in mathematics education for students with VI is that TSVIs do not have ample time to prepare materials in large print or braille (Annis, 2011); but in this situation, accessibility was not an afterthought to lesson planning that could be delayed until the last minute - rather accessibility had to be considered from conception through implementation and assessment of learning. The mathematics teacher at SCSDB, who was not proficient in braille or Nemeth, relied on software to convert materials into braille code: and so I wondered if mathematics teachers with VI students could be given access to and training in braille-transcription software. The mathematics teacher at SCSDB acknowledged that transcription software is not always accurate, but her students seemed to know when there was a transcription error and they would ask their teacher for clarification when needed. The high school mathematics students as SCSDB knew how to use their preferred tools and assistive technologies (e.g., braille and Nemeth, talking calculators, refreshable braille displays, screen reading software, and screen enlargement software), and so the mathematics teacher did not have to teach these skills, but only had to consider how these tools and technologies would be used to access the content and demonstrate understanding. Nonetheless, these skills must be taught at some point in elementary or middle school, and so I wondered "Who was teaching these skills?" and in which contexts (specifically, were these skills being taught within the contexts of mathematics, and were students who attended their community school equally proficient and able to work independently with these devices and technologies).

Cumulative impact of these educational experiences

My interest in issues impacting persons (especially students) with VI began by coincidence: I happened to move to a neighborhood where I regularly encountered people with VI working with service professionals. A novel interest became a passion when I started researching issues in mathematics education for students with VI. Research, coursework, and especially field experiences, have motivated my study of issues in VI education. I was inspired to ask: "How do TSVIs define their role in mathematics education?" and "How are TSVIs prepared to support students with VI in their study of mathematics?" A review of the literature, observation of a middle school student with VI, interviews with two practicing TSVIs, and observation of the high school mathematics classes at a school for the blind, have influenced my research. Through these experiences, I have come to believe that (1) every student with VI is unique and their teaching accommodations cannot be determined by their visual acuity, (2) TSVIs define their role in mathematics education based on their formal education, work experience, and self-perceived proficiency in mathematics, and (3) inclusion of students with VI in mathematics education is jointly impacted by their TSVI's proficiency in mathematics and by their mathematics teacher's proficiency in VI education/accommodation.

The Impact of COVID-19

In the spring of 2020, as I was preparing to implement a study for my dissertation research, most schools and businesses in the U.S. closed, and many states implemented a "shelter in place" policy to slow the spread of the Novel Coronavirus Disease, hereafter referred to as COVID-19. The closing of schools to in-person learning meant that I would not be able to execute my dissertation study as planned (the design of which included classroom observations and subsequent teacher interviews). Consequently, I developed a survey of TSVIs that could be administered electronically. In the initial survey design, I included questions about the impact of

COVID-19 on TSVIs' delivery of instruction and their ability to provide support to students with VI amid the pandemic. However, through my connections with other researchers in the field (namely Dr. Tina Herzberg and Dr. L. Penny Rosenblum) I learned that a national survey was already being distributed to assess the impact of COVID-19 on the educational experiences of students with VI. I proceeded with the development and distribution of my survey of TSVIs to assess their preparation for supporting students with VI in mathematics education, but omitted the section of questions about the impact of COVID-19, and instead joined the national team of researchers as a data analyst. The national team of researchers agreed to let me analyze a subset of their de-identified data for my own research.

The responses to my survey of TSVIs are analyzed in Chapter 2 of this dissertation: *A survey to assess the preparation of teachers of students with visual impairments for supporting high school students in general education mathematics classes.* More than 40 TSVIs responded to the survey. While 81.0% of TSVI respondents reported holding a graduate degree, only 33.3% reported completing an advanced college mathematics course and 16.7% reported not taking any college-level mathematics course. Nearly half of the TSVIs reported that their proficiency in mathematics impacted their ability to support high school students in mathematics (for better or worse). A third of responding TSVIs reported feeling unprepared to support high school students in mathematics at the start of their career, but 81.6% reported increased confidence over time – whether through teaching or attending mathematics classes, professional development or self-study, or by learning from students or colleagues.

While my life, and certainly my research plans, were disrupted by the COVID-19 pandemic, I couldn't help but wonder about how COVID-19 was impacting students with VI. As I mentioned before, I initially included questions in my survey of TSVIs to assess the impact of

COVID-19 on their delivery of educational services to students with VI. Coincidentally, one of my committee members, Dr. Tina Herzberg, who was advising me throughout the development of this survey, informed me of two national surveys that were being administered to assess the impact of COVID-19 on persons with VI: the *Access and Engagement Survey* (to assess the impact on the educational experiences of students with VI) and the *Flattening Inaccessibility Survey* (to assess the impact of COVID-19 on adults with VI). Dr. Herzberg reached out on my behalf to the teams of researchers working on these studies (including Dr. L. Penny Rosenblum and Dr. Tiffany Wild, whom I had contacted more than five years prior for research and course-taking advice) and I was soon brought on board to assist with data analysis on both projects. I was given access to the de-identified survey results and permission to analyze sections of the data for my own (dissertation) research. In Chapter 3 of this dissertation, *The impact of the COVID-19 pandemic on the educational experiences of school-aged children with visual impairment*, I present findings from my analysis of 312 responses to the *Access and Engagement Survey* from family members and guardians of school-aged children with VI. I investigated the impact of the COVID-19 pandemic across five dimensions: (1) concerns of parents, (2) access to materials, tools and technologies, (3) access to classroom teachers, (4) access to a TSVI, and (5) access to an O&M instructor. Despite their best, and often extraordinary efforts, parents (family members or guardians) were concerned about the educational experiences of their children with VI because they did not have the time, training, or recourses to facilitate at-home instruction. Parents commonly reported not having adequate access to large-print or braille materials, software, or mathematics tools. While most parents reported “the same” or increased support from classroom teachers, their comments indicated that they believed academic and special education teachers do not fully understand the needs of students with VI. On the other hand,

most parents provided positive comments about their child's TSVI; and dismissed the responsibilities of O&M instructors.

The closure of schools and the move to on-line and at-home learning meant that more students with VI than ever would be taking classes remotely. Researchers, including myself, quickly realized that the impact of the COVID-19 pandemic must be studied while it was ongoing. Even at present (amid the pandemic), federal and state government and local school systems are struggling to decide upon a best course of action for re-opening schools. If schools do not reopen or if schools open and then return to at-home and online learning, there is much to be learned by the experiences of TSVIs and parents of students with VI, to inform the future of online and at-home learning for students with VI. Even if the pandemic does not persist, and students are able to safely return to in-person learning, there are lessons to be learned through examination of the educational experiences of students with VI during the pandemic (e.g., that could be applied to virtual-learning experiences for students with VI). Through study of the impact of this current pandemic, we can learn how to prepare for the next pandemic (if there is one). Also, we can learn about the general challenges of at-home learning and on-line instruction, more generally, for students with VI. The COVID-19 pandemic necessitated an unprecedented, quick, and almost total transition to online instruction. By researching this phenomenon, we can be informed of the challenges of online education for students with VI – whether necessitated by pandemic, catastrophe, or personal preference.

CHAPTER 2

A SURVEY TO ASSESS THE PREPARTAION OF TEACHERS OF STUDENTS WITH VISUAL IMPAIRMENTS FOR SUPPORTING HIGH SCHOOL STUDENTS IN GENERAL EDUCACTION MATHEMATICS CLASSES[1]

[1] McBride, C.R.To be submitted to: The Journal of Visual Impairment and Blindness

Abstract

In the spring of 2020, an online survey was distributed to Teachers of Students with Visual Impairments (TSVIs) to gather information about their (1) preparation for (2) confidence in, and (3) practice of, supporting students with visual impairments in general education high school mathematics classes. Forty-two TSVIs responded to the survey including 31 TSVIs who supplied information about 41 high school (HS) students they were supporting in the fall of 2019. While 81.0% of respondents reported holding at least a Master's degree, only 33.3% reported completing an advanced college mathematics course and 16.7% reported not taking any college-level math courses. Nearly half of respondents indicated their proficiency in mathematics impacted their ability to support HS students in math (for better or worse). A third of respondents reported feeling unprepared to support HS students in mathematics at the start of their career, but 81.6% reported increased confidence over time – whether through teaching or attending mathematics classes; professional development or self-study; or by learning skills from students or colleagues. The most commonly reported accommodation for students with VI was adapted materials (via large print or braille). Interestingly, this was also the one accommodation that TSVIs reported being unable to provide in a timely manner.

Introduction

Mathematics education has been referred to in the literature as a *pipeline, gatekeeper, pump or filter* (Moses & Cobb, 2001; Gutstein, 2006; Frankenstein, 1995). These terms imply that one high school (HS) mathematics course is often a pre-requisite for the next, and achievement in HS mathematics is correlated with higher test scores; and consequently with higher participation rates in Science, Technology, Engineering, and Mathematics (STEM) college majors, advanced degrees, and professions. Other researchers have characterized mathematics education as a civil rights issue - arguing that an understanding of mathematical concepts is necessary for full and meaningful participation in a democratic society (Moses & Cobb, 2001). Therefore, students with visual impairment (VI) must be prepared and encouraged to participate in advanced mathematics, with support and instruction from highly-qualified teachers.

A student with VI may be blind or have low vision. For the purposes of determining eligibility for special education services, a VI is defined by the U.S. Department of Education in the Individuals with Disabilities Education Act (IDEA, 2004) as "an impairment in vision that, even with correction, adversely affects a child's educational performance." In the United States, 0.05% of students aged 6 to 21 are visually impaired and 0.4% of students with disabilities served under IDEA are visually impaired (McLeskey, Rosenberg, & Westling, 2018). Many of the educational accommodations for students with VI depend on the student's level of usable vision and their use of regular or large print, or braille. Therefore, it is common in research to categorize students with VI as either *low-vision, print-readers* or *blind, braille or dual-media readers* (where *dual-media reader* means a student uses both print and braille).

Students with VI have the same range of cognitive abilities as their non-disabled peers (Kumar, Ramasamy & Stefanich, 2001) and with proper support, have the same potential for achievement in mathematics as their non-disabled peers (Tindell, 2006; Malisig and Zhang, 2015). Support for a student with VI generally includes a *Teacher of Students with Visual Impairments* (TSVI), who is a certified teacher with expertise in teaching students with VI. A TSVI assists in the development of a visually impaired student's *Individualized Education Plan* (IEP) by assessing how the student uses their vision and whether print, braille, or a combination is appropriate for the student. An IEP is a plan for providing educational support, accommodations, and related services to a student with an identified disability. A TSVI also provides direct instruction in the Expanded Core Curriculum (ECC), which is a non-academic curriculum encompassing skills necessary for students with VI to access the general education curriculum, prepare to live independently as adults, and participate fully in society. Instruction in the ECC may take place in a *Resource Classroom* (a special education classroom for teaching ECC skills to students with VI), in which case the TSVI may be referred to as a *Resource Teacher*. When a TSVI co-teaches an academic class with a general education teacher, the TSVI may be referred to as an *Inclusion Teacher*.

Since the 1950s, it has become increasingly common for students with VI to be educated in the general education classroom (sometimes referred to as a *regular*, *mainstream*, or *inclusion* classroom) in their community school (Martin & Hoben, 1977; Korir, 2015). Recent data shows that 68.1% of students with VI spend 80% or more of their day in a general education classroom (Holbrook, McCarthy, Kamei-Hannan, 2017). These data do not provide current or recent participation rates for specific classes (such as HS mathematics classes), but Rapp & Rapp

(1992) reported that 78.8% of 160 high school students with VI were taking a general education mathematics course in the 1988-1989 school year.

The duties of a TSVI in supporting a HS student taking a general education mathematics class may include: procuring adapted course materials and assistive technologies (e.g., screen readers, talking calculators, and magnifiers); adapting materials ad hoc (e.g., handouts, quizzes, and tests); providing training in the use of tools and assistive technologies to students and classroom teachers, resolving accessibility issues, or pre-teaching concepts and providing supplemental instruction. Many HS students with VI who are taking academic classes on, or near their grade level, are assigned an *itinerant TSVI.* An itinerant TSVI travels within a region to meet with VI students and to consult with classroom teachers. The frequency of these meetings and consultations can range from once per academic term to several meetings each week

Opportunity to participate in the general education curriculum (through placement) does not in-and-of itself mean equal opportunity to access content, learn, and demonstrate understanding. While students with VI are increasingly likely to attend general education classes with support from a TSVI, research shows that students with VI do not demonstrate achievement in mathematics on par with their non-disabled peers. In a few states (e.g., Pennsylvania, Texas, and North Carolina), data for students with VI are disaggregated from "all students with disabilities" and analyses of these data show that students with VI generally have lower math scores (North Carolina Board of Education, 2009; Winford, 2003; Fox, 2012) and lag behind their non-disabled peers by up to three years (Malasig and Zhang, 2015).

Mathematics education for students with VI (at all levels, including HS) is a collaborative effort of classroom (mathematics) teachers and TSVIs. However, neither Mathematics Education, Special Education, nor VI Education Programs adequately address mathematics

education for students with VI. Many undergraduate Mathematics Education programs require a single course addressing either diversity or inclusion of students with special needs. VI may receive greater attention in Special Education programs, and certainly within VI Education programs, but mathematics and mathematics education are not a substantial part of Special Education or VI Education programs.

The purpose of this study was to better understand the preparation of TSVIs and how TSVIs are supporting students with VI in general education HS mathematics classes. The goals of the study were to find ways in which the experiences of practicing TSVIs might inform (1) the training of future TSVIs with recommendations for education programs, and (2) the training of practicing TSVIs with recommendations for professional development programming. The research questions guiding the study follow.

Research Questions

1. *What training have TSVIs received in mathematics and mathematics education (including training in abacus skills and Nemeth)?*
2. *How has this training impacted their ability to support high school students with VI in mathematics coursework?*
3. *How confident were TSVIs at the start of their career in their ability to support students in mathematics and by which means (if at all) has their confidence changed over time?*
4. *What accommodations are commonly used by TSVIs to support high school print-readers and braille (or dual media) readers in high school mathematics?*
5. *Are TSVIs confident in their ability to teach students and math teachers how to use the tools and technologies commonly used by students with VI to access mathematics?*

Literature Review

This study aims to build on the existing literature related to the preparation of TSVIs for supporting students with VI in HS mathematics.

TSVIs' Preparation in Mathematics

The requirements for TSVI certification vary from state to state (USA), but many TSVIs hold an undergraduate degree in General or Special Education and earn their TSVI certification with a Master's degree in VI Education or through their state's continuing education certification program. In a survey of 103 TSVIs (Seitz, 1994), just over half of respondents (53%) rated their TSVI program as "very effective" (13%) or "somewhat effective" (40%) in general education preparation; and analysis of comments from TSVIs revealed that, on the whole, respondents "were not prepared to provide support to students who were enrolled in courses across the curriculum, such as foreign languages, advanced mathematics, and the sciences" (p. 4). Since more than 25 years have passed since that study, I was curious about whether and how such percentages have changed. I therefore included questions in this survey to assess TSVI's' self-perceived (1) competence in various HS mathematics subject areas, (2) preparation for supporting students with VI in mathematics at the start of their career, and (3) if, and how, their confidence had changed over time.

Research on mathematics course-taking among TSVIs (exclusively) was not available (nor was research on mathematics education course-taking), but a study by Rosas and Campbell (2010) of 26 students enrolled in a graduate-level special education program found that special education teachers (more generally) were unlikely to have taken an advanced (2000-level or above) mathematics course in their undergraduate program. Only a third of participants in the study indicated their undergraduate program provided a solid foundation in mathematics, and just a quarter reported they had sufficient content knowledge to teach secondary (Grades 9 – 12) mathematics. While it is not the responsibility of TSVIs to teach mathematics content (except when the TSVI is a co-teacher in a general education mathematics class or the mathematics teacher at a residential school for the blind), it is often incumbent on TSVIs to pre-teach concepts

and provide supplemental instruction to students with VI. TSVIs also adapt mathematics education materials and teach students with VI how to use tools and technologies to learn and practice mathematics.

A TSVI's understanding of mathematics may impact their efficiency, accuracy, and effectiveness in adapting materials and providing support services. Therefore, several questions were included in this survey to learn about the college mathematics and mathematics education course-taking of TSVIs. Participants were also asked whether they were able to provide adapted materials and procure tools and assistive technologies in a timely manner.

