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Experiences of Middle School Students With Visual Impairments Accessing Technologies In Inclusive Classrooms

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EXPERIENCES OF MIDDLE SCHOOL STUDENTS WITH VISUAL IMPAIRMENTS ACCESSING TECHNOLOGIES IN INCLUSIVE CLASSROOMS

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ABSTRACT

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As the educational environment is moving more towards a technology-rich system, students with visual impairments (VI) educated in general education classrooms must be guaranteed equitable access to content curricula. The purpose of this study was to understand the experiences of middle school students with VI when accessing and using technologies in general education classrooms. In this multiple case study, three middle school students with VI were observed in general education settings for two school days. In addition to the students, general education teachers and teachers of students with VI (TVI) also participated in the study to understand how best they support access to technologies for students with VI in their classrooms. The theoretical framework that guided this study was Piaget's cognitive development theory, and the learning model was Universal Design for Learning. Data were collected through multiple instruments: observations, interviews, and educational documents. Students, their general education teachers, and TVIs were interviewed about their experiences with the use of technologies in classrooms. After data collection, the analysis was completed using within-case and cross-case analysis.

The within-case analysis revealed the experiences of using technologies in general education classrooms for each student in the form of a narrative story. Each student's story included the components: (a) how did they see their world?, (b) how did they experience their school day?, and (c) how did their ideal world compare to their real world? The cross-case analysis was conducted by comparing participants' experiences with technologies in general education classrooms. Four broad themes emerged from the cross-case analysis: (a) technology is imperative in general education classrooms; (b) frustrations with accessibility issues in general education classrooms; (c) for general education teachers, it has been a learning curve; and (d) for TVIs, the buck stops with them when it comes to access technology. Within the above four broad themes, some emerged findings were intriguing. General education teachers were open to training on technologies that are more engaging for students, as opposed to technologies that were universally accessible. Inaccessible technologies used in classrooms were not only the ones adopted by the school or district, but they included programs that were created and shared by other teachers through learning communities. While the students, general education teachers, and TVIs in this study understood the legal mandates of IDEA and an IEP, they did not know any other accessibility laws related to technologies that Kindergarten-Grade 12 schools should abide by. Conceptually, some sub-themes found in this study were: (a) the majority of educators were differentiating the curricula to meet the needs of students through constant adaptation as opposed to using tools that account for learner variability at the outset, and (b) student choice and advocacy played a big role in the experiences of students with VI in general education classrooms. Based on the findings, implications for practice and future research directions are discussed in this study.

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INTRODUCTION

Like all other students in public schools, students with visual impairments (VI) in the United States of America (U.S.A.) are exposed to several technologies between kindergarten to 12th grade (K-12) general education classrooms. Educational technologies often referred to as "EdTech" can range from instructional videos to complex software that allows students to access information, engage, and learn. Oftentimes such technologies are not accessible in a format that students with VI can seamlessly learn from like their sighted peers (Siu & Presley, 2019). This is my 11th year working as an itinerant teacher of students with VI (TVI) in a public school district. One of the primary responsibilities of a TVI is enabling access to materials and learning curricula presented to our students with VI in classrooms. Over the last decade, technologies in classrooms, especially in secondary classrooms, have become ubiquitous (Purdue Online, 2022). As a practicing TVI, I found very few resources that support students with VI to access educational technologies in general education classrooms. After many failed attempts, I realized that students and teachers had to figure out an efficient way to catch up with the ever-changing ed tech products and overcome accessibility issues in classrooms. I have attended training for braille technology and wrote instructional manuals for teachers in my school district. My co-workers acknowledged my curiosity and approached me with all technology-related questions. They called me the "technology guru" in my department. I am also intrigued by new technologies, and I spend hours trying to learn how to use them. I use these technologies in my schools to understand how they help my students access their special or general education curricula. Apps that help access school assemblies, switches that facilitate communication, and devices that help complete homework efficiently have made a huge difference in my students' academic and social life. I am always looking to broaden my knowledge of technology that improves inclusive practices for students with VI.