TSVIs' Preparation to Support Mathematics Learners (via the Abacus and Nemeth)

Within VI Education programs, mathematics education is tangentially addressed in courses that teach *abacus* skills and *Nemeth Code within UEB Contexts* (hereafter, referred to as Nemeth).

The abacus is used by students with VI to perform mathematical computations, much in the same way that sighted-people would use pencil-and-paper. In order to teach abacus skills to students with VI, TSVIs need to know the mechanics of the abacus and understand the goals of abacus operations (including addition and subtraction; multiplication and division; fraction operations; and prime factorization). In a study of 72 TSVIs in New England (USA), Rapp & Rapp (1992) found that 58% of TSVIs used the abacus with their HS braille students, but Amato, Hong, and Rosenblum (2013) reported many middle and HS students prefer other technologies – such as the talking calculator. Amato et al., (2013) reported that nearly a third (31.3%) of TSVIs do not teach the abacus because "[They] do not have the knowledge or skills to be an effective abacus instructor for [their] students" (p. 5). Rapp and Rapp (1992) found that 60% of TSVIs supporting HS students were interested in a professional development workshop on the use of the

abacus in the contexts of HS mathematics, suggesting many responding TSVIs were not sufficiently prepared in abacus skills through their TSVI preparation programs, but were interested in furthering their training. Participants in the current survey were asked about their proficiency with the abacus, where they learned abacus skills, and whether they were interested in professional development with focus on particular levels of abacus training.

Nemeth is used by students with VI and teachers to produce mathematical and scientific content in braille. Preparation and proficiency in Nemeth varies greatly among TSVIs. Some VI Education programs include introductory Nemeth as a topic in a literary braille course, while other programs require a separate course that gives focus to Nemeth (e.g., an "Advanced Braille" or "Mathematical Braille" course). A survey of 45 instructors, representing 34 of the 39 TSVI preparation programs in the USA and Canada, revealed that 20% of programs did not include Nemeth training anywhere in their program (Amato, 2002). Rosenblum and Amato (2004) found that less than three-quarters (73.2%) of TSVIs have taken a course that includes Nemeth; and Wittenstein (1993) reported that only a third (35.8%) of TSVIs have a satisfactory knowledge of Nemeth. TSVIs who are not proficient in Nemeth, cannot provide instruction in Nemeth to their students, nor reliably transcribe materials in Nemeth; therefore, their students are disadvantaged in terms of being able to produce their own mathematical work and access advanced mathematical content. On a more positive note, Rapp and Rapp (1992) reported that 73% of TSVIs responding to their survey were interested in a professional development workshop on Nemeth in the contexts of HS mathematics. Participants in the current survey were asked about their proficiency in Nemeth, where they learned Nemeth, and whether they were interested in professional development with focus on Nemeth.

Other Tools and Assistive Technologies Used to Support Mathematics Learning

There are several studies or publications that could be classified as handbooks for teaching STEM content to students with VI that are not necessarily geared towards TSVIs, but rather towards general education (classroom) teachers. An oft-cited example is *Accommodating Students with Disabilities in Science, Technology, Engineering, and Mathematics* (Moon, Todd, Morton, & Ivey, 2012); which is an assemblage of findings from research offering discipline and disability specific resources with sections devoted to mathematics education and VI. Annis (2011) presents a more concise summary of STEM resources for general education teachers and people with VI. Other research gives focus to specific tools or technologies for including students with VI in STEM education: such as assistive technology (Ahmed & Chao, 2018; Mulloy, Gevarter, Hopkins, Sutherland, & Ramdoss, 2014), 3D printing (Hasper, Windhorst, Tuyl, Gonzales, Martinez, Yu, Farkas, & Baluch, 2015), tactile and acoustic materials (Leuders, 2016), e-learning (Huang, Shiu, Hwang, & Wang, 2014), and audio description of visual content (Emerson & Anderson, 2018).

TSVIs' Preparation to Support Mathematics Learning (via Other Tools and Assistive Technologies)

While the abacus and Nemeth are used almost exclusively in the contexts of mathematics and science education and most commonly by students who use braille, there are many other tools and assistive technologies that are used more broadly (by blind and low-vision students) across the general education curriculum; TSVIs must be prepared to support students with VI in these other tools and technologies within the context of HS mathematics. There is a gap in the literature regarding the preparation and proficiency of TSVIs in other tools and technologies (besides the abacus and Nemeth) within the context of HS mathematics education. DePountis, Pogrund, Griffin-Shirley, and Lan (2015) surveyed TSVIs to evaluate their use of high-tech

assistive technologies for supporting braille students in their study of advanced mathematics, but they did not evaluate the use of low-tech tools nor the implications for low vision or print students. Rosenblum, Cheng, Sebahazy, Emerson, and Beal (2020) surveyed TSVIs to evaluate their proficiency in verbal descriptions of graphics to low vision and blind students and concluded there is a need for "training to ensure that teachers are familiar with and are following existing guidelines for making graphics accessible [to students with VI] (p.235).

Method

In the spring of 2020, an online survey was distributed to TSVIs to gather information about their (1) preparation for (2) confidence in, and (3) practice of, supporting students with VI in general education HS mathematics classes. A link to the survey was shared via email lists, website announcements, and "word-of-mouth" (i.e., recipients of the announcement were encouraged to forward the survey link to colleagues and to post the announcement freely on websites and social media; for example, via Facebook and Twitter). The geographic range of responses, from TSVIs practicing in 19 states or territories (USA), is evidence the link was broadly disseminated. Forty-five people opened the survey and 42 *respondents* both agreed to participate and answered additional questions in the survey.

Design of the Survey

The survey was created in Qualtrics and was divided into three sections. In the first section, a general overview of the study was presented which included notice of approval from the University of Georgia's Institutional Review Board. This section concluded with a single question asking for consent from participants. The second and third sections included multiple-choice, multi-select, and limited-text-entry questions (e.g. explanations of the choice of "other" in multiple choice or multi-select questions) to gather quantitative date; and open-ended

questions to gather qualitative date. The second section of the survey consisted of 43 questions about the participant's educational background, teaching experience, and self-perceived confidence in supporting HS students with VI in their study of mathematics. The third section consisted of 27 questions which were repeated for each (if any, and up to five) HS student(s) the TSVI was supporting in the fall of 2019. The third section included question about mathematics accommodations for HS students with VI. Respondents who were not supporting a HS student in the fall of 2019 skipped the third section and ended the survey. Respondents who were supporting more than one HS student in the fall of 2019 were asked to order their HS students alphabetically by their last names and to respond to the block of 27 questions once for each student (up to the fifth) in their alphabetical list. The survey was developed with oversight from the director of the VI Education program at the University of South Carolina Upstate (Dr. Tina Herzberg). Many of the question in the survey were informed by prior research (Rapp & Rapp, 1992; DePountis, et al., 2015) and a pilot study that included interviews with two practicing TSVIs.

The Rapp and Rapp survey was distributed to TSVIs in the fall of 1988 and findings were later published an article of the Journal of Visual Impairment and Blindness (JVIB): *A survey of the current status of visually impaired students in secondary mathematics* (Rapp & Rapp, 1992). The Rapp & Rapp study revealed that participation rates varied between blind, or braille students; and low-vision, or print students, across the HS mathematics curriculum. Rapp and Rapp also reported results to questions about various accommodations in HS mathematics for students with VI. Twenty years later, in a JVIB column, *This Mattered to Me*, Dr. Derrick Smith (Associate Dean and Associate Professor at the Univeristy of Alabama at Huntsville, and a prolific researcher in VI Education) selected the Rapp and Rapp article as the piece of academic

literature that most influenced his professional career as a VI educator and researcher (Smith, 2012). However, the Rapp and Rapp study has not been replicated and its findings have not been confirmed, updated, nor compared over time. Therefore, despite its age, the Rapp and Rapp study is cited in almost all VI mathematics education literature from the past 30 years (Kapperman & Sticken, 2003; Rosenblum & Amato, 2004; Kelly, 2009; Klingengerg, Fosse & Augestad, 2019).

Analysis of the Data

The survey results were downloaded from Qualtrics and analyzed in Excel (the quantitative data) and Word (the qualitative data from two open-ended questions). I carefully read all limited-text-entry responses prompted by the selection of "other" within multiple choice and multi-select questions. In some cases, I re-categorized text-responses into an existing response option. When several respondents wrote in the same or similar responses, a new category was created. The quantitative data were then analyzed with descriptive statistics (e.g., mean, standard deviation, median, and percentages) using Excel formulas and pivot tables.

The survey included two open-ended questions to gather qualitative data. Responses to these questions were compiled in Word documents (one document for each question). Inductive content analysis (Patton, 2002) was used to identify categories and to group responses according to these categories. The researcher read through the responses a first time for an overview of the responses and to gain familiarity with the data. In a second reading, the researcher made note of similarities in the substance of various participants' responses. Since the number of responses to each question was relatively small (under 30 responses for each question), it was feasible to cut-and-paste responses in Word to move similar responses into emergent groups. This method of analysis is similar to the open-coding method described by Strauss & Corbin (1998). After

several rounds of reading and cutting-and-pasting responses, categories emerged and individual responses were selected to represent the categories of responses.

Results

In this section I present demographic information about respondents (TSVIs) and the students with VI they supported in the fall of 2019. I also examine TSVI's preparation and proficiencies in mathematics, and how these have impacted their ability to support HS students with VI in mathematics education.

Respondents

All 42 respondents were practicing TSVIs during the 2019-2020 academic year. There was a broad range of TSVI experience among respondents: from 1 to 39 years, with a median of 8 years (meaning half of the respondents had been practicing as TSVIs for at least 8 years). Most respondents were serving as itinerant TSVIs (n = 28). Four respondents were serving as Resource Teachers and three respondents split their time as TSVIs and O&M instructors. One respondent was a teacher at a residential school for the blind; and six did not provide information about the role in which they served. Respondents reported practicing in 19 states or territories (USA): with 11 respondents practicing in Georgia, 7 in Arizona; 3 in Iowa and Michigan; 2 in New Jersey, Pennsylvania and Texas; and 1 in each of the following states or territories: California, Florida, Guam, Illinois, North Carolina, South Carolina, Tennessee, Utah, Virginia, Washington, Wisconsin, and West Virginia.

College education among respondents

Participants were asked about their undergraduate and graduate college education. More than half of respondents (57.1%, n = 24) had either an undergraduate degree or a Master's degree (or both) in VI Education. Thirty respondents held an undergraduate degree in Education or dual

undergraduate degrees in Education (either General Education and Special Education, General Education and VI Education, or Middle School Education and VI Education). None of the Middle or HS Education majors indicated a STEM concentration and only one respondent who selected "other" for their undergraduate major provided a STEM major (*Computer Science*, Respondent #18). See Table 1 for counts and percentages for various categories of undergraduate degrees among respondents.

Table 1: Undergraduate degrees reported by respondents.

Undergraduate Degrees		**Count**	**Percentage**
Education	Elementary or General Education	9	21.1
	Special Education	8	19.0
	Dual degrees in Education	6	14.3
	VI Education	4	9.5
	Middle or HS Education	3	7.1
	Total (Education)	**30**	**71.4**
Other	Other (specified)	6	14.3
	Other (unspecified)	5	11.9
	No response	1	2.4
	Total (Other)	**12**	**28.6**
Total	**Education and Other**	**42**	**100.0**

Four-in-five respondents (81.0%) held an advanced (Master's or Ph.D.) degree. The most commonly reported Master's degree was in VI Education (n = 19), followed by Special Education (n = 10). See Table 2 for details about Masters' degrees among respondents.

Table 2: Master's degrees reported by respondents

Master's Degrees	**Count**	**Percentage**
Visual Impairment Education	19	45.2
Special Education	10	23.8
General or Elementary Education	2	4.8
Other	3	7.1
No response or "not applicable"	8	19.0
Total	42	100.0

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TSVIs' Coursework

I focused survey items of four specific areas of training: mathematics, mathematics education, abacus skills, and Nemeth. I also asked respondents about their self-perceived proficiency in various HS mathematics subject areas; and whether their proficiency in mathematics has impacted their ability to support students with VI.

The study of VI education and TSVI practice is complicated by diversity within the population of students with VI: which includes students with low vision and blindness; with and without additional disabilities, with cognitive abilities within its full-range; and grade levels from early intervention to transitional studies. Additionally, TSVIs provide support across the academic curriculum – not just in mathematics, but also in Science, English and Language Arts, History and Social Studies, Physical Education, Music and the Arts – it should not be expected that every TSVI would be equally interested in or qualified to support students with VI in every subject included in the general education curriculum.

Not every TSVI's caseload will include the gamut of these students – not within a school term, or within the entirety of a career. Many TSVIs have caseloads that include only low vision students, or only Elementary students. Additionally, TSVIs provide support to students with VI across the academic curriculum, and so it is not reasonable to expect that all TSVI's would be experts in mathematics (or any particular subject of the academic curriculum) – they are expected to be experts in VI Education.

Mathematics coursework completed by the respondents

Seven out of 42 respondents (16.7%) indicated that "A high school mathematics class" (n = 6) or "A not-for-college-credit…mathematics course" (n = 1) was their highest level of mathematics coursework, while 50% (n = 21) indicated an introductory (1000-level) college mathematics course was the highest level completed. Only a third of respondents (33.3%)

indicated they had taken an upper-level college mathematics course (2000-level or higher). In a study of special education graduate students, Rosas and Campbell (2010) found that only 23% of participants had completed an advanced (2000-level or higher) mathematics course. It may be that TSVIs are more likely than special education teachers (more broadly) to take college-level mathematics courses because many TSVIs have undergraduate degree in general education, elementary education or other fields. See Table 3 for details about respondents' highest levels of completed mathematics coursework.

Table 3: Highest level of mathematics coursework reported by respondents.

Highest level of mathematics coursework	**Count**	**Percent**
A high school (HS) mathematics class (such as HS Math I, II, or III; HS Algebra, HS Geometry, etc.).	6	14.3
A not-for-college-credit "remedial" or "developmental" college mathematics course (such as Developmental Mathematics or Pre-College Algebra).	1	2.4
A for-college-credit, introductory (1000-level or equivalent) mathematics course.	21	50.0
A 2000-level (or equivalent) college mathematics course (such as Calculus I, II, or III; Probability, Differential Equations, or Linear Algebra).	6	14.3
An advanced (3000-level or above) college course in mathematics (such as Real Analysis, Complex Analysis, or Mathematical Statistics).	8	19.0
Total	**42**	**100.0**

Mathematics education coursework completed by the respondents.

Half of the respondents (50.0%) indicated they had taken one or more mathematics education courses. In a follow-up question, respondents provided details about their mathematics education coursework. Eleven respondents indicated they had taken one or two elementary mathematics education courses; eight respondents indicated they had taken a mathematics education course, but did not respond to the follow-up question or did not specify the focus of their mathematics education coursework (i.e., elementary, middle or HS mathematics). Two respondents indicated it had been too long to recall or provide course details. Three respondents

indicated they had taken a statistics course (presumably as a requirement of their undergraduate or graduate education program), but since statistics is generally considered a mathematics course and not a mathematics education course, these respondents were not included among the respondents who had taken mathematics education coursework.

Mathematics or mathematics education coursework completed by the respondents.

Among the seven respondents who indicated they had not taken a college-level mathematics course, two indicated they had not taken a mathematics education course. Respondents who indicated they had taken an introductory-level college mathematics course were more likely to indicate they had also taken a mathematics education course (12 out of 21, or 57.1%), while respondents who indicated they had taken an advanced-level college mathematics course were less likely to indicate they had also taken a mathematics education course (4 out of 14, or 28.6%). While inferences should be made with caution due to the small sample size, these findings suggest that while most TSVIs have taken at least one college-level mathematics or mathematics education course, a small percentage have not (there were two among the 42 respondents to this survey who reported not having taken a college-level mathematics or mathematics education course). Since TSVIs transcribe mathematics materials for HS students, provide instruction in the use of tools and technologies within the contexts of HS mathematics, pre-teach mathematical concepts, and provide supplemental instruction in HS mathematics, it is alarming that even a small proportion of TSVIs have circumvented college-level coursework in mathematics and mathematics education. The two respondents who reported taking neither college-level mathematics nor college mathematics education coursework reported holding undergraduate and Master's degrees in education fields. These findings are consistent with prior

research in special education (e.g., Rosas & Campbell, 2010) and show that TSVIs do not universally participate in college-level mathematics or mathematics education coursework.

Self-reported Proficiencies and Impact

Self-reported proficiency in high school mathematics courses.

College course-taking does not necessarily correlate with one's proficiency in HS mathematics courses. Thus, participants were asked to rate their personal and current proficiency in common subject areas of the HS mathematics curriculum: where "5" indicated "I am an expert in the subject material" and "1" indicated "I don't know the subject material at all." Generally, as the subject levels increased, self-reported proficiencies decreased. In every subject other than General Math, Pre-Algebra, and Algebra I, the mean response was below three (a neutral assessment of proficiency): meaning that TSVIs do not generally indicate proficiency in more advanced HS mathematics subject areas (i.e., Algebra II, Geometry, Statistics). See Table 4 for the means and standard deviations (SD) of self-reported proficiencies among TSVIs by HS mathematics subject area.

Table 4: Self-reported proficiency among TSVIs by HS mathematics course.

Subject	**Mean**	**SD**
General Math or Pre-Algebra	3.81	0.92
Algebra I	3.34	1.00
Algebra II	2.92	1.05
Geometry	2.83	0.85
Statistics	2.25	1.08
Trigonometry	1.92	1.05
Pre-Calculus	1.89	0.98
Calculus	1.67	0.99

Self-perceived impact of mathematics proficiency on support of HS students' mathematics learning

In an open-ended follow-up question, respondents were asked: "In what ways, if any, has your personal proficiency in HS mathematics impacted your ability to support your students?" Twenty-nine responses were given. Responses were categorized as (1) a *hindrance* - meaning the TSVI's response indicated their personal proficiency in mathematics negatively impacted their ability to support students with VI in HS mathematics, (2) an *asset* (meaning the TSVI's response indicated their personal proficiency positively impacted their ability to support students with VI in HS mathematics, (3) *irrelevant by circumstance,* meaning the TSVI had no experience supporting a HS student with VI in the general education curriculum, and (4) *irrelevant by conviction*, meaning the TSVI indicated they did not view their proficiency in mathematics as relevant since TSVIs are not content teachers. Representative responses from each category are presented in italics. Respondent IDs and mean self-reported proficiencies across mathematics subject areas follow in parentheses.

Eleven respondents indicated TSVIs' proficiency in mathematics was a *hindrance* to supporting HS students with VI in mathematics:

> *I find it very hard to teach my students to use the tools they need to use and the symbols they need to learn. To do so most effectively, is to do it in context. I have forgotten most of what I had learned in middle and high school. The way that they teach math in elementary is confusing to me and I often don't understand what my students are supposed to be doing. Teaching anything to do with math is my weakest area because of this. Teaching tools and symbols in isolation is not effective, but neither is teaching them in context when I don't know what I am doing* (Respondent #24, M = 3.6).

> *I don't understand a lot of the content. It is difficult to assist with the Braille or technology when I don't understand the content* (Respondent #11, M = 1.6).

Nine respondents indicated TSVIs' proficiency in mathematics was an *asset* in supporting HS students with VI

> *I believe that my basic understanding of mathematics has been beneficial in following the math teacher. I am able to provide the accommodations needed and to "reteach" the student with proficiency* (Respondent #12, M = 3.9).

> *If I know how to solve the problems, I can help my student problem-solve and figure out ways that they can complete the problems more efficiently. When I don't know how to complete a problem, I look it up or ask the math teacher to explain it to me…* (Respondent #9, M = 2.9).

Four respondents indicated that regardless of their mathematics proficiency, they were not called upon to support HS students in general education mathematics coursework, which rendered their personal proficiency *irrelevant by circumstance*.

> *I was proficient in HS, but [that] was over 40 years ago! So, my proficiency in HS has not impacted my ability to support HS students. My time away from HS and the fact that I have never had a VI student at grade level in a high school class during my entire career* (Respondent #2, M = 1.1)

Finally, four respondents indicated their personal proficiency in mathematics was *irrelevant by conviction*.

> *I firmly believe that it is the responsibility of the general educator to teach the subject while I make it accessible to my student. I also stress self-advocacy to the point my students are able to ask for the assistance they need. My students are also able to explain their equipment as well as the supplementary aids/services which are in their IEPs. My students also feel confident enough to schedule a meeting between the general educator, the student, and myself should one be needed. It helps that I have an office at the high school and my students know my schedule. Any lack of mathematical knowledge on my part does not affect my ability to support my students* (Respondent #41, M = 3.0).

Analysis of these responses indicates that nearly three-quarters of TSVIs (71.4%) view their proficiency in mathematics as relevant to providing support to students with VI in HS mathematics, while the remainder do not see their proficiency in mathematics as relevant – either

because they do not support, nor have they supported, HS students in mathematics; or because they do not believe it to be their responsibility to provide mathematics instruction.

Preparation for Supporting Students with VI in Matheamtics: TSVIs' Proficiency with Assistive Tools and Technologies

The Abacus.

The abacus is used by persons with VI to perform mathematical computations, much in the same way that a sighted person would use pencil-and-paper. Amato et al., (2013) reported that nearly a third of TSVIs (31.3%) do not teach the abacus because "[They] do not have the knowledge or skills to be an effective abacus instructor for [their] students" (p. 5). While research suggests that many students favor talking calculators and other technologies over the abacus after Grade 5 (Amato, Hong, & Rosenblum, 2013), training in abacus skills remains indicative of preparation for supporting students with VI in mathematics across grade-levels. Participants in the current study were asked "How prepared are you to provide instruction in the use of an abacus?" where "0" indicated "I don't know the abacus or don't feel prepared to teach abacus skills to my students" and "100" indicated "expertly prepared." The median response was 66.5 (meaning half of respondents rated their proficiency below 67 on the 100-point scale); and five respondents (11.9%) selected "0"("I don't know the abacus or don't feel prepared to teach abacus skills to my students.") These results are consistent with prior research (Amato et al., 2013) which reported that nearly a third (31.3%) of TSVIs do not teach the abacus because "[They] do not have the knowledge or skills to be an effective abacus instructor for [their] students" (p. 5). While nearly 70% of respondents (n = 29) reported learning the abacus in a TSVI preparation course, about 10% (n = 4) reported learning the abacus exclusively through professional development (PD) or self-study. When survey participants were asked to select the

PD course in abacus skills that would be of greatest interest to them, more than half (52.4%) indicated interest in the most advanced training: "Abacus Fractions, Decimals and/or Prime Factorization." See Table 5 for participants' responses to this survey item.

These results show that many TSVIs do not view their current level of training in the abacus as sufficient and are interested in continuing their education to learn abacus skills. The abacus is not used by every student with VI: in fact, the abacus is primarily used by blind, or braille students in elementary education (Amato et al., 2013). It may be that some TSVIs do not support blind or braille students, or they do not support middle or high school students, and therefore do not have interest in learning or advancing abacus skills. Additional research is needed to inform VI Education programs (as to whether proficiency in the abacus should be mandatory), but this research suggest there is interest among TSVIs in PD to advance their abacus skills.

Table 5: Abacus PD of most interest to respondents.

Which of the following is of most interest to you for PD?	**Count**	**Percentage**
Abacus Addition and Subtraction	5	11.9
Abacus Multiplication and Division	10	23.8
Abacus Fractions, Decimals, and/or Prime Factorization	22	52.4
No response	5	11.9
Total	**42**	**100.0**

Nemeth Code within UEB Contexts.

Students and teachers use Nemeth to produce mathematical and scientific content in braille. According to Wittenstein (1993), only a third (35.8%) of TSVIs report a satisfactory knowledge of Nemeth; and according to Rosenblum and Amato (2004), less than three-quarters of TSVIs (73.2%) have taken a course in Nemeth. Participants in the current study were asked "How prepared are you to provide instruction in Nemeth Code within UEB Contexts?" where "0" indicated "I don't know Nemeth or don't feel prepared to teach Nemeth skills to my

students") and "100" indicated "expertly prepared." The median response was 61.5 (meaning half of respondents rated their proficiency in Nemeth below 62 on a 100-point scale). Two respondents selected "0." Two-thirds of respondents (66.6%) indicated they had learned Nemeth in one of their TSVI training courses, while, 11.9% indicated "I don't know Nemeth code or don't feel prepared to teach Nemeth code to my students." These results were consistent with finding from prior research reporting that 20% of VI Education programs in the U.S. and Canada do not include Nemeth training in their program (Amato, 2002) and less than three-quarters (73.2%) of TSVIs have taken a course that includes Nemeth (Rosenblum & Amato (2004). Participants were also asked to select the PD course in Nemeth that would be of greatest interest to them. Nearly one-fifth (19.0%) were interested in a "Beginners" course and 23.8% were most interested in an "Intermediate" course: suggesting that many TSVIs do not have foundational knowledge of Nemeth but see value in learning Nemeth. See Table 6 for participants' responses to this survey item. While the abacus may be an elective skill for HS students who are blind or use braille, Nemeth is a necessary skill for many blind, or braille students to access and produce work in advanced mathematics. Therefore, TSVIs who support blind or braille students must be prepared to adapt material in Nemeth and provide instruction in Nemeth to their students, therefore either VI Education or TSVI PD programs should include opportunities to learn Nemeth.

Table 6: Nemeth Code PD of most interest to respondents.

Which of the following is of most interest to you for PD?	**Count**	**Percentage**
Beginner/Introduction to Nemeth Code	8	19.0
Intermediate Nemeth Code for General Math	10	23.8
Advanced Nemeth Code (for Algebra, Geometry, or more advanced mathematics).	17	40.5
None of these	4	9.5
No response	3	7.1
Total	**42**	**100.0**

Other tools and assistive technologies.

Participants were given a list of tools and technologies and asked: "What is your current level of confidence in providing instruction/support to a HS mathematics students in the use of the following tools or assistive technologies?" The list was informed in consultation with the director of the VI Education program at USC Upstate and a review of the literature (Rapp & Rapp, 1992; DePountis et al., 2015). Respondents were also asked: "What is your current level of confidence in providing instruction to a HS mathematics teacher in the use of the following tools and assistive technologies – so that he/she may provide in-the-moment assistance to a student with visual impairment (in your absence) and/or utilize the technology for the benefit of the whole class?". The survey response items included the following choices: (1) *Not at all confident,* (2) *Somewhat confident*, and (3) *Very confident.* Responses to these questions are summarized in Table 7 in order from greatest-to-least proportion of TSVIs reporting confidence in teaching the tool or technology to students.

Table 7: Percentages of TSVIs indicating confidence in teaching tools and technologies.

Tool or assistive technology	**% confident in teaching students (n = 37)**	**% confident in teaching math teachers (n = 35)**
Magnifiers (hand-held or electronic)	100.0	100.0
Audio recordings	100.0	85.7
CCTV	97.3	100.0
Compass, protractor, and ruler	89.2	77.1
Talking calculators	86.5	88.2
Screen readers	83.8	77.1
Refreshable Braille Display (RBD)	78.4	68.6
Excel	70.3	57.1
Optical Character Recognition (OCR)	62.2	60.0
Braille translators	62.2	54.3

Math Flash	56.8	42.9
Accessible Graphing Calculator	54.1	60.0
Scientific Notebook	27.0	22.9
Graph-It	10.8	8.6

Percentages of respondents indicating confidence in teaching various tools and technologies varied greatly. All respondents were confident in teaching magnifier skills to both students and math teachers. High proportions also reported confidence in teaching the use of audio recordings and Closed-Circuit TV (CCTV). In most cases, respondents indicated greater confidence in teaching skills (e.g., audio recordings; Math Flash; Excel; compass, protractor, and ruler) to students than to mathematics teachers. Yet more TSVIs reported confidence in teaching CCTV, Talking Calculators, and Accessible Graphing Calculator to mathematics teachers than to students. Percentages reporting confidence (in responses to both questions) were lowest for Math Flash, Accessible Graphing Calculator, Scientific Notebook, and Graph-It – all of which are accessible software applications for students with VI. It is not surprising that more TSVIs reported confidence in teaching tools and technologies that are employed across the curriculum (e.g., magnifiers, audio-recordings, and CCTV). It is concerning, in terms of preparation for supporting students in mathematics, that 13.5% of TSVIs were not confident in teaching talking calculator skills to students; and 45.9% were not confident in teaching students how to use Accessible Graphing Calculator. Students with VI need access to tools or technologies to execute mathematical computations – whether an abacus, a talking calculator, or Accessible Graphing Calculator. It is possible that not all TSVIs have caseloads (past, present, or foreseeable) that include students who use an abacus, talking calculator, or Accessible Graphing Calculator. PD programming could target TSVIs who are interested in learning to teach these skills.

Confidence in Supporting Students with VI in Mathematics

Participants were asked questions about their self-perceived confidence in supporting HS students with VI in general education mathematics classes at the start of their career as a TSVI; and whether, and how, their confidence had changed over time or through experience. Just over a third of respondents (34.2%) reported feeling unprepared at the start of their career, but 81.6% reported an increase in confidence over time. Responses to an open-ended follow-up question suggest there are diverse means by which TSVIs gain confidence in their ability to support HS students with VI, rendering content analysis difficult. Clear categories among responses did not emerge, but responses were grouped (most often in pairs) to categorize the means-by-which confidence in supporting students with VI in mathematics might change over time. In the following section, several of those means are identified with representative quotes from respondents. The respondent's IDs and their reported level of confidence at the start of their career are included parenthetically with each quote.

Two respondents attributed their change in confidence to teaching or co-teaching mathematics classes.

> *I have taught or co-taught math throughout my career, so the content was not my worry. Providing the types of supplemental materials (graphics, etc.) to help my student was my concern…* (Respondent #15, "Neutral").

> *Immediately after graduating with my master's degree, I co-taught several high school math classes, which allowed me the opportunity to improve my teaching methods & gain confidence in teaching math* (Respondent #21, "Somewhat prepared").

Two TSVIs remarked that sitting in on math classes with students served as a refresher for mathematics content or their TSVI training.

> *The more math classes I sit through helping my students the more I remember how to complete the problems and I am able to help my students figure out how to solve using an abacus or calculator* (Respondent #7, "Somewhat prepared").

> *I have gained more and more experience in high school math classes with my student that reads braille. With that, I have had to become more familiar with Nemeth codes that are required for the student to access*. (Respondent #13, "neutral")

Several (nine) TSVIs attributed their change in confidence to taking courses or self-study.

> *I was hired without any experience in teaching students with visual impairments and started taking classes when I was hired. Since then, I have had graduate level coursework and professional development training in supporting students with visual impairments in their study of high school mathematics. I am much more confident now as I am familiar with the concepts, materials, Nemeth code, and instructional methods* (Respondent #24, "Not at all prepared").

A couple of comments indicated that TSVIs learned skills from their children and students.

> *I have had to learn from my own kids who are math whizzes about math symbols found in calculus and trigonometry, which I did not study in high school or college* (Respondent #27, "Somewhat prepared").

> *I had an exceptional braille reader who discussed [problems] he was having in math class. I needed to be able to provide on the spot Nemeth in order to help support his concept development. He would go over any Nemeth mistakes I had made. When he said that I was doing it correctly, I could believe him* (Respondent #41, "Somewhat prepared").

> Support from a state agent or local colleague may promote confidence among TSVIs.

Two respondents indicated their confidence was bolstered by consultation with a state agent or fellow teachers.

> *Through PD and support from our statewide math consultant…I know where to go to get questions answered, I know what materials are available to me, and I know more about the Nemeth Code in general.* (Respondent #23, "Not at all prepared").

> *I used several manuals, online resources, help from math teacher[s] and often ask questions of a math teacher at the [state school] for the blind, as he is an expert in both math and Nemeth (Respondent #35,* "Not at all prepared").

Additional comments from TSVIs reveal cautious-optimism, despite a lack of opportunity to exercise their skills (including a comment from the only self-reported "expertly prepared" respondent).

> *There have not been blind or visually impaired students who needed advanced teaching in Nemeth or abacus; therefore, my skills waned from lack of use! I believe when I have a student needing these services, I will be able to pick up these skills with the resources available!* (Respondent #12, "Expertly prepared").
>
> *It has been a few years since I took the advanced braille course that included Nemeth. This is my first year as a TVI but I do not serve any students using braille. I am concerned that I am unprepared for an academic braille student* (Respondent #34, "Not at all prepared").

Accommodations for HS Students with VI

Participants were asked to provide information about the HS students they were supporting in the fall of 2019. Thirty-one TSVIs provided information about 41 HS students who were enrolled in a general education math class in the fall of 2019. Twenty-five of the students were low vision, print students; and 16 were blind, braille or dual-media students. Nine of the students were Grade 9, eleven were Grade 10, ten were Grade 11 and eleven were Grade 12. Responses indicated diverse course-taking among the represented students: with 7 students enrolled in General Math or Pre-Algebra, 10 enrolled in Algebra I, and 24 enrolled in a more advanced mathematics course.