Since the Corona Virus 2019 (COVID-19) pandemic, barriers to implementing accessible technology in classrooms have become more evident in my professional world. Teachers struggle to modify their curriculum to make it inclusive for a minority of students (Rosenblum et al., 2020). In a recent survey conducted by Johnson (2022), 84% of the teachers reported that equity in education cannot be achieved without "accessible learning tools" (p. 1). There is a lack of funds for training teachers in using accessible mainstream technology. Teachers do not have the resources to communicate with technology developers. Teachers feel that there is a gap between what they have in schools and what they need for equitable instruction in schools (Johnson, 2022). Although the majority of educators feel that there is a positive impact of technology on their instruction (Johnson, 2022), barriers to using such classroom technology to meet the needs of all their students still seem to exist (Staff, 2019). Despite several accessibility laws such as Section 508 of the Rehabilitation Act and the Americans with Disabilities Act, individuals with VI encounter many websites that are not accessible by screen readers. Lawsuits are on the rise as businesses fail in complying with accessibility laws (Gonzales, 2022). The purpose of this study was to understand the experiences of middle school students with VI when accessing and using technologies in general education classrooms. The study sought to understand both successes and challenges experienced by middle school students with VI in accessing various technologies used in general education classrooms.

Statement of the Problem

"In a society that relies heavily on audiovisual content for both the creation and dissemination" of information, students with VI "are increasingly at risk of being excluded from participating in social discourse" (Youngblood et al., 2018, p. 339). Among all the digital materials used in classrooms, 66% of them are videos from an instructional program, 65% are communication technologies such as emails, 64% are educational resources that are free or paid for via an online community, 59% are digital versions of print materials, 58% are applications, websites, and digital games, and 57% are free open-source digital content (Staff, 2019). If digital materials in classrooms as described above are not accessible to students with VI, then these students will be excluded from their learning environment for the majority of their time in their classrooms. Students with VI access their learning environment in diverse ways (Siu & Presley, 2019). When classroom technologies do not have the ability to cater to the diverse needs of students with VI, then these students are excluded from learning in an equitable manner as their sighted peers. For example, when a middle school student is asked to complete a project by researching on the internet, if the website is not accessible with a screen reader, then students who are auditory learners cannot learn from such websites. Similarly, if the images on the websites are not of high contrast or do not have descriptions, low-vision learners cannot complete the learning activity in a meaningful manner. There are several studies related to the accessibility of technologies used by individuals with VI (Bohnsack & Puhl, 2014; Muwanguzi & Lin, 2010; Park et al., 2019); however, the focus of such studies was not on K-12 students or classroom technologies. Accessibility of curriculum presented in universities or websites was studied (Taylor, 2016), but none focused on the experiences of younger students with VI in general education classrooms. By understanding the challenges and successes experienced by students with VI in accessing classroom technology, one can potentially create a more inclusive setting for students with VI where they can access and learn from technologies seamlessly like their sighted peers.

Purpose

The purpose of this study was to understand the experiences of middle school students with VI when they are presented with technologies in their general education classrooms. Not all students with VI are the same in how they learn and engage with learning content and tools. While some students in my caseload are low vision learners where the primary mode of access is through vision, some are braille learners where the primary mode of access is through their tactile sense. Some of my students in my caseload are dual learners who access content through both tactile and visual modalities, and there are a few who access content through all three modalities, vision, tactile and auditory. Moreover, digital accessibility for students with disabilities should be considered irrespective of how the curriculum is delivered (synchronous, asynchronous, hybrid, remote, or in-person). The main purpose of assistive technologies for students with disabilities including those with VI is to remove barriers so they can be fully included in classrooms and can complete tasks at the same time as their sighted peers. Siu and Presley (2019) argued that technology in schools would be successfully implemented if two primary goals were met: (a) the classroom digital environment “must be designed with accessibility in mind,” and (b) students must have well-informed skills for flexible use of a variety of technology tools (p. 5).

To build an accessible digital environment for all students, a universal design for learning (UDL) framework should be implemented across the entire school with the starting assumption that there will be students with disabilities, including those with sensory losses, accessing those environments (U.S. Department of Education, n.d.). When the UDL framework is implemented in classrooms, educational technologies will incorporate features that have multiple ways by which learning content is presented to students, multiple ways by which students can express their knowledge, and multiple ways by which students can engage with the learning content. Schools around the nation should acknowledge that just providing access to information through technology is not going to be an equalizer for students with disabilities. Educators must evaluate whether tools include effective features in creating inclusive classroom environments for all students (U.S. Department of Education, n.d.).