In the following sections, accommodations for low vision, or print students and blind, braille or dual-media students are discussed. Many of the most commonly reported accommodations (e.g., providing materials in large-print or braille; and allowing extra time for tests and assignments) are neither high-tech, nor specific to mathematics instruction (with the possible exception of producing materials in Nemeth).

Accommodations for low vision, print students and blind, braille or dual-media students

Participants were asked about the accommodations they provided for the 25 low vision, print students they supported. Specifically, respondents were asked if assignments were reduced for these students and whether a dedicated aid or paraprofessional attended mathematics classes with the student. For 28% of the low vision students, assignments were "usually," "frequently," or "always" reduced. Only one of the 25 low vision students had a dedicated aide or paraprofessional who regularly attended mathematics classes with the student.

Participants were provided a list of common accommodations for low vision, print students and asked to select all of the accommodations that were listed on their low vision or print students' IEPs. The list of accommodations and the number of IEPs on which these accommodations were included are presented in Table 8 (from most commonly to least commonly selected).

Table 8: Reported accommodations for low vision or print-readers.

Accommodations for low vision or print-readers	**Count of IEPs (n = 19)**	**% of IEPs**
Specified seating (e.g., at the front of the class or near the board)	16	84.2
Extra time for tests	15	78.9
Large-print materials (textbooks, handouts, worksheets, exams, etc.)	14	73.7
Calculator (standard, talking, or Accessible)	11	57.9
Magnifier (digital/screen)	9	47.4
Specialized software (e.g., ZoomText or MAGic)	8	42.1
Magnifier (hand-held)	7	36.8
CCTV	4	21.1
Note-taker	1	5.3

In a follow-up question, TSVIs were asked to list any additional accommodations on their low vision, print students' IEPs. Many of the responses (n = 15) indicated testing accommodations and included: reading of test questions (n = 5), small-group or Resource Room test sites (n = 3), paper-and-pencil tests (n = 2), verbal response to test questions (n = 2), marking of answers on test documents (n = 2), and reducing test items (n = 1).

The most common accommodations on the IEPs of low vision, print students could be implemented by mathematics teachers and paraprofessionals with consultation from a TSVI (e.g., specified seating in the classroom and many of the testing accommodations on IEPs). Through consultation with TSVIs or PD, mathematics teachers could be impowered to produce materials in large-print (e.g., handouts, worksheets, and tests) and assist low vision students in their use of calculators.

Accommodations for blind, braille or dual-media readers.

Participants were asked about the accommodations they provided to the 16 braille or dual media readers they worked with in the fall of 2019. Specifically, TSVIs were asked if the abacus was an accommodation; whether they produced materials using Nemeth, UEB Technical, or another braille code; if assignments were reduced for students; or whether an aide or paraprofessional attended math classes with the student to provide dedicated support. The abacus was used to accommodate three of the 16 students, which is consistent with existing research that indicates the abacus is not a preferred accommodation for HS students with VI (Brawand & Johnson, 2016). Nemeth was used to produce materials for 14 students, while UEB Technical code was used for one student, and another student did not read braille. According to respondents, 10 of 16 braille or dual-media students (62.5%) were "usually," "frequently," or "always" given reduced homework assignments; and nine of 16 (56.3%) had a dedicated aide or paraprofessional who regularly attended math classes with the student and provided 1-1 or focused support.

Participants were provided a list of other common accommodations for blind or braille students and asked to select all that were listed on their students' IEPs. The provided accommodations and the number of IEPs on which these accommodations were included are presented in Table 9 (from most commonly to least commonly selected).

Table 9: Reported accommodations for braille and dual media readers.

Accommodations for braille or dual media readers	**Count of IEPs (n = 16)**	**% of IEPs**
Braille materials (textbooks, handouts, worksheets, exams, etc.)	15	93.8
Extra time for tests	15	93.8
Screen reader (such as JAWS or VoiceOver)	14	87.5
Electronic Refreshable Braille Display/notetaker	13	81.3
Talking calculator	12	75.0
Personal computer, laptop, or tablet	12	75.0
Accessible Graphing Calculator	10	62.5
Audio recordings	5	31.3
Duxbury Braille Translator (DBT)	5	31.3
Scanner or reader	3	18.8
Optical Character Recognition	2	12.5
Scientific Notebook	1	6.3
Graph-It	1	6.3

Respondents were also given the opportunity to write-in additional accommodations from their Braille and dual-media-readers' IEPs. Among the most common were: (1) note-taking assistance, reader/scribe, or transcription support (2) extra time for assignments (3) reduced workload and (4) tactile graphics.

Providing accommodations to students with VI

When asked "Were you able to provide/produce materials and procure all the tools and technologies that you felt were needed to accommodate the student in their mathematics class (and in a timely manner)?" nearly one-third (5 of 16 respondents to this question) answered "no." The reasons given were attributed to timing: either the mathematics teacher did not provide the materials in a timely manner or a vendor did not produce the materials in a timely manner:

> *I was often given materials the day before they were needed…* (Respondent #41).
>
> *Materials were sent to a vender and material was not received in a timely manner.* (Respondent #30).

These findings confirm that adapting the curriculum in a timely manner is a persistent problem for TSVIs and students with VI (Annis, 2010). Adapted materials were among the most common accommodation on IEPs of students with VI: included on 73.7% of IEPs of low vision or print students; and 93.8% of IEPs of blind, braille or dual-media students. Mathematics Education and mathematics teachers bear some responsibility for the persistence of this issue and could play a part in the solution. Mathematics education program should address including students with disabilities more broadly across their curriculum, and pre-service teachers could be directed towards field experiences in inclusive classrooms or in mathematics classroom at residential schools for the blind. These experiences would give insight to pre-service teachers into the challenges of adapting materials for diverse students. Additionally, practicing mathematics teachers could be taught how adapt course materials in large print or braille with PD addressing enlargement and transcription software. While these technologies have not been perfected, HS students are often able to recognize errors in transcription and ask their mathematics teacher or TSVIS for clarification, as needed. It may be more efficient for mathematics teachers for produce materials in alternative formats (such as large print, braille, or Nemeth) and for TSVIs to make

edits. Of course, for this process to work (where the mathematics teacher produces materials in alternative formats and the TSVI checks for accuracy), TSVIs must be proficient in the alternative formats (especially braille and Nemeth), and whether the TSVI is producing or editing materials, it is helpful for the TSVI to understand the mathematical contexts and the desired learning outcomes of the lessons.

Summary

While it is generally and "officially" the responsibility of mathematics teachers to teach mathematics content in general education HS mathematics classes, it is often incumbent on TSVIs to provide pre-teaching or supplemental instruction to students with VI – in addition to producing materials and providing instruction in assistive technologies so that students can access the content. Findings from this survey show that most TSVI's view their proficiency in mathematics as relevant to supporting students with VI in HS mathematics. Results of this study suggest that most TSVIs have taken a least one college-level mathematics or mathematics education course, but a few have not taken a course in either discipline. Many TSVIs do not consider themselves proficient in HS mathematics beyond General Math, Pre-Algebra, and Algebra. Responding TSVIs indicated their content knowledge (or lack thereof) was relevant to their ability to support students: either as an asset (37.0%) or hindrance (37.9%). Universally requiring at least one college-level mathematics (methods) course for undergraduate education majors could impact future TSVIs' preparation for supporting students with VI in HS mathematics.

Half of the respondents scored their abacus proficiency below 67 on a 100-point scale, but the abacus was an accommodation on just three of the IEPs of 16 HS braille students represented in by respondents. It was nonetheless surprising that more than half of respondents

were interested in engaging in professional development experiences focused on advanced abacus skills. This may be due to the diverse caseloads of responding TSVIs, which included students across the K-12 curriculum (many for whom the abacus is not an accommodation).

Providing materials in braille was the most common accommodation listed on the IEPs of blind, braille or dual-media students. Nemeth is necessary to produce higher-level mathematics content in braille. Yet, only two-thirds of respondents reported learning Nemeth in a TSVI preparation course and 19.0% reported being un-prepared to provide instruction in Nemeth. This helps explain why the vast majority of respondents indicated interest in advancing their Nemeth skills through PD. Requiring Nemeth training in VI Education programs or offering PD in Nemeth more broadly, would impact TSVIs' ability to support HS students with VI.

One-third of respondents did not feel prepared at the start of their career as a TSVI to provide support to HS students with VI in mathematics, but four-fifths reported gaining confidence over time through experience. Respondents attributed their change in confidence to factors including: (1) teaching or co-teaching a mathematics class, (2) attending mathematics classes with their students, (3) taking additional courses or self-study, (4) learning from their students, or (5) taking advantage of within-school or regional resources (e.g., mathematics teachers, fellow TSVIs, and state consultants). Pairing newly qualified TSVIs with mentors, whether more experienced TSVIs or mathematics teachers, may help all TSVIs navigate through the sharing of experiences and resources.

The most common accommodations on IEPs of low vision students were (1) specified seating, (2) extra time for tests, (3) other testing accommodations, (4) large-print materials, and (5) a calculator. For blind, or braille students, the most common accommodations were (1) braille materials, (2) extra time for tests, (3) screen reader software, (4) electronic refreshable

braille displays, and (5) a talking calculator. Many of the most common accommodations were neither “high-tech” nor specific to mathematics: with the exceptions of producing mathematics materials in braille which requires knowledge of Nemeth, and calculators. Most TSVIs (86.5%) reported confidence in teaching talking calculator skills to students, but only 54.1% reported confidence in teaching Accessible Graphing Calculator to students (a graphing technology listed on 10 of 16 IEPs for braille students). Thus, if appears there could be demand among TSVIs for PD addressing talking calculator and Accessible Graphing Calculator support.

TSVIs reported not being able to produce materials in large-print or braille in a timely manner because they were not given the materials by the mathematics teacher in a timely manner, or because an outside vendor did not produce the materials in a timely manner. These issues are not easily addressed through TSVI Education or PD. Additional research is needed to investigate whether it would be more efficient to shift responsibility to mathematics teachers for producing materials in alternative formats (such as large print and braille)– in which case, the role of the TSVI would be shifted to reviewing and editing materials, and helping students resolve transcription issues.

Limitations

Conclusions from this study were limited by the sample size. The survey was open for three weeks (from May 10 to May 31, 2020) when many schools were closed due to the COVID-19 pandemic and teachers were finishing up the 2019-2020 academic year. If the survey had been open during “normal” times, there may have been more responses: which would have permitted between-group statistical comparisons (e.g., to test whether TSVIs who had not taken a college-level mathematics course felt less confident in their ability to provide support to HS students with VI than TSVIs who had taken a college-level mathematics course).

I also acknowledge that the survey was not administered randomly. Respondents self-selected and it is possible the respondents were among those most interested in the topic of HS mathematics education for students with VI. Respondents did not provide information for all HS students they were supporting in the fall of 2019 (not even the first five, when listed alphabetically). Respondents reported supporting 159 HS students collectively yet provided information for only 61 students of whom just 41were taking a HS mathematics class.

CHAPTER 3

THE IMPACT OF THE COVID-19 PANDEMIC ON THE EDUCATIONAL EXPERIENCES OF SCHOOL-AGED CHILDREN WITH VISUAL IMPAIRMENTS[2]

[2] McBride, C.R. To be submitted to: The Journal of Visual Impairment and Blindness

Abstract

In the spring of 2020, the *Access and Engagement Survey* (AES) was distributed in the United States and Canada to ask questions about the impact of the COVID-19 pandemic on the education of school-aged children with visual impairments (VI). The survey was open from April 22 to May 13, 2020 to family members and guardians of students with VI (hereafter, referred to as *parents*), and to teachers of students with VI (TSVIs) and orientation and mobility (O&M) instructors. Responses to the AES from parents of school-aged students were analyzed (n = 312), and among the students represented, approximately two-thirds had low-vision (67.5%) and one-third (32.5%) were blind; and more than two-thirds (67.8%) attended their local public school prior to the COVID-19 pandemic. In this article, the impact of the COVID-19 pandemic is investigated across five dimensions: (1) concerns of parents, (2) access to materials, tools and technologies, (3) access to classroom teachers, (4) access to a TSVI, and (5) access to an O&M instructor. Despite their best, and often extraordinary efforts, parents were concerned about the educational experiences of their children with VI: because they did not have the time, training, or recourses to facilitate at-home instruction. Parents commonly reported not having adequate access to large-print and braille materials, software, and mathematics tools. While most parents reported “the same” or increased support from classroom teachers, comments indicated that academic and special education teachers do not fully understand the needs of students with VI. Most parents provided positive comments about their child’s TSVI; and comments that dismissed the responsibilities of their child’s O&M instructor.

Overview of the Access and Engagement Survey

In the spring of 2020, the Access and Engagement Survey (AES) was distributed in the United States and Canada with two goals: (1) to understand how educational services for children with visual impairments were impacted by the COVID-19 pandemic; and (2) to gather information on how TSVIs and O&M instructors were providing services during the pandemic. The AES was developed by Dr. L. Penny Rosenblum (Director of Research at the American Foundation for the Blind), Dr. Tina Herzberg (Director of the VI Education program at the University of South Carolina Upstate), and Dr. Tiffany Wild (Assistant Chair of the Department of Teaching and Learning at The Ohio State University); and was distributed with assistance from more than 20 organizations and companies with interests in blindness and VI. The survey was open from April 22 through May 13 (2020) and was completed by 1,764 participants who were either a parent of a child with a VI, a TSVI, an O&M instructor, or a combination of these roles. The survey included 290 questions: however, not every participant was expected to answer every question. The questions were organized into blocks according to the target participant: either a parent or a service provider. Questions for parents were subdivided to target parents of children receiving early intervention services (children from birth to age 3); parents of preschool children (not yet aged 7); and parents of school-age children (in kindergarten through exiting school). Questions for service providers were subdivided to target TSVIs or O&M instructors. Other blocks of question addressed demographics of parents and service providers. A few initial questions determined which block(s) of questions would be included in a participant's survey. The types of questions included Likert-scaled questions, multiple choice questions, and multi-select questions to gather quantitative data; and open-ended questions to gather qualitative data.

The Institutional Review Board of the University of Georgia determined that my analysis of the AES data was not Human Subjects Research since the data were de-identified.

Methods

The focus of this paper is on the responses to 73 questions included in the AES that were targeted to parents of school-aged children (ages 5 to 22) residing in the United States. The questions that were analyzed are included in as an appendix. Twenty-five questions asked about the education of students with VI prior to and during the pandemic (e.g., whether students were attending a public or private school prior to the pandemic; and whether students continued to attend school during the pandemic). Seven questions asked about the general response of school districts to the COVID-19 pandemic (e.g., how districts were providing instruction to non-disabled students). Five questions asked about instruction from classroom teachers during the pandemic, nine questions asked about instruction from TSVIs, and nine questions asked about instruction from O&M instructors. The remaining 18 questions were intended to gather demographic and background information about parents and to understand the broad impact of the COVID-19 pandemic on families that included a school-aged child with VI.

The responses to these questions from parents (n = 312) are hereafter referred to as "the data." The complete de-identified AES data were shared with me in an SPSS (.sav) file, which I exported to an Excel spreadsheet for analysis. The data were isolated from the full set of responses using sort functions based on the country indicated by the AES respondent (United States vs. Canada) and the role identified by the AES respondent (parent vs. educator). The AES was offered in English and Spanish, but translation of the seven Spanish-language responses was not available and consequently these responses were not included in the analysis.

For purposes presented here, percentages were calculated based on responses to individual questions. Because not every respondent replied to every question, the total number of responses (n) varies from question to question. When percentages are reported here, they are based on the number of responses to that question or the number of respondents who selected at least one option when multiple selections were possible, and not the total number of respondents (312). The "n" reported immediately after a percentage is the number of respondents who selected that answer. Open-ended and short-answer responses were analyzed to find patterns of response and to identify unique and poignant elaborations.

The qualitative data (responses to open-ended questions) were analyzed using inductive content analysis (Patton, 2002) to group responses according to emergent categories. The researcher read through the responses a first time for an overview of the responses and to gain familiarity with the data. In a second reading, the researcher made note of similarities in the substance of various participants' responses. In multiple additional readings, the researcher categorized responses based on emergent codes. This method of analysis is similar to the open-coding method described by Strauss & Corbin (1998). Selected quotes from the qualitative data were selected to represent categories, support key findings, and give voice to the respondents.

Respondents

The respondents in the data were the parents of school-aged children with VI (i.e., children enrolled in Grades K-12, or *transition studies*). Students participating in transition studies include adult students with VI (up to age 21) who are learning ECC skills such as self-advocacy and independent living in HS settings. Many respondents provided demographic information about themselves. The data show that respondents were living in one of 41 states, with the highest proportion of responses coming from Texas (11.3%), Florida (7.0%) and New

York (6.1%) - some respondents did not provide their state-of-residence, so it is possible that additional states are represented in the data. Nearly all respondents (97.3%) indicated there was a state or local "shelter in place" policy in place at the time they completed the survey (whether a mandate, advisory notice, or recommendation). Most respondents (88.2%) indicated that "No one in my household has exhibited symptoms or been tested for COVID-19," but the remainder (more than 10%) indicated that a member of their household had either shown symptoms, been tested, or was at high-risk for exposure to COVID-19.

The responses in the data may not be representative of all parents of school-aged children with VI: almost all respondents identified as female (91.6%), and 80.1% identified as White (see Table 10 for race/ethnicity among respondents). Nearly a quarter of respondents (24.4%) indicated having a disability or health concern themselves. Thirty-four respondents reported a chronic health condition, fourteen reported a VI; and ten reported a mental health condition. Perhaps most importantly in terms of possible bias in the data: several respondents (12.7%, n = 31) reported being both a TSVI **and** a parent of a child with VI.

Table 10: Race/Ethnicity reported by respondents in the data.

Race/Ethnicity	**Count**	**Percentage**
White	181	80.1
Hispanic or Latino/Latina	15	6.6
Black or African American	9	4.0
Multi-racial	3	1.3
Asian	3	1.3
Native Hawaiian or Pacific Islander	3	1.3
Other	1	0.4
I prefer not to answer	11	4.9
Total	**226**	**100.0**

Students Represented by the Respondents

Respondents were asked to provide information about the school-aged child/children with VI within their charge. More than half of the students (55%) were 5-12 years old (presumably in grade-school) while the remainder (45%) were 13-22 years old (presumably in middle, high school, or transition studies). See Table 11 for ages of students represented by respondents. Among the students represented, approximately two-thirds had low vision (67.5%) and one-third (32.5%) was blind. See Table 12 for details about levels of vision and additional disabilities among the represented students. More than two-thirds (67.8%) of students reportedly attended their local public school (see Table 13 for information about school attendance prior to the pandemic).

Table 11: Ages of children represented by respondents.

Age	**Count**	**Percentage**
5 - 7	40	13.7
8 - 10	76	26.0
11 - 12	44	15.1
13 - 15	59	20.2
16 - 18	57	19.5
19 - 22	16	5.5
Total	**292**	**100.0**

Table 12: Visual impairments and additional disabilities among students.

Visual Impairment	**Additional disability/disabilities**	**Count**	**Percentage**
Low vision			
	No additional disability	90	30.8
	Additional disability/disabilities	107	36.6
Total (low vision)		*197*	*67.4*
Blind			
	No additional disability	43	14.7
	Additional disability/disabilities	52	17.8
Total (blind)		*95*	*32.5*
Total (all)		**288**	**100.0**

Table 13: School-setting for students prior to the pandemic.

School/Classroom setting prior to the pandemic.	**Count**	**Percentage**
A public school classroom with nondisabled peers for the entire school day.	74	25.3
A public school classroom with nondisabled peers for most of the day.	67	22.9

A public school special education class for most of the day.	57	19.5
A center-based school for children with varying disabilities.	11	3.8
A school for the blind/residential school.	40	13.7
A charter or private school.	23	7.9
My child was home schooled	20	6.8
Total	**292**	**100.0**

Findings

In the following section, I present findings that emerged from my analysis of the data. I was interested in how the COVID-19 pandemic has impacted school-age children: specifically through (1) concerns of parents (2) access to materials, tools and assistive technologies, (3) support from classroom teachers, (4) support from TSVIs, and (5) support from O&M instructors. Findings are presented in this order.

Concerns of Parents

The change in education delivery due to the COVID-19 pandemic impacted students with VI and their families. With almost all schools closed to in-person learning (with the possible exception of residential schools for the blind), parents and siblings of students with VI did their best to assist with at-home, mostly online, teaching and learning. When asked how the change in education has impacted their child or children with VI and family, respondents were forthcoming. Many parent(s) of a child with VI reported that they worked full-time and that there was more than one child in their care. Understandably, these parents reported they simply did not have the time to “home-school” their child with a VI.

> *We are deemed essential workers and have continued to work during the pandemic. We have 3 children, 1 of which is blind. They are all home doing "virtual" school while my husband and I go to work nearly every day…* (Parent of a blind student).

Alternately, families reported having to make sacrifices to provide or monitor at-home instruction. For example, some parents described leaving their jobs to stay at home as "teachers" or siblings are stepping-in to help.

> *I have had to give up my job mostly to become a full-time educator for my child (*Family member of a blind student with additional disabilities).

> *My child uses a VI assistant at school to facilitate his following and participating in the classroom. Thus, to complete the at home assignments, he requires someone to facilitate. As both parents are still working, we are having his 15 year old brother assist him. This is obviously not ideal and not everything gets accomplished. The first week he was home, I was off, and so I assisted him. It took about 6 hours a day at his side to get his work done correctly. This was more than we can continue to do and to keep the basics of life going (laundry, cleaning, meal prep, etc.). It is also a burden for the 15 year old who has his own schoolwork to maintain* (Family member of a blind student with additional disabilities).

Despite these sacrifices and best-efforts, many parents identified their lack of training as a hindrance to their ability to support their child with VI:

> *My child has a total of 8 teachers and therapists. These professionals have education in their fields to work with my child and use tools and manipulatives to accomplish the desired skills that I do not have* (Parent of a blind student with additional disabilities).

> *Parents are not teachers, so while we are going through the motions to complete assignments, we are not teaching the fundamentals of the subjects. We, as parents of blind kids, are also not TVIs, and not trained to teach the blind. The workload is intense for working parents who are trying to balance time for both. As a parent of a special needs child, I must spend most of the time working directly with my daughter on all assignments* (Parent of a blind student with additional disabilities).

In addition, many students with VI (and perhaps with additional disabilities) benefit from the routine and structure of going to school and many parents discussed the difficulty of replicating this environment at home.

> *My child refuses to do work in the home setting. Having removed her from the environment where focus is required and expected, she has become lax and will not do the tasks required* (Parent of a low vision student).

> *She gets frustrated without the routine of school. Home is her safe place where she can relax. That has been taken away from her* (Parent of a low vision student with additional disabilities).

Parents recognized that attending school plays a part in the socialization and emotional well-being of students with VI. When students are not able to attend school, they miss their friends and they also miss out on learning social and communication skills.

> *…too much time away from friends and activities has led to sadness and symptoms and feelings of depression* (Parent of a low vision student).

> *I feel like we can provide most of the academic supports my child needs, but he needs help with social skills and communication. Those are hard to support when there is severely limited interactions with others/peers. This is his biggest area of need and is the area he is not receiving support in. This is incredibly frustrating* (Parent of a blind student with additional disabilities).

> *I worry about the social skills that my student was working on. He will not have this opportunity learning at home* (Parent of a low vision student).

> *Although my child is significantly globally developmentally disabled, the social aspect of school—being surrounded by his peers, many of whom are involved in the implementation of his curriculum—has been his biggest motivator during the time he has been at school. His school team has been incredible at guiding us through this time of remote learning, but our child surely misses that important social component that school has always provided for him* (Parent of a low vision student with additional disabilities).

Accessibility was another issue for students with VI learning at home.

> *He experiences frequent frustration because materials posted online and/or online resources (classroom meetings, instructional videos etc.) aren't adapted for him. The print is always too small or he can't zoom the screen enough. For me (his mother) it's a very big load on me to fill in those gaps- reading things out to him, scribing his work, etc. I am of course happy to do it so he can continue engaging with his schoolwork but it definitely feels overwhelming*. (Parent of a low vision student).

Likewise, access to technology and the internet was a concern among parents:

> *The technology he uses has been glitchy at home, resulting in additional frustration for him. We have had to troubleshoot ZoomText since it doesn't work well with Google Classroom. The way teachers are assigning work and asking for work to be completed in Google*

> *Classroom is new to him, and also results in frustration. Some of the adaptive resources like slant boards are not available at home and his posture is suffering from not having a surface that we can vary the height on while he is spending so much time in front of a screen. I don't know how well he will be for 8th grade next year which is such a crucial year* (Parent of a low vision student).

Participants were asked three Likert-scaled questions about their concerns regarding their child's instruction during the COVID-19 pandemic, where "1" indicated "strongly disagree," and "5" indicated "strongly agree." The questions are listed below along with tables showing the percentages of respondents who either agreed or strongly agreed with the statement, by categories of disability.

1. I believe that I am not living up to the expectations of my child's educators because I cannot complete everything they are asking me to do with/for my child.
   Table 14: Percent in agreement by vision/disability.

Category of the students represented	% agreed
Low vision students	23.2
Low vision students with additional disabilities	39.8
Blind students	42.5
Blind students with additional disabilities	58.7
Overall	**38.3**

More that half of parents of blind students with additional disabilities expressed concern they were not meeting the expectations of their child's educators.

2. I believe my child is continuing to make progression the same way they would if there had not been a change in where and how my child is receiving educational services.
   Table 15: Percent in agreement by vision/disability.

Category of the students represented	% agreed
Low vision students	26.8
Low vision students with additional disabilities	20.4
Blind students	36.6
Blind students with additional disabilities	24.4
Overall	**25.6**

Only a quarter of parents indicated belief that their child was making progress in the same way they would if not for the changes necessitated by the pandemic.

3. Because of the changes in my child's education I do not believe my child will be ready for the next school year.

Table 16: Percent in agreement by vision/disability.

Category of the students represented	% agreed
Low vision students	12.0
Low vision students with additional disabilities	36.7
Blind students	19.5
Blind students with additional disabilities	48.9
Overall	**28.5**

Parents of students with additional disabilities were more likely to express concern about their child's readiness for the next school year. Parents of low vision students with additional disabilities reported concern at three times the rate of parents of low vision students with VI as a primary or only disability; and parents of blind students with additional disabilities reported concern at more than twice the rate of parents of blind students with VI as a primary of only disability.

These findings suggest that students who are blind or have additional disabilities are the most vulnerable to the impact of school closings. If schools remain closed, or in the case of future school closing, schools, teachers, and VI professionals should give consideration to the challenges of at-home learning for students and their parents.

Tools and Assistive Technologies

Students with VI use a variety of tools and assistive technologies to access content and produce materials. AES participants were provided a list of common accommodations for students with VI and asked to "Select all the tools your child was using before the COVID-19 pandemic changed how your child receives their education." Tablets (e.g., iPads and Android tablets) were the most commonly selected tool and were reportedly used by about three-quarters of low vision students and nearly half of blind students. Laptops were used by approximately

two-thirds of students without additional disabilities, but by less than half of low vision students with additional disabilities, and just over a quarter of blind students with additional disabilities. A white cane was the most common tool for blind students, followed by the Perkins braillewriter. Full results are presented in Table 17 by categories of students (all students, low vision students, low vision students with additional disabilities, blind students, and blind students with additional disabilities) in order from "most used" to "least used" among all students. The second column, "Count among all students" (with n = 312), includes the 20 students whose vision/disability was not indicated by the responding parent. Within group percentages that were at least 50% are in bold print.

Table 17: Tools and assistive technologies used by students before the pandemic.

Tool or Assistive Technology	Count among all students	% among Low vision students	% among Low vision students w. additional disabilities	% among Blind students	% among Blind students w. additional disabilities
	n = 312	n = 90	n = 107	n = 43	n = 52
Tablet	173	**72.3**	**72.2**	**50.0**	44.9
Cane / White cane	169	**56.6**	43.3	**92.9**	**83.7**
Laptop	143	**67.5**	46.4	**66.7**	28.6
Perkins braille writer	114	41.0	14.4	**81.0**	**65.3**
Screen reading software	98	33.7	18.6	**69.0**	46.9
Large print books	93	**51.8**	49.5	0.0	4.1
Screen enlargement software	83	47.0	38.1	2.4	12.2
Math manipulatives	78	13.3	32.0	47.6	32.7
Braille recreational books	75	20.5	6.2	**76.2**	40.8
Materials for tactile graphics	71	9.6	14.4	**71.4**	38.8
Hand-held magnifier	71	47.0	29.9	2.4	4.1
Electronic magnifier / CCTV	64	43.4	24.7	4.8	4.1
Braille textbooks	63	14.5	4.1	**69.0**	36.7
Refreshable braille display	58	16.9	4.1	**52.4**	36.7
Abacus	47	10.8	5.2	**52.4**	22.4
Victor Reader Stream	45	16.9	7.2	33.3	20.4
Braille notetaker	44	13.3	3.1	**50.0**	18.4
Adapted books	43	8.4	21.6	9.5	22.4

Communication device	43	2.4	26.8	7.1	24.5
Hand-held monocular	39	31.3	11.3	2.4	2.0
Other	36	12.0	16.5	11.9	10.2
I'm not sure if there are additional items my child used	35	7.2	18.6	9.5	14.3
Pre-cane	11	1.2	5.2	0.0	10.2
Artificial vision device	6	3.6	2.1	2.4	0.0

For many purposes it is convenient to categorize tools and assistive technologies as *tools and assistive technologies for low vision, print students* or *tools and assistive technologies for blind, or braille students*. These findings show that such categorizations should not be interpreted as strict and definitive. Nearly every tool or assistive technology on the list was used by a percentage of students in each category (i.e., low vision, low vision with additional disabilities, blind, and blind with additional disabilities). The only exception was large print books, which were not used by any blind student that did not have an additional disability (even though 4.1% of blind students with additional disabilities used large print books). These results emphasize the important role that VI professionals play in assessing how a student uses their vision and recommending appropriate tools and assistive technologies for each student. In on-line learning environments, classroom teachers need to refer to each student's IEP to know which accommodations are appropriate.

Participants were also asked to "Select the tools that your child *does not have* at home which impacts their ability to learn." Responses indicated that materials, software, and mathematic tools were generally unavailable at home. Overall, "large-print books" were the most commonly selected tool, but "adapted books" was also in the top five and "braille textbooks" was selected by more than a third of respondents representing blind students. Screen reading software (e.g., JAWS, NVDA, and VoiceOver), screen enlargement software (e.g., ZoomText),

electronic magnifiers, and tools used in the study of mathematics (manipulatives and tactile graphics materials) were the also commonly selected. See Table 18 for details.

Table 18: Tools needed at home by students with visual impairments.

Tool or Assistive Technology	Count among all students	% among Low vision students	% among Low vision students w. additional disabilities	% among Blind students	% among Blind students w. additional disabilities
	n = 312	n = 90	n = 107	n = 43	n = 52
Large print books	55	40.5	54.2	5.3	20.0
Screen reading software	42	26.2	28.8	36.8	28.0
Screen enlargement software	41	33.3	32.2	10.5	24.0
Electronic magnifier / CCTV	40	38.1	27.1	10.5	24.0
Adapted books	35	14.3	33.9	0.0	36.0
Math manipulatives	35	11.9	28.8	21.1	36.0
Materials for tactile graphics	34	14.3	22.0	36.8	32.0
Braille textbooks	33	21.4	13.6	36.8	36.0
Other	33	16.7	27.1	15.8	28.0
Laptop	30	21.4	20.3	15.8	24.0
Tablet	29	21.4	16.9	21.1	24.0
Hand-held magnifier	29	19.0	23.7	15.8	16.0
Hand-held monocular	24	19.0	15.3	10.5	20.0
I'm not sure if there are additional items my child used	24	11.9	22.0	15.8	12.0
Communication device	23	4.8	23.7	0.0	28.0
Braille notetaker	22	9.5	15.3	15.8	24.0
Braille recreational books	22	11.9	15.3	15.8	20.0
Refreshable braille display	21	14.3	13.6	15.8	16.0
Perkins braille writer	20	7.1	15.3	10.5	24.0
Artificial vision device	19	7.1	16.9	10.5	16.0
Victor Reader Stream	17	4.8	15.3	5.3	20.0
Abacus	14	9.5	13.6	0.0	8.0
Pre-cane	13	2.4	15.3	0.0	12.0
Cane / White cane	12	2.4	11.9	5.3	12.0

These findings show that the educational experiences of students with VI were impacted by access to tools and assistive technologies at home. More than a quarter of VI students with or without additional disabilities (29.0%) did not have access to screen reading software. Nearly half of low vision students with or without additional disabilities (47.9%) did not have access to

large print books. Nearly of third of low vision students with or without additional disabilities (32.7%) did not have access to screen enlargement software, and 32.1% did not have access to an electronic magnifier or CCTV. More than a third of blind students with or without additional disabilities (36.4%) did not have access to braille textbooks, and 34.2% did not have access to materials for tactile graphics. When schools are closed and students are expected to learn at home, schools need to make sure that accommodations are available to students with VI.