By understanding the experiences of middle school students with VI using classroom technologies, this study helps identify strategies that will include students with VI in general education classrooms without them having to be dependent on their teachers or peers to help access such technologies. This study did not test the accessibility of technologies used in classrooms. Instead, the study was about understanding the experiences of middle school students with VI in general education classrooms and how they are accessing and learning from technologies used in their classrooms.

Research Questions

The research questions explored in the study were:

Q1 How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms?

Q2 How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms?

Q3 How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms?

Significance of the Study

Educational technology plays a significant role in 21st-century schools in the world (Knowing Technologies, 2015). The educational environment is moving more towards a technology-rich system and students with VI in such classrooms should be guaranteed equitable access. By understanding the experiences (both successes and challenges) of middle school students with VI in accessing technologies used in their classrooms, I can potentially help implement continued successes of their experiences and help identify strategies that can break barriers of inaccessibility. The findings of this study could create more inclusive educational practices in technology-rich classrooms in the U.S.A.

Conceptual Framework

I chose Piaget's cognitive development theory as the theoretical framework for my understanding of the problem of accessibility needs of students with VI in middle schools because it acknowledges differences in how students learn. Acknowledging that all children, including children with VI, learn differently, universally designed technology is a practice that can minimize the dependency of those students and maximize their inclusion in general education classrooms. As a practitioner, I strongly believe in the application of theory into a framework that can be practiced in real-life situations. Universally designed classroom technology that will allow equitable access for all students with and without disabilities will be the practice that will include students with VI in general education classrooms. Since the research is based on understanding the experiences of middle school students with VI in general education classrooms, knowledge was constructed via multiple perspectives and versions of reality as observed or described by the participants in the study. Hence, I used constructivism as my theoretical stance as it guided me to analyze the subjective interpretations of multiple participants in the study.

Summary of Methodology

Using a constructivist paradigm, I conducted my study using qualitative research design as it allowed me to study the experiences of middle school students with VI in using technologies in inclusive classrooms. The research genre of the study was multiple case study. An in-depth analysis was conducted on more than one individual, and detailed information was collected using multiple procedures (Creswell & Creswell, 2018). As the purpose of the study was to examine the experiences of middle school students with VI in general education classrooms, the student participants in the study attended mainstream classes for the majority of their school day so that other factors such as their cognitive abilities or past academic interventions did not influence student experiences with technologies. I used observations, interviews, and educational documents as data collection methods. I conducted my study by following the method as described in the steps below:

1. Recruited students for the study using purposeful sampling after getting approval from the University of Northern Colorado (UNC) Institutional Review Board (IRB).
2. Obtained consent from parents/guardians of students, general education teachers, and TVIs of nominated students.
3. Obtained approval from the school districts where the student participants attended school.
4. Observed each of the three students for one full school day (first observation).
5. Interviewed the three students, their general education teachers, and TVIs.

6. Obtained students' individualized education program (IEP), including the Functional Vision Assessment and Learning Media Assessment Reports and past academic progress reports.
7. Observed each of the three students for another full school day (second observation).
8. Completed narrative (within-case analysis) and thematic (cross-case analysis) analysis using triangulation of data collected through observations, interviews, and educational documents.
9. Consulted with the peer-debriefer to confirm emerged themes from interviews of participants.
10. Narrated each student's story about their experiences accessing technologies in general education classrooms from the within-case analysis and described emerging themes from the cross-case analysis.

Definition of Terms

Access technology or accessibility. Apart from the above definitions, "accessibility" is another term used in the context of educational technology. According to Summers and Peters (2017), accessibility is the "absence of barriers" (p. 1). In 2010, a joint letter issued by the U.S. Department of Justice and the U.S. Department of Education stated that "educational materials and technologies are 'accessible' to people with disabilities if they can acquire the same information, engage in the same interactions, and enjoy the same services as people who do not have any disabilities" (National Center on Accessible Educational Materials, n.d., p. 1). The term "access technology" is often used to refer to technologies that are accessible to students.