Access to Classroom Teachers

Classroom teachers (general education and special education teachers) provide instruction in the academic curriculum. According to responses, 87.5% of educational teams for students with VI include a general education teacher, special education teacher, or both. The AES included five questions about participants' experiences with classroom teachers during the pandemic. When asked to select all the ways their child was getting instruction from their classroom teachers during the COVID-19 pandemic, the most common selections were:

- Classroom teacher(s) is/are sending students/families ideas of web sites, videos, or books to use as part of instruction *(Selected by 40.1% of respondents).*
- Classroom teacher(s) is/are recording videos for students, including my child, to watch *(Selected by 38.4% of respondents).*
- Classroom teacher(s) is/are meeting online with the entire class, including my child, to deliver instruction *(Selected by 36.7% of respondents).*

These findings suggest that less than half of classroom teachers are using existing online resources, original content, or synchronous class sessions to provide instruction to their students. This could mean that many parents and students are left to their own devices to find instructional content.

Participants were also asked about the challenges they experienced with the classroom teachers once their children stopped attending class in-person due to the COVID-10 pandemic. The most common selections were:

- My child doesn't have the support of the teaching assistant (paraprofessional, aide) to support them in accessing and completing classwork the classroom teacher(s) is/are requiring (selected by 34.8% of respondents).
- The classroom teacher(s) is/are assigning work in online programs (software applications) that my child cannot access because of their visual impairment (selected by 33.2% of respondents).
- My child's teacher of students with visual impairments has not been able to prepare all the materials my child needs to use to access the material the classroom teacher(s) is/are using (selected by 24.5% of respondents).

These finding suggest that many students with VI were not able to access materials and complete assignments at home, since they did not have access to support from paraprofessionals or TSVIs, or because software was inaccessible. At the same time, nearly a quarter of respondents (23.9%) indicated their child had not experienced any challenges with the classroom teacher's materials.

Many participants (74.4%) indicated "the same" or increased communication with their child's classroom teacher(s) during the pandemic; and almost as many (72.7%) indicated they were receiving "the same" or increased support from the classroom teacher(s). While these results are encouraging, more than a quarter of respondents indicated experiencing less communication and diminished support from their child's classroom teacher(s). In an open-ended-text question, respondents were asked to share any challenges, successes, or concerns about the education their child is receiving from their classroom teacher(s) during the COVID-19 pandemic. Several comments were positive, wherein the respondent described their child's classroom teacher using terms such as "incredible," "phenomenal," or "wonderful."

> *I have been incredibly impressed with the way my child's school district, school administration, and team of educators, paraeducators, and therapists have stepped up to support their students during this time. We never feel the stress that they must certainly be experiencing. They have made the transition seem almost effortless from our end, and have provided, with patience and love, so much wonderful support, guidance and*

> *availability to students and families (in our experience). We feel very fortunate to be in this particular district and school, particularly at this time* (Respondent #1745).

However, it was more common for respondents to indicate a more neutral assessment of their child's classroom teacher(s): indicating the classroom teacher was "trying" or "doing their best."

> *Most of the work is on the parents' shoulders. But I think the teacher is doing the best she can* (Respondent #1682).

While many responses were positive or neutral assessments of the efforts of classroom teachers, more responses were critical or negative. Many comments were indicative of a belief among parents that classroom teachers do not understand the instructional and assessment needs of students with visual impairments:

> *Limited understanding of visual impairment by classroom teachers is leading them to miss the mark when it comes to preparing home materials. Websites with bright backgrounds, online forms with fonts that cannot easily be changed, enlarged, or zoomed in, and the use of videos with small print and poor contrast are all obstacles* (Respondent #1093).

> *Teachers think he should be doing same thing such as other students and write out notes - not type. I have had to advocate for his needs. They don't seem to understand VI* (Respondent #1612).

Access to a TSVI

A TSVI provides instruction to students with visual impairments in the Expanded Core Curriculum (ECC) and support to students with visual impairments in the academic curriculum (by adapting materials, providing instruction in the use of tools and assistive technology, and very often through pre-teaching or supplemental instruction). Participants reported that prior to the COVID-19 pandemic, 85.6% of the represented students received services from a TSVI. Among students who were receiving services from a TSVI prior to the pandemic, 83.1%

indicated a TSVI had been in contact with their family during the pandemic, but only 70.9% indicated a TSVI was currently working with their child at the time they completed the survey. When asked to select all the ways their child was being supported by a TSVI during the COVID-19 pandemic, the most common selections were:

- My child's teacher of students with visual impairments has individually met with a family member/guardian and/or my child using the internet (e.g., Zoom, Google Hangout/Meet, FaceTime) *[selected by 71.7% of respondents]*.
- My child's teacher of students with visual impairments has recommended web sites, videos, or other online resources (e.g., posts on Paths to Literacy, Virtual ExCEL Academy, accessible iPad apps, sites to download audio books) *[selected by 49.1% of respondents]*.
- My child's teacher of students with visual impairments has met with a family member/guardian and/or my child on the telephone *[selected by 45.3% of respondents]*.

These finding show that during the pandemic most parents (71.7%) communicated with their child's TSVI using online meeting apps, while 45.3% used the telephone. Additional research is needed to know how online meetings versus telephone communication with TSVIs impacts at-home instruction of students with VI.

Most respondents (85.8%) reported "the same" or increased communication with their child's TSVI during the pandemic, and nearly as many (84.7%) reported "the same" or increased support from their child's TSVI during the pandemic. In an open-ended question, respondents were asked to share any challenges, successes, or concerns about the education their child was receiving from their TSVI during the COVID-19 pandemic.

By far, most of the comments could be classified as "success stories:" with TSVIs described as "amazing," "awesome," or "extremely helpful."

> *I have been very impressed with the level of interaction our TVI has brought to this time. My child meets with her twice a week to deliver instruction (it is less time than in the*

> *school year, but at this age level our [TSVI] has decided that 90 minutes is the appropriate time to be spent on "virtual learning," and she is trying to accommodate those guidelines). The first few days of the "safer at home" order, she ran around to all the schools grabbing braille textbooks, devices, tactile manipulatives, etc. and is currently storing a lot of our resources in district her basement, garage, and car. She has done an excellent job at keeping our team together and finding ways to connect, including a weekly Google Meet VI time where the 3 academic braille students in our district can get together for a hang out, instruction, or activity* (Respondent #1204).

Additional comments from parents indicated understanding, while acknowledging the challenges of the pandemic: such as a lack of "hands-on" instruction and providing instruction via Zoom meetings.

> *So much if our son's learning with his TVI is hands on and needed in person, so we are struggling to figure out how to achieve success instruction from home* (Respondent 1682).

Other comments indicated that parents are concerned about the amount of time allocated to their child during the pandemic.

> *I am disappointed in the direct instruction received. My son gets two 45 minutes sessions a week of direct instruction from his TVI* (Respondent 1535).

Access to an O&M Instructor

O&M instructors teach people with VI how to travel safely, efficiently, and confidently. Parents responding to the AES reported that 70.6% of the children they represented received services from an O&M instructor before the COVID-19 pandemic. Among the parents of students who reported receiving services from an O&M instructor prior to the pandemic, 83.1% indicated their child's O&M instructor had been in contact with the family regarding plans for their child during the COVID-19 pandemic, but only 70.9% indicated an O&M instructor was working with their child at the time they completed the survey.

When asked to select all the ways in which an O&M instructor was working with their child during the pandemic, participants commonly selected:

- My child's O&M instructor has individually met with a family member/guardian and/or my child using the internet (e.g., Zoom, Google Hangouts) *[selected by 71.7% of respondents]*.
- My child's O&M instructor has recommended web sites, videos, or other online resources (e.g., posts on Paths to Literacy, Virtual ExCEL Academy, accessible iPad apps) *[selected by 49.1% of respondents]*.
- My child's O&M instructor has met with a family member/guardian and/or my child on the telephone *(selected by 45.3% of respondents).*

These responses indicate that during the pandemic, most parents (71.7%) communicated with their child's O&M instructor using online meeting apps, while 45.3% used the telephone. Additional research is needed to understand how online meetings versus telephone conversations impact at-home O&M instruction for students with VI.

Most respondents (85.8%) reported "the same" or increased communication with their child's O&M instructor during the pandemic, and nearly as many (84.7%) reported "the same" or increased support from their child's O&M instructor during the pandemic. In an open-ended question, respondents were asked to share any challenges, successes, or concerns about the education their child is receiving from the O&M instructor during the COVID-19 pandemic. Most parents indicated low expectations for O&M instruction during the pandemic since O&M skills are generally learned through guided practice "out-and-about in the world" and shelter in place mandates restricted these learning activities. However, there were a couple of respondents who viewed the experience as an opportunity to be involved in this aspect of their child's education.

> *I love the support from our O&M team right now. This style of instruction also supports and educates families…I certainly have a much better understanding of how to support her increased independence and understanding of the world around her* (Respondent #)

> *We have been working on learning our neighborhood block, so the O&M's lessons have been geared toward practicing technique, familiarizing with our block itself through tactile mapping and repeated traveling, as well as formal "travel plans" and "routes". It has been a great experience to be so involved in my child's lessons so I can see how their skills have grown in the past few years, as well as informing me of where and how she needs to grow so I can be sure I am reinforcing the skills whenever possible. Even though her COMS writes great reports, I was not as precisely aware of how it all looked in practice until now, and am grateful for that opportunity* (Respondent #1204).

Summary

In the spring of 2020, the U.S. education system was thrown into flux by the COVID-19 pandemic which necessitated the closing of schools to in-person teaching and learning. Teachers were required to move instruction online and parents and family members were asked to assume the role of "teacher" or "teacher's aide." Across the county, teachers and parents scrambled to accommodate the educational needs of their students and children. By responding to the AES, parents of students with visual impairment and VI professionals provided insight into the particular challenges of educating students with visual impairments during the COVID-19 pandemic. In this paper, 312 responses to the AES from parents were analyzed to assess the impact of the COCID-19 pandemic on the educational experiences of school-aged children with visual impairments in five (5) areas:

- Concerns of parents
- Access to Materials, Tools and Technology
- Access to Classroom Teachers
- Access to TSVIs
- Access to O&M Instructors

Respondents commonly reported concerns about providing instruction to their children with visual impairments: mostly because they did not have the time or resources. Not having materials (large print and braille materials), software, and mathematics education tools were common

concerns of parents. Respondents were more critical of classroom teachers than TSVIs or O&M instructors. Many respondents indicated their child's classroom teacher did not understand the needs of students with VI. Respondents were most likely to praise their child's TSVI and dismiss the responsibilities of their child's O&M instructor.

CHAPTER FOUR

SUMMARY AND DISCUSSION

A person with *visual impairment* (VI) is a child or an adult who is blind or has low vision. For purposes of determining eligibility for special education services, a VI is defined for students by the U.S. Department of Education in the Individuals with Disabilities Education Act as "an impairment in vision that, even with correction, adversely affects a child's educational performance" (IDEA, 2004). In the United States, 0.05% of students aged 6 to 21 are visually impaired [about one in 2000 students] and 0.4% of students with disabilities served under IDEA are visually impaired [about one in 250 students with disabilities] (McLeskey, Rosenberg, & Westling, 2018). Therefore, VI is generally considered a "low-prevalence" disability among students and supports for students with VI are commonly addressed only within the contexts of sensory impairments or disabilities more broadly. This is unfortunate because issues of support and accommodations for students with VI are unique and deserve focused attention in education research and teacher education programs.

The manuscripts included in this dissertation address two critical issues in VI education: (1) mathematics education for HS students with VI, and (2) education for students with VI during the COVID-19 pandemic.

A Survey to Assess the Preparation of Teachers of Students with Visual Impairments for Supporting High School Students in General Education Mathematics Classes

Mathematics education is a critical issue since participation and persistence in mathematics are correlated with economic opportunity and full participation in a democratic

society (Frankenstein, 1995, Moses & Cobb, 2001; Gutstein, 2006). The first manuscript included in this dissertation includes findings from a survey of 41 TSVIs who were practicing during the 2019-2020 school year. TSVIs adapt mathematics materials and teach students with VI how to use tools and assistive technologies to access mathematics content. Furthermore, it is often incumbent on TSVIs to pre-teach content and to provide supplemental instruction in mathematics. While many of the respondents held advanced degrees in VI Education or Special Education, and most had taken at least one college-level mathematics or mathematics education course, a few respondents had not taken a college course in either discipline. If all undergraduate education programs required either mathematics content or mathematics methods coursework, more teachers would be prepared to provide mathematics instruction and support to HS students with VI. Comments from respondents revealed that nearly three-quarters (71.4%) viewed their proficiency in mathematics as relevant to providing support to students with VI in HS mathematics, while the remainder did not see their personal proficiency in mathematics as relevant – either because they did not foresee supporting a HS student in mathematics; or because they did not believe it was their role to provide instruction in mathematics. TSVIs with knowledge of mathematics and mathematics pedagogy may be uniquely able to help student with VI learn mathematics Additional research is needed to understand how a TSVIs beliefs about *the relevance* of their own mathematical proficiency might be impacted by the proficiencies in, and dispositions towards, mathematics and mathematics pedagogy. Beliefs, understanding of content, knowledge of instructional methods, and personal dispositions may jointly impact how TSVIs' define and enact their role in mathematics education. All of which may impact student learning.

More than a third of respondents (34.2%) reported feeling unprepared to support HS students in mathematics at the start of their career as a TSVI, but 81.6% reported an increase in

their confidence over time. Responses to an open-ended follow-up question suggest there are diverse means by which TSVIs gain confidence in their ability to support HS students in mathematics: such as teaching or co-teaching mathematics classes, attending mathematics classes with students, or consulting with students or colleagues. Additional research is needed to understand how attending mathematics classes might impact a TSVIs confidence in providing support to students. Research questions might include (1) Does a TSVI need to attend every math class with their student, or is an occasional visit to the classroom sufficient for impacting confidence? (2) How does the role of the TSVI in the mathematics classroom impact their confidence? In other words, are TSVIs who passively observe mathematics classes impacted in the same way as TSVIs who are actively engaged in providing one-on-one support to a student with VI, or even whole class instruction?

The respondents were also asked about their training and proficiency in the abacus and Nemeth, two of the most common tools students with VI use to access and engages in mathematics activity. Half of respondents rated their proficiency with the abacus below 67 on a 100-point scale; and five respondents (11.9%) indicated “I don’t know the abacus or don’t feel prepared to teach abacus skills to my students.” These results are consistent with prior research (Amato et al., 2013) which reported that TSVIs do not teach the abacus because "[They] do not have the knowledge or skills to be an effective abacus instructor for [their] students" (p. 5). Nearly 70% of respondents (n = 29) reported learning the abacus in a TSVI preparation course, while about 10% (n = 4) reported learning the abacus exclusively through PD or self-study and about 12% (n = 5) reported not knowing how to use the abacus. If a TSVI does not know how to use the abacus, they will not be able to teach the abacus to students, and many blind and braille students rely on the abacus to perform calculations (especially in elementary mathematics).

Additional research is needed to know whether abacus training is needed across-the-board and should be mandatory in VI Education or whether abacus training should be targeted, through PD, to TSVIs who have interest and whose caseloads include blind or braille students who require instruction abacus skills.

Respondents typically rated their proficiency in Nemeth below 62 on a 100-point scale. Only two-thirds of respondents (66.6%) indicated they had learned Nemeth in a TSVI training course. These results were consistent with findings from prior research reporting that less than three-quarters of TSVIs (73.2%) have taken a course that includes Nemeth (Rosenblum & Amato, 2004). Nemeth is used by blind and braille students to access advanced mathematics content. If TSVIs are not proficient in Nemeth, they will not be able to accurately transcribe mathematics materials and provide instruction in Nemeth to students. Participants were also asked to select the PD course in Nemeth that would be of greatest interest to them. Nearly 20% were most interested in a "Beginners" course and nearly 25% were most interested in an "Intermediate" course suggesting that many TSVIs do not have foundational knowledge of Nemeth but see value in learning or advancing their Nemeth skills.

Participants were then asked about their confidence in teaching students and mathematics teachers how to use other tools and technologies. Many TSVIs reported confidence in teaching tools and technologies that are employed across the general education curriculum such as magnifiers, audio recordings, and CCTV. However,13.5% were not confident in teaching students talking calculator skills and 45.9% were not confident in teaching students how to use an Accessible Graphing Calculator. This is disheartening because calculators (whether a standard calculator, talking calculator, or Accessible Graphing Calculator) were a common accommodation on the IEPs of students with VI, according to respondents. For example, an

Accessible Graphing Calculator was included on 62.5% of the IEPs of blind, braille or dual-media students (n = 16). It is thus troubling that less than half of the respondents to this survey were confident in their ability to teach Accessible Graphing Calculator technology to their students. PD programming may be needed to provide instruction to TSVIs in how to use and teach calculator technologies.

Among the most common accommodations on students' IEPs were adapted materials. However, the respondents reported that providing adapted materials in a timely manner was a persistent problem. Additional research is needed to know whether it would be more efficient to shift the responsibility of producing materials in alternative formats (such as large print, braille and Nemeth) to mathematics teachers – in which case, the role of TSVIs would be to provide training to mathematics teachers, review and edit transcribed materials, and help students resolve transcription issues. If mathematics teachers were to produce materials in alternative formats it would "cut out the middle-man" and encourage mathematics teachers to consider accessibility from lesson development through implementation and assessment. Furthermore, if a mathematics teacher were to procrastinate in adapting materials, it would be at their own peril. Transcription software, while not perfect, is sufficiently accurate for most students. When there is a transcription issue, students usually know it, and can ask their classroom teacher or TSVI for help in resolving the issue. Of course, there would be a cost component to be considered since school districts would need to purchase additional software licenses and mathematics teachers would need training in how to use transcription software.

The Impact of the COVID-19 Pandemic on the Educational Experiences of School-aged Children with Visual Impairments

Education for students with VI during the COVID-19 pandemic is a critical issue since legislators, school administrators, teachers, and parents must consider the impact of their decisions on the educational experiences of students with VI when deciding if and when to resume in-person classes; and whether to close schools in the case of future pandemics, catastrophes, or natural disasters. Study of the impact of the COVID-19 pandemic may also inform on-line instruction more generally by giving focus to issues of accommodation and accessibility. In the second manuscript included in this dissertation, findings from a survey of 213 parents of school-aged children with VI are presented.

Families that included students with VI made considerable sacrifices to facilitate at-home learning for students with VI: parents left their jobs or siblings stepped-in to assist with instruction. Nonetheless, families were constrained by their lack of preparation as teachers, their lack of access to adapted materials, and their lack of access to technology. Additionally, parents reported not being able to replicate the structure and social components of in-person learning. If schools cannot reopen or if schools have to close again, more needs to be done to by school systems and classroom teachers to ensure that students with VI have access to materials and instruction, structure, and socialization.

Students who are blind or have additional disabilities were disproportionately impacted by the COVID-19 pandemic according to the responding parents. More than half of parents of blind students with additional disabilities expressed concern they were not meeting the expectations of their child's educators; and parents of students with additional disabilities were more likely to express concern about their child's readiness for the next school year. If the pandemic persists or in the case of future school-closing, more must be done to address the needs of blind and VI students with additional disabilities.

Prior to the pandemic, students were using a variety of tools and technologies to support learning in the academic curriculum. This survey shows that tools and technologies should not be strictly categorized as instruments for low vision, print students, or for blind, or braille students. Some of the low vision students used a White Cane or braillewriter, and some of the blind students used large print books. These findings also emphasize the importance of the role of VI professionals in assessing how a student uses their vision and in recommending appropriate tools and assistive technologies. In on-line learning environments, classroom teachers need to refer to each of their students' IEPs to know which accommodations are appropriate; and schools need to make sure these accommodations are available at-home.

The educational experiences of students with VI were impacted by access to tools and assistive technologies at home. More than a quarter of VI students with or without additional disabilities (29.0%) did not have access to screen reading software. Nearly half of low vision students (47.9%) did not have access to large print books; 32.7% did not have access to screen enlargement software, and 32.1% did not have access to an electronic magnifier or CCTV. More than a third of blind students (36.4%) did not have access to braille textbooks, and 34.2% did not have access to materials for tactile graphics. When schools are closed and students are expected to learn at home, schools need to make sure that accommodations are available at-home to students with VI.

According to responding parents, less than half of classroom teachers were using online resources, original content, or synchronous class sessions to provide instruction to their students. This could mean that many parents and students were left to their own devices to find instructional content. Findings from this research suggest that many students with VI are not able to access materials and complete assignments at home, since they did not have access to support

from paraprofessionals or TSVIs, or because software is inaccessible. Nonetheless, almost a quarter of responding parents (23.9%) indicated their child had not experienced any challenges with their classroom teaching materials. Additional research is needed to understand how recorded instruction vs. synchronous instruction, and access to materials impacts at-home learning for students with VI. Comments for parents, in response to an open-ended question about the support they were receiving from their child's classroom teacher(s), revealed diverse sentiments: while many parents praised their child's classroom teacher(s), other were more neutral or even critical. Several comments from parents indicated their child's classroom teacher was 'doing their best;" while other comments indicated that not all classroom teachers understand the needs of a students with VI. These findings suggest that classroom teachers need opportunity for training in accessibility and accommodations - perhaps through PD.

Parents' comments about support from TSVIs were generally very positive. Only a few parents indicated they were disappointed with the support their child was receiving during the pandemic. Parents' comments about support from O&M instructors were generally positive: many parents dismissed the responsibilities of O&M instructors during the pandemic, since O&M instruction is innately "hands-on" and "in-person." However, if the pandemic persists or in the case of future school closings, O&M instructors must find a way to assist with at-home instruction. The skills that O&M instructors teach are essential for persons with VI and cannot be delayed to more convenient times.

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APPENDIX

Access and Engagement Survey (AES): Questions Selected for Analysis in Chapter 3.

Q1 Introduction and Informed Consent Block

1 = I agree to participate in the survey.

2 = I do not agree to participate in the survey.

Q2 Where do you live?

1 = United States

2 = Canada

4 = I do not live in the United States or Canada.

Q113 Are you the family member/guardian of a child with a visual impairment in kindergarten through completing school?

1 = Yes

3 = No

Q115 Where did your child go to school before the COVID-19 pandemic?

1 = A public school classroom with nondisabled peers for the entire school day. A teacher of students with visual impairments and/or O&M instructor may work with my child.

2 = A public school classroom with nondisabled peers for most of the day with 1-2 periods of resource or pull-out special education services. A teacher of students with visual impairments and/or O&M instructor may work with my child.

4 = A public school special education class for most of the day with 1-2 periods, lunch and/or recess in a classroom with nondisabled peers. A teacher of students with visual impairments and/or O&M instructor may work with my child.

3 = A center-based school for children with varying disabilities. A teacher of students with visual impairments and/or O&M instructor may work with my child.

5 = A school for the blind/residential school. My child may work with an O&M instructor.

8 = A charter or private school. A teacher of students with visual impairments and/or O&M instructor may work with my child.

7 = My child was home schooled. A teacher of students with visual impairments and/or O&M instructor may work with my child.

Q116 How old is your child with a visual impairment?

1 = 5-7 years old

2 = 8-10 years old

3 = 11-12 years old

4 = 13-15 years old

6 = 16-18 years old

7 = 19-22 years or older

Q117 Which statement best describes your child with a visual impairment at this time?

1 = My child is blind (cannot see more than light or large objects) and has no other learning and/or medical challenges.

2 = My child has low vision (some usable vision) and no other learning and/or medical 1 = challenges.

3 = My child is blind (cannot see more than light or large objects) and has other learning and/or medical challenges (e.g., a hearing impairment, motor delays).

4 = My child has low vision (some usable vision) and other learning and/or medical challenges (e.g., a hearing impairment, motor delays).

Q118 Does your child have:

2 = An Individualized Education Program (IEP)

1 = A 504 Plan

5 = Neither / I do not know.

Q119 Does your child have An Individualized Education Program (IEP)?

1 = Yes

5 = No

Q120 When was your child's last IEP (Individualized Education Program) or 504 Plan meeting?

1 = Between April 2019 and February 29, 2020

2 = Between March 1, 2020 and today

3 = We are working to schedule my child's IEP or 504 Plan meeting.

4 = My child is overdue for an IEP or 504 Plan meeting, but no one has contacted me to schedule it.

5 = I'm not sure.

Q122 Select all the professionals who are part of your child's educational team.

15 = Regular Classroom Teachers

1 = Special Education Teachers

16 = Teachers at the School for the Blind (Residential School)

2 = Teacher of Students with Visual Impairments (TVI) / Braille Teacher / Vision Teacher

3 = Orientation and Mobility (O&M) Instructor / Cane Teacher

18 = Career / Vocational / Job Site Teacher

17 = Assistive Technology (AT) Teacher

4 = Teaching Assistant / Paraprofessional / Aide

5 = Physical Therapist (PT)

6 = Occupational Therapist (OT)

7 = Speech Therapist / Speech Language Pathologist / Communication Specialist

9 = Teacher of the Deaf / Hard of Hearing

10 = Nurse

11 = Behavior Specialist / Behavior Interventionist

12 = Other, please describe Text _____

14 = I am not sure of the professional role of one or more people who are part of my child's educational team.

Q123 Where do you anticipate your child will be at the start of the 2020-2021 school year?

1 = My child will attend the same school as they did in 2019-2020.

3 = My child will transition from one public school to another public school, (e.g., to the middle school or high school).

6 = My child will graduate from school and receive a diploma.

14 = My child will receive a certificate.

4 = My child will transition from the public school to the school for the blind (residential school).

5 = My child will transition from the school for the blind (residential school) to a public school.

10 = My family will continue to home school my child.

9 = My child will transition from public school or a school for the blind (residential school) to home school.

11 = My child will transition from home school to public school or a school for the blind (residential school).

12 = My child will attend a transition program (typically age 18 or older).

7 = My child will be too old to attend school.

13 = My child will transition to a college or a university.

8 = I am unsure of the plan for my child for the 2020-2021 school year.

Q124 Which statement describes your feelings about your child's upcoming transition or return to school?

1 = I have no concerns about my child's transition or return to school.

2 = I am unsure how my child's transition or return to school will happen as the schools in my area are closed.

3 = I have tried to contact someone to talk about my child's transition or return to school, but no one has gotten back to me.

4 = I am unsure who I should talk to about my child's upcoming transition or return to school.

5 = Other, please describe Text _____

Q125 Because of COVID-19, how, if at all, has the plan changed for your child's transition to a new setting for the 2020-2021 school year?

Text _____

Q126 Select all the tools your child was using before the COVID-19 pandemic changed how your child receives their education.

1 = Tablet (e.g., iPad, Android tablet)

2 = Laptop (e.g., Windows, Chromebook, Mac Book)

25 = Screen reading software (e.g., JAWS, NVDA, VoiceOver)

26 = Screen enlargement software (e.g., ZoomText)

5 = Hand-held magnifier

6 = Hand-held monocular telescope

7 = Electronic magnifier / CCTV

27 = Artificial vision device (e.g., OrCam)

8 = Large print books

3 = Cane / Long cane / White cane

4 = Pre-cane / Adapted mobility device / AMD

9 = Perkins braille writer

10 = Refreshable braille display

11 = Braille notetaker

12 = Victor Reader Stream or other device for listening to audio books

13 = Braille textbooks

14 = Braille recreational books

15 = Abacus

16 = Math manipulative (e.g., counting bears, digi blocks, protractor, compass)

17 = Materials for tactile graphics (e.g., Draftsman, textures, tactile graph paper)

18 = Communication device

19 = Adapted books

20 = Other, please describe Text _____

23 = I am not sure if there are additional items my child used at school.

Q127 Select the tools that your child does not have at home which impacts their ability to learn.

My child has all the tools at home they need to continue learning at home. (24)

1 = Tablet (e.g., iPad, Android tablet)

2 = Laptop (e.g., Windows, Chromebook, Mac Book)

22 = Screen reading software (e.g., JAWS, NVDA, VoiceOver)

23 = Screen enlargement software (e.g., ZoomText)

3 = Hand-held magnifier

4 = Hand-held monocular telescope

5 = Electronic magnifier / CCTV

25 = Artificial vision device (e.g. OrCam)

6 = Large print books

26 = Cane / Long cane / White cane

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7 = Perkins braille writer

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10 = Victor Reader Stream or other device for listening to audio books

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12 = Braille recreational books

13 = Abacus

14 = Math manipulatives (e.g., counting bears, digi blocks, protractor, compass)

15 = Materials for tactile graphics (e.g., Draftsman, textures, tactile graph paper)

16 = Communication device

17 = Adapted books

18 = Other, please describe_____

21 = I am not sure if there are additional items my child used at school.

Q128 I believe that I am not living up to the expectations of my child's educators because I cannot complete everything they are asking me to do with/for my child.

8 = Strongly agree

9 = Agree

10 = Neither agree or disagree

12 = Disagree

12 = Strongly disagree

Q129 I believe my child is continuing to make progress in the same way they would if there had not been a change in where and how my child is receiving educational services.

1 = Strongly agree

2 = Agree

3 = Neither agree nor disagree

4 = Disagree

5 = Strongly disagree

Q130 Because of the changes in my child's education I do not believe my child will be ready for the next school year.

1 = Strongly agree

2 = Agree

3 = Neither agree nor disagree

4 = Disagree

5 = Strongly disagree

Q131 Describe how the changes in your child's education, as a result of the COVID-19 pandemic, have impacted your child and family.

Text _____

Q133 How is the school (district, daycare, etc.) providing instruction to children without disabilities during the COVID-19 pandemic. Select all the options you are aware of at this time.

1 = No children in the district are receiving instruction.

2 = Families can go and pick up packets from the teachers.

3 = School buses or other groups are delivering packets from the teachers.

4 = Schools are mailing materials to families.

5 = Teachers are recording videos for students to watch.

6 = Teachers are meeting online with small groups of students to deliver instruction.

7 = Teachers are meeting online with the entire class to deliver instruction.

14 = Teachers are emailing a family member/guardian materials for the child to use.

8 = Teachers are sending students/families ideas of web sites, videos, or books to use as part of instruction.

9 = Teachers are assigning projects for students to do on their own that are not typical of what would have been assigned before the COVID-19 pandemic.

10 = Teachers are calling students and families individually.

15 = I do not know.

11 = Other, please describe Text _____

Q134 Select all the ways you are aware of that school for the blind (residential school) students are getting instruction during the COVID-19 pandemic.

1 = No children are receiving instruction.

2 = Families can go and pick up packets from the teachers.

3 = School buses or other groups are delivering packets from the teachers.

4 = Schools are mailing materials to families.

5 = Teachers are recording videos for students to watch.

6 = Teachers are meeting online with small groups of students to deliver instruction.

7 = Teachers are meeting online with the entire class to deliver instruction.

14 = Teachers are emailing a family member/guardian materials for the child to use.

8 = Teachers are sending students/families ideas of web sites, videos, or books to use as part of instruction.

9 = Teachers are assigning projects for students to do on their own that are not typical of what would have been assigned before the COVID-19 pandemic.

10 = Teachers are calling students and families individually.

15 = I do not know.

11 = Other, please describe. Text _____

Q135 How many days notice were you given before there was a change in the way your child typically attends school?

1 = 1 day

2 = 2 days

3 = 3 days

4 = 4 days

5 = 5 days

6 = 6 days

7 = 1 week

8 = More than a week but less than 2 weeks

9 = More than 2 weeks but less than 3 weeks

10 = More than 3 weeks

Q136 As a family member/guardian, do you receive lesson plans electronically from any of your child's teachers or therapists (e.g., through email, Google Drive, or a private Facebook group)?

1 = Yes

3 = No

Q137 How many times a week are lesson plans sent to you?

1 = 1 to 2 times

2 = 3 to 4 times

3 = 5 to 6 times

4 = 7 or more times

5 = It varies each week

Q138 Are you asked by any of your child's teachers or therapists to send evidence that your child has completed assignments (e.g., uploading a video, sending an email, signing off on a form)?

1 = Yes

2 = No

Q139 Describe your experiences being asked to show evidence of your child's work to teachers or therapists.

Text _____

Q141 Which statement describes your child's attendance at school in a school building?

1 = Before the COVID-19 pandemic my child attended school in a school building. Currently my child is **still** attending school in the school building.