Accommodations. When students with disabilities cannot access their learning curricula, accommodations are provided to them. Accommodations are "adaptations or changes in educational environments or practices that help students overcome the barriers presented by their disability" (International Resource Information System Center, 2022a, p. 1). The list of specific accommodations required based on the needs of students with disabilities is written in their IEP and all educators should comply by law to provide these accommodations. For example, a student with VI may have an accommodation of providing magnification for reading printed text.

Assistive technology. This type of technology describes products or devices that are used to maintain or increase the functional capabilities of individuals with disabilities to access their environment (Federal Definitions of AT, 2020). Assistive technology improves the functional capacity of an individual, but its effectiveness can be limited when accessible mainstream or instructional technology is not present (Tony, 2019). For example, if the coding on a website is not accessible by a screen reader (assistive technology used by people who are blind), then the assistive technology is of no use to the individual.

Distance visual acuity. Distance visual acuity is the clarity with which an individual can see details of a target presented at a distance (Montgomery, 2022). Visual acuity of 20/20 is considered perfect vision. When a person has a distance visual acuity of 20/200, it means that what a person with 20/20 acuity can see at 200 feet, the person with 20/200 visual acuity can see the details of the same target only if he or she gets as close as 20 feet.

Expanded core curriculum. In addition to the general education curriculum, students with VI require specialized instruction in nine areas "to compensate for decreased opportunities to learn incidentally by observing others" (Texas School for the Blind, 2022, p. 1). The nine areas of the ECC include assistive technology, career education, compensatory skills, independent living skills, orientation and mobility skills, recreation and leisure, self-determination, sensory efficiency, and social interaction skills (Texas School for the Blind, 2022).

Functional vision assessments and learning media assessments. Functional vision assessments (FVA) and learning media assessments (LMA) are assessments completed by TVIs as part of the evaluation of their students for determining eligibility and services under the "Visual Impairments" category of special education.

General education classes. In this study, I defined general education classes as any class where the majority of students being educated are those without disabilities. Examples of general education classes can be social studies, science, math, language arts, choir, drama, etc.

General education teacher. A certified teacher who teaches any of the general education classes is a general education teacher.

Inclusion. Although federal laws related to special education do not specifically define "inclusion," the concept of inclusion is supported through equal opportunity mandates as required by several laws (Connect, 2009). Inclusion means "supporting students with disabilities through individual learning goals, accommodations, and modifications so that they are able to access the general education curriculum (in the general education classroom) and be held to the same high expectations as their peers" (International Resource Information System Center, 2022b, p. 1).

Individualized education program. The IEP is both a process in which an IEP team develops an appropriate program and a written document detailing the special education and related services that must be provided to result in meaningful educational benefits for the student for whom it is developed (Yell, 2019).

Individuals with Disabilities Improvement Education Act. The Individuals with Disabilities Improvement Education Act **(**IDIEA) is the name given to all reauthorizations of the federal law that guarantees students with disabilities the right to free appropriate education in the least restrictive environment (Individuals with Disabilities Education Act of 2004, 2006).

Instructional technology. This type of technology is designed to meet the needs of a diverse user base, with and without disabilities, and usually refers to technologies that reinforce or provide practice for skills already taught (Cheesman & Winters, 2020). Examples of instructional technology are software that allows students to practice reading and math skills such as IXL, I-Ready, etc.

Legal blindness. When an individual is legally blind, it does not mean that the person has no vision. It means that the central distance visual acuity of the person is 20/200 or less with the best correction in the better eye, or a visual field of 20 degrees or less (American Foundation for the Blind, 2020).

Mainstream technology. This refers to any devices, software, or applications that were designed for use by individuals without disabilities (Siu & Presley, 2019). Examples of mainstream technology are a laptop or a smartphone that was designed originally to be used by individuals without disabilities.

Middle school. Schools with ages of students ranging between 11 and 14 were referred to as middle schools. The grades of students in middle school are sixth, seventh, or eighth grades.

Technology. As the study's main purpose was to understand the experiences of middle school students with VI with technologies in general education classrooms, I would like to define the term "technology" first. In school settings, technology is often defined as any device or tool that provides students with access to information that is needed to accomplish a task (Siu & Presley, 2019). There are three technology terms used in schools: (a) mainstream; (b) instructional; and (c) assistive technology.

Mainstream technology with built-in accessibility features is often a better solution for students with disabilities than a dedicated assistive technology device (Siu & Presley, 2019). For example, free and low-cost assistive technology (AT) solutions available in Google Chrome apps and extensions will optimize student motivation and engagement levels (Ok & Rao, 2019). For this study, the term "technology" will include any technology defined above (mainstream, assistive, or instructional) that enables students with VI to access their general education curriculum. Such technologies can be mainstream or instructional products used by all students or can be assistive technologies used to meet students' specific needs.

Teacher of students with visual impairments. A TVI is a certified teacher who works with students with VI and who work with the multidisciplinary team members of the students with VI to ensure that their students have access to the general, special education curriculum and other services identified in their IEPs (Colorado Department of Education, 2022). Teachers of students with visual impairments also help provide specialized instructions in the nine areas of the spell out ECC (ECC). Since most students with VI attend public schools in Colorado, many of the TVIs are itinerants which means they go to multiple schools serving the students in their caseload (Colorado Department of Education, 2022).

Visual impairments. According to the Colorado Department of Education (2022),

> A child with a Visual Impairment, including Blindness shall have a deficiency in visual acuity and/or visual field and/or visual functioning where, even with the use of lenses or corrective devices, he/she is prevented from receiving reasonable educational benefit from general education. (p. 1)

Conclusion

In this chapter, I described the purpose and the research questions explored in this study. I also described the methodology and theoretical framework that I followed throughout my study. Answers to my research questions provided information on how middle school students with VI experienced technologies in general education classrooms, as well as successful strategies that will increase meaningful inclusive practices in middle schools in the U.S.A. In the next chapter, I will discuss the literature review pertaining to the accessibility of technologies by students with VI, the barriers to inclusive practices, current accessibility laws that guarantee equal access by students with VI, and evidence-based practices that include students with VI in general education classrooms. In addition, I will discuss how Piaget's cognitive development theory and universal design for learning influence the experiences of students with VI in technology-rich classrooms.

CHAPTER II

REVIEW OF LITERATURE

Inclusion in education is the practice of providing equal access to opportunities and resources to all individuals with and without disabilities. Krug (2014) called for implementing inclusive practices across all aspects of living:

> The one argument for accessibility that doesn't get made nearly often enough is how extraordinarily better it makes some people's lives. How many opportunities do we have to dramatically improve people's lives just by doing our job a little better? (p. 171)

Technology plays a critical role in 21st-century schools, and the promise of technology in classrooms enables personalized and mastery-based learning for all students (Bryant et al., 2020). As the educational environment is moving more towards a technology-rich system, students with diverse needs must be guaranteed equitable access to content curricula. In the 2020-21 academic year, 7.2 million or 15% of all public-school students, ages 3-21, in the U.S.A. received special education services under the Individuals with Disabilities Education Act (IDEA) (National Center for Education Statistics, 2022). If content presented in classrooms is inaccessible, 7.2 million is certainly a significant number of students who may be affected. There is limited research on how students with disabilities, including those with VI, are accessing and using technologies presented to them in general education classrooms.

In this chapter, I will review relevant literature on technologies used in classrooms and how they are accessed by students with VI. First, I provide background on students with VI and how technology plays a crucial role in their learning environment. Then, I discuss the theoretical framework that guided me in understanding the problem of accessibility needs of students with VI in general education classrooms. I then review the literature around the topic of “barriers to inclusion of students with VI in general education classrooms” which informed me of the problem addressed in this study and its significance. In this chapter, I also discuss the various accessibility laws and the legal basis in the U.S.A. that can influence the implementation of compatible technologies in classrooms. In addition to discussing barriers to implement inclusive practices for students with VI, I also examined some universally accessible technologies and evidence-based practices that help break such barriers in technology-rich classrooms for students with VI.

Students with Visual Impairments and Technology

Students with disabilities have varying learning needs, and technology can help provide personalized learning environments that can create a level playing field for these students. Dikusar (2018) described the advantages of using technology for students with disabilities:

> Teachers can use technology to offer a variety of learning opportunities and approaches that engage, instruct, and support special education students with a myriad of tactics designed to appeal to individual learners. No longer students are stuck in a classroom they don’t understand, trying to learn at a pace they can’t keep up with or participate in. (p. 2)

According to the Office of Special Education Program (2022), the percentage of students, ages 6 through 21, who received services under the category of VI or blindness in the U.S.A. was 0.4% of all students receiving special education services under IDEA in the school year 2019-2020. In a related report by the American Printing House (2021), 84.5% of students with VI in the U.S.A. attended public schools run by the State Department of Education and were served by itinerant teachers of students with VI. Among all students with VI in public schools, nearly 69% spent 80% more of their day in general education classrooms during their school day (Office of Special Education Program, 2022). This means that most students with VI received services in inclusive settings with itinerant TVIs who facilitated access to content provided by general education teachers.

According to the annual quota census by American Printing House (2021), in the year 2020, among students with VI, approximately 8.2% were braille readers, 33.3% were print readers, 9.8% were auditory readers, 30.7% were non-readers, and 18% were pre-readers. As portrayed in the above statistics, even within one disability category of VI or blindness, students differ in how they access their curricula including braille, print, or auditory modalities. The technology used in general education classrooms can address the divergent needs that arise from the impact of VI, thereby serving as a great facilitator in achieving optimal accessibility to educational environments (Siu & Presley, 2019). Some of the benefits of technology for students with VI as described by Brauner (2019, p. 1) are: (a) technology tools in classrooms can be seamlessly adapted to student's optimal learning modality (visual, auditory, or tactile) without additional time and resources; (b) "technology equalizes the playing field enabling students with VI to instantly research" and take notes collaborating with sighted peers; and (c) strong technology skills can open up opportunities in a variety of professions for students with VI.

Despite the benefits of using technology in general education classrooms, there are several challenges in how technology tools can restrict students with VI to access the content presented in classrooms. It is important to understand that "Assistive Technology" is one of the nine areas of specialized instruction addressed in ECC that TVIs provide for their students with VI and should be competent to teach those skills. Ajuwon et al. (2016) found that most general education teachers need professional development training to meet the instructional needs of diverse learners through technology. Many other limitations have been identified for general education teachers to use technology to include students with VI. Teachers may be against the use of technology in their classrooms and may not perceive any value of technology that benefits a very small number of students with disabilities (Dikusar, 2018). Others may have limited ability to implement technology tools and limited time for training to integrate technology into existing classroom practices (Lee, 2020). Remote teaching experiences of TVIs during the COVID-19 pandemic indicated that the majority of TVIs struggled with accessibility issues for their students on online digital platforms (Rosenblum et al., 2020). The ever-changing nature of the technology used in special education and the explosion of technology options available to learners with and without special needs (Edyburn, 2013) can confuse and overwhelm professionals who want to know how best to proceed (Hartmann & Weismer, 2016).

It is also crucial to understand that teachers' proficiency in technology or digital literacy use in classrooms is directly linked to students' postsecondary education experiences and employment outcomes for all students including students with VI (U.S. Department of Education, 2017). The degree of effective technology used by students with VI in K-12 schools directly influences the independence and foundation for success beyond high school (Thatcher, 2020). Based on the number of high school students with VI enrolled in the college readiness program at the Perkins School for the Blind, only 50% self-report that they can type at 40 words per minute when college-level work requires students to type a minimum of 60 words per minute (Perkins School for the Blind, 2022). In addition, 46% of the enrolled high school students with VI are not using electronic calendars or reminders, which are important time-management skills critical to building independence for success in higher education (Perkins School for the Blind, 2022). To close the achievement gap between students with VI and their sighted peers, both teachers and students need to be confident in the use of assistive and mainstream technologies in accessing learning content (Thatcher, 2020).

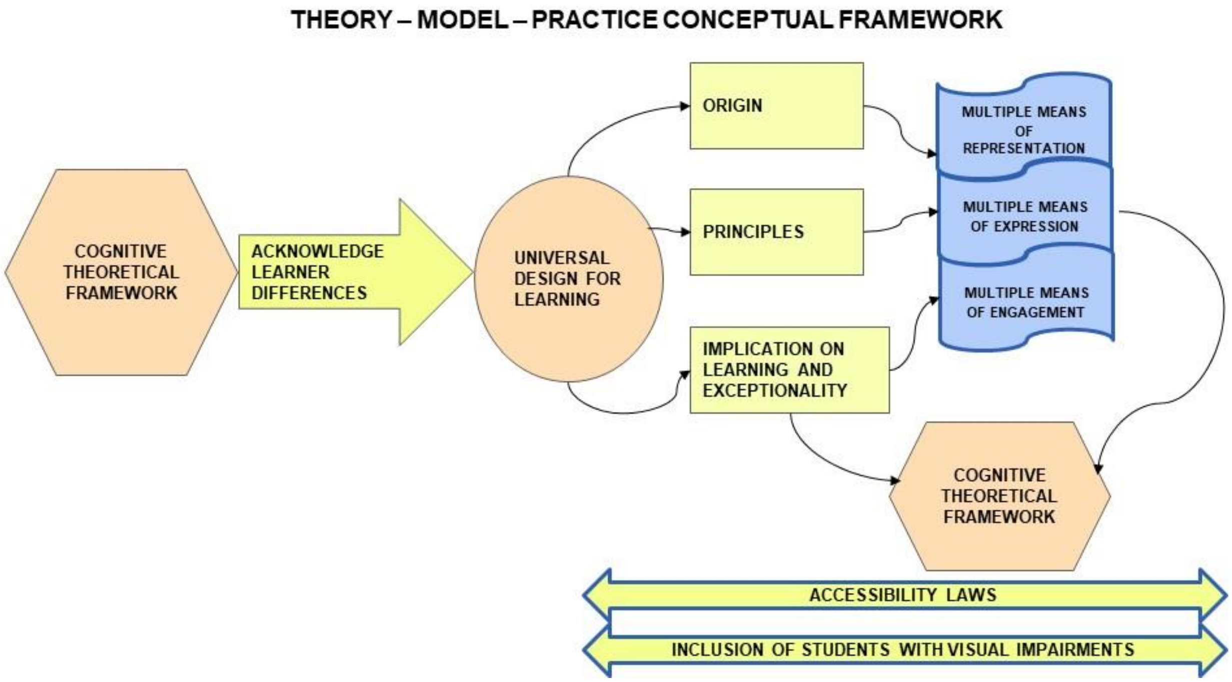
One way of seamlessly integrating accessible technology in classrooms is to use universally designed accessible technologies and applications to meet the range of access needs of students with VI (Siu & Presley, 2019). Cognitivism gives importance to the "role of mental activities in the learning process including thinking, remembering, perceiving, interpreting, reasoning, and problem-solving" (Clark, 2018, p. 176). The next section will provide an overview of how learner differences conceived by Piaget's cognitive development theory influence the framework of UDL in the discipline of special education with an emphasis on the disability category of VI and/or blindness.

Theoretical Framework

To get a holistic picture of how students with VI were included in general education classrooms and how they were accessing technologies to learn, I created the theory–model–practice conceptual framework as shown in Figure 1. Piaget's cognitive development theory acknowledges learner differences which leads to the UDL model. The principles of UDL which included multiple means of representation, expression, and engagement lead to the instructional practice of universally accessible technologies that catered to the divergent access needs of students with VI in general education classrooms.

Figure 1

Theory--Model--Practice Conceptual Framework



Piaget's Cognitive Development Theory

In the 1950s, there was a shift from a behavioral orientation, where students were viewed as unreflective responders to a cognitive orientation and where knowledge was seen as actively processed in the minds of learners (Ertmer & Newby, 2018). Behaviorists' dismissal of human agency to learning led several psychologists to conduct studies related to mental processes, or cognitivism (Berkeley Graduate Division, n.d.-b). Among several theories of human cognitive development that emerged in the late 19th century, the most influential has been the work of the Russian philosopher, Lev Vygotsky (Bates, 2016). Vygotsky developed a social constructivist