2 = Before the COVID-19 pandemic my child attended school in a school building. Currently my child is **not** attending school in the school building.

4 = My child was not attending school in a school building before the COVID-19 pandemic.

Q142 What is your plan if the school building closes? What, if anything, will you do to help your child continue to learn?

Text _____

Q143 Before the COVID-19 pandemic how many days a week did your child go to school?

1 = 1 day a week

2 = 2 days a week

3 = 3 days a week

4 = 4 days a week

5 = 5 days a week

6 = Other, please describe Text _____

Q144 Before the COVID-19 pandemic, approximately how many hours a week was your child going to school?

1 = Less than 5 hours a week

2 = 6 to 10 hours a week

3 = 11 to 15 hours a week

4 = 16 to 20 hours a week

6 = 21 to 25 hours a week

7 = 26 to 30 hours a week

8 = 31 or more hours a week

Q145 Does your child receive free or reduced breakfast and/or lunch at school?

1 = Yes

2 = No

3 = I prefer not to answer.

Q146 Select the statement(s) that describe changes to your child's school schedule due to the COVID-19 pandemic.

2 = The school has reduced the number of hours they are open in a week

3 = The school has reduced the number of days they are open each week

4 = The school is only open for families in which a family member/guardian is an essential employee (healthcare, grocery store, first responder, manufacturing).

6 = The school has closed and the teachers and/or therapists are working by calling on the telephone, sending materials, and/or meeting online.

5 = The school has closed and none of the teachers or therapists are working.

Q147 Describe your feelings about the school being closed and none of the teachers or therapists working with your child. What, if anything, are you doing to help your child continue to learn?

Text _____

Q148 During the COVID-19 pandemic how many hours a week is your child attending school class/session **online** with direct instruction in real-time (e.g., using Zoom, Google Hangout/Meet, FaceTime)?

1 = My child is not being schooled online.

2= 1 to 3 hours

3 = 4 to 6 hours

4 = 7 to 9 hours

5 = 10 to 12 hours

8 = 13 to 15 hours

9 = 16 to 18 hours

10 = 19 to 21 hours

11 = 22 or more hours

Q150 Select all the ways your child with a visual impairment is getting instruction from their classroom teacher(s) during the COVID-19 pandemic.

1 = No children in the district are getting any instruction from classroom teacher(s).

2 = I can go to the school to pick up packets from the classroom teacher(s).

3 = School buses or other groups are delivering packets from the classroom teacher(s).

4 = The classroom teacher(s) is/are mailing materials to me.

5 = Classroom teacher(s) is/are recording videos for students, including my child, to watch.

6 = Classroom teacher(s) is/are meeting online with small groups of students, including my child, to deliver instruction.

7 = Classroom teacher(s) is/are meeting online with the entire class, including my child, to deliver instruction.

14 = Classroom teacher(s) is/are emailing a family member/guardian materials to print and have my child use.

8 = Classroom teacher(s) is/are sending students/families ideas of web sites, videos, or books to use as part of instruction.

9 = Classroom teacher(s) is/are assigning projects for students to do on their own that are not typical of what would have been assigned before the COVID-19 pandemic.

10 = Classroom teacher(s) is/are calling students and families individually.

13 = Other, please describe Text _____

Q151 Select all the challenges with the classroom teacher(s) that your child has experienced once they stopped attending class at the school due to the COVID-19 pandemic.

1 = My child has not experienced any challenges with the classroom teacher(s) materials.

12 = Due to their visual impairment, my child is not able to access the information in the packets the classroom teacher(s) are sending home.

2 = My child has had difficulty getting online for the classroom teachers' live class sessions.

3 = My child's teacher of students with visual impairments has not been able to prepare all the materials my child needs to use to access the material the classroom teacher(s) is/are using.

4 = My child cannot view the videos classroom teacher(s) is/are pre-recording and posting.

6 = My child does not have the technology at home they are used to having at school so cannot do the work the classroom teacher(s) is/are requiring.

11 = My child doesn't have the support of the teaching assistant (paraprofessional, aide) to support them in accessing and completing classwork the classroom teacher(s) is/are requiring.

7 = The classroom teacher(s) is/are assigning work in online programs (software applications) that my child cannot access because of their visual impairment.

8 = Other, please describe Text _____

Q152 Which statement best describes your current level of communication with your child's classroom teacher(s) during the COVID-19 pandemic?

1 = I have no communication with my child's classroom teacher(s).

2 = I have very little or limited communication with my child's classroom teacher(s).

4= I have the same level of communication with my child's classroom teacher(s) as I did before the COVID-19 pandemic.

5 = I have increased communication with my child's classroom teacher(s) the start of the COVID-19 pandemic.

Q153 Which statement best describes the amount of support you are receiving from your child's classroom teacher(s) during the COVID-19 pandemic?

1 = I am not receiving support from my child's classroom teacher(s).

2 = I have received very little or limited support from my child's classroom teacher(s).

4 = I have the same level of support from my child's classroom teacher(s) as I did before the COVID-19 pandemic.

5 = I have increased support from my child's classroom teacher(s) since the start of the COVID-19 pandemic.

Q154 Please share any challenges, successes, and concerns you have about the education your child is currently receiving from their classroom teacher(s).

Text _____

Q156 Before the COVID-19 pandemic did your child receive services from a teacher of students with visual impairments?

1 = Yes

3 = No

4 = I am not sure.

Q157 Has the teacher of students with visual impairments been in contact with your family regarding plans for your child during the COVID-19 pandemic?

1 = Yes

2 = No

Q158 What are your thoughts about not receiving any communication from your child's teacher of students with visual impairments?

Text _____

Q159 Please describe the communication you have received from the teacher of students with visual impairments.

Text _____

Q160 Is the teacher of students with visual impairment currently working with your child during the COVID-19 pandemic?

1 = Yes (1)

3 = No (3)

Q161 How does your child's teacher of students with visual impairments work with your child or your family during the COVID-19 pandemic? Select all that apply to your child and family.

2 = My child's teacher of students with visual impairments sends packets of materials home for a family member/guardian to complete with my child.

3 = My child's teacher of students with visual impairments meets online with my child's class or a small group of children from my child's class to provide instruction.

4 = My child's teacher of students with visual impairments has met with a family member/guardian and/or my child on the telephone.

5 = My child's teacher of students with visual impairments has individually met with a family member/guardian and/or my child using the internet (e.g., Zoom, Google Hangout/Meet, FaceTime).

6 = My child's teacher of students with visual impairments has recommended web sites, videos, or other online resources (e.g., posts on Paths to Literacy, Virtual ExCEL Academy, accessible iPad apps, sites to download audio books)

7 = Via email, my child's teacher of students with visual impairments has sent my family ideas and activities that my child does with them (e.g., braille activities, independent living skills to practice, games to practice monocular skills).

10 = My child's teacher of students with visual impairments has recommended web sites, videos, or other online resources specific to children with visual impairments (e.g., Paths to Literacy, Virtual ExCEL Academy, Perkins eLearning).

11 = My child's teacher of students with visual impairments has mailed or delivered toys or materials to our home for us to use.

1 = Other, please describe Text _____

Q162 Which statement best describes your current level of communication with your child's teacher of students with visual impairments during the COVID-19 pandemic?

1 = I have no communication with my child's teacher of students with visual impairments.

2 = I have very little or limited communication with my child's teacher of students with visual impairments.

4 = I have the same level of communication with my child's teacher of students with visual impairments as I did before the COVID-19 pandemic.

5 = I have increased communication with my child's teacher of students with visual impairments since the start of the COVID-19 pandemic.

Q163 Which statement best describes the amount of support you are receiving from your child's teacher of students with visual impairments during the COVID-19 pandemic?

1 = I am not receiving support from my child's teacher of students with visual impairments.

2 = I have received very little or limited support from my child's teacher of students with visual impairments.

4 = I have the same level of support from my child's teacher of students with visual impairments as I did before the COVID-19 pandemic.

5 = I have increased support from my child's teacher of students with visual impairments since the start of the COVID-19 pandemic.

Q164 Please share any challenges, successes, and concerns you have about the education your child is currently receiving from their teacher of students with visual impairments.

Text _____

Q166 Before the COVID-19 pandemic did you child receive services from an orientation and mobility (O&M) instructor? Sometimes the O&M instructor is also your child's teacher of students with visual impairments. If the same person provides both services, please answer these questions for the O&M part of the services your child receives.

1 = Yes

3 = No

4 = I am not sure.

Q167 Has the O&M instructor been in contact with your family regarding plans for your child during the COVID-19 pandemic?

1 = Yes

2 = No

Q168 What are your thoughts about not receiving any communication from your child's O&M instructor?

Text _____

Q169 Please describe the communication you have received from the O&M instructor.

Text _____

Q170 Is the O&M instructor currently working with your child during the COVID-19 pandemic?

1 = Yes

3 = No

Q171 How does your child's O&M instructor work with your child or your family during the COVID-19 pandemic? Select all that apply to your child and family?

2 = My child's O&M instructor sends packets of materials home for a family member/guardian to complete with my child.

3 = My child's O&M instructor meets online with my child's class or a small group of children from my child's class to provide instruction.

4 = My child's O&M instructor has met with a family member/guardian and/or my child on the telephone.

5 = My child's O&M instructor has individually met with a family member/guardian and/or my child using the internet (e.g., Zoom, Google Hangout/Meet, FaceTime).

6 = My child's O&M instructor has recommended web sites, videos, or other online resources (e.g., posts on Paths to Literacy, Virtual ExCEL Academy, accessible iPad apps).

7 = Via email, my child's O&M instructor has sent my family ideas and activities that my child does with them (e.g., cane skills to practice, ideas for a sensory walk, guidelines for practicing street crossings).

10 = My child's O&M instructor has recommended web sites, videos, or other online resources specific to children with visual impairments (e.g., Paths to Literacy, Virtual ExCEL Academy, Perkins eLearning).

11 = My child's O&M instructor has mailed or delivered toys or materials to our home for us to use.

8 = Other, please describe Text _____

Q172 Which statement best describes your current level of communication with your child's O&M instructor during the COVID-19 pandemic?

1 = I have no communication with my child's O&M instructor.

2 = I have very little or limited communication with my child's O&M instructor.

4 = I have the same level of communication with my child's O&M instructor as I did before the COVID-19 pandemic.

5 = I have increased communication with my child's O&M instructor since the start of the COVID-19 pandemic.

Q173 Which statement best describes the amount of support you are receiving from your child's O&M instructor during the COVID-19 pandemic?

1 = I am not receiving support from my child's O&M instructor.

2 = I have received very little or limited support from my child's O&M instructor.

4 = I have the same level of support from my child's O&M instructor as I did before the COVID-19 pandemic.

4 = I have increased support from my child's O&M instructor since the start of the COVID-19 pandemic.

Q174 Please share any challenges, successes, and concerns you have about the education your child is currently receiving from their orientation and mobility specialist.

Text _____

Q272 In what state do you live? Please use the 2 digit abbreviation, e.g., SC for South Carolina.

Text _____

Q274 What is your 5-digit zip code?

Text _____

Q275 Which best describes you day to day gender identity?

1 = Male

2 = Female

4 = Gender non-conforming/non binary

5 = Personally identified or culturally defined identity

6 = I prefer not to provide this information.

Q276 What is your race / origin?

3 = American Indian or Alaska Native

4 = Asian

2 = Black or African American

9 = Hispanic or Latina/Latino

5 = Native Hawaiian or Pacific Islander

6 = Multi-racial

1 = White

7 = Other, please provide Text _____

8 = I prefer not to provide this information.

Q277 Select any of the statements that describe you.

6 = I do not have any disabilities or health conditions.

1 = I am blind.

2 = I have low vision.

3 = I am Deaf/hard of hearing.

4 = I have a physical disability.

5 = I have a chronic health condition, e.g., asthma, diabetes, high blood pressure.

9 = I have a learning disability.

10 = I have a mental health challenge.

11 = I have autism.

7 = Other, please describe Text _____

8 = I prefer not to provide this information.

Q278 How many children live in your household?

1 = 1

2 = 2

3 = 3

4 = 4

5 = 5

6 = 6

7 = 7

8 = 8

9 = 9

10 = 10 or more

11 = 0

Q279 How many children are you taking care of in your household?

1 = 1

2 = 2

3 = 3

4 = 4

5 = 5

6 = 6

7 = 7

8 = 8

9 = 9

10 = 10 or more

11 = 0

Q280 Do you have a smartphone?

1 = Yes

3 = No

4 = I prefer not to provide this information.

Q281 Which statement describes your internet availability at your home on March 1, 2020?

3 = I had internet access at home on March 1, 2020. I continue to have internet at home.

1 = I did not have internet access at home before March 1, 2020. I now have internet at home.

2 = I had internet access at home before March 1, 2020. I've canceled my internet.

12 = I do not have internet at home.

11 = I prefer not to provide this information.

Q282 Which statement describes how you are now receiving internet at home?

7 = I am paying a monthly internet charge.

12 = A business (e.g., cell phone company, cable company) is providing our home free internet for 1 or more months.

11 = The school has provided me internet (e.g., a hot spot, paid for internet use while school is out).

10 = Other, please describe Text _____

Q283 How many people are trying to access the internet at once in your household?

1 = 1

2 = 2

3 = 3

4 = 4

5 = 5

6 = 6

7 = 7

8 = 8

9 = 9

10 = 10 or more

11 = 0

Q284 How are you and/or your children accessing the internet? Select all that apply to your household.

13 = I/we are using a smartphone (e.g., iPhone, Android Galaxy) or tablet (e.g., iPad) with a data plan.

7 = I/we use internet at a family member/guardian or friend's house.

6 = An employer has provided us internet.

11 = The school has provided me internet (e.g., a hot spot, paid for internet use while school is out).

12 = A business (e.g., cell phone company, cable company) is providing our home free internet for 1 or more months.

8 = I/we go to a public place's parking lot (e.g., library, school) to use the internet.

9 = I/we go to a location where internet is provided on a limited basis (e.g., a school bus comes to my neighborhood 2 hours a day Monday-Friday).

9 = I/we are not using the internet.

10 = Other, please describe Text _____

Q285 Select which option describes your current state's response to COVID-19.

1 = My state has a shelter-in-place order.

2 = My state has an advisory to stay home.

7 = My state recommends you stay home.

3 = My state has no restrictions.

4 = Other, please describe Text _____

5= I prefer not to provide this information.

Q286 Select all the statement(s) that describe your household's experience with COVID-19.

1 = No one in my household has exhibited symptoms or been tested for COVID-19.

2 = One or more people in my household have symptoms that may be COVID-19, but no one has been tested.

3 = One or more people in my household have symptoms that may be COVID-19, and have been tested and received negative results.

4 = One or more people in my household have been tested for COVID-19, have the virus, but have not been hospitalized.

5 = One or more people in my household have been tested for COVID-19 and have been hospitalized.

6 = One or more people in my household have died as a result of COVID-19.

9 = An extended family member or friend has contracted COVID-19 and I am assisting them.

7 = Other, please describe Text _____

8 = I prefer not to provide this information.

Q287 Select all the statement(s) that describe your household's experience with COVID-19 and employment.

11 = There have been no changes with employment in my household.

1 = No one in my household was employed prior to the COVID-19 pandemic.

2 = One or more people in my household had their hours reduced because of the COVID-19 pandemic.

3 = One or more people in my household have been furloughed because of the COVID-19 pandemic.

4 = One or more people in my household have lost their job because of the COVID-19 pandemic.

5 = One or more people in my household have applied for a job because of the COVID-19 pandemic but are not working yet.

6 = One or more people in my household have applied for a job because of the COVID-19 pandemic and are now working.

12 = One or more people in my household have applied for a job because of the COVID-19 pandemic but are not working yet.

7 = One or more people in my household have had their hours increased at their job because of the COVID-19 pandemic.

8 = One or more people in my household have transitioned to working at home because of the COVID-19 pandemic.

9 = Other, please describe. Text _____

10 = I prefer not to provide this information.

Q288 Are you working during the COVID-19 pandemic?

1 = Yes, I am working as an essential worker (e.g., healthcare provider, grocery store employee, first responder) outside of the home. (1)

2 = Yes, I am working remotely from home. (2)

3 = No, I am not working. (3)

4 = Other, please describe (4) _____

Q289 How have you balanced the need to work from home and provide for your child's educational needs?

Text _____

Q290 Please share any additional challenges, successes, and concerns you have related to your child's education as a result of the COVID-19 pandemic.

Text _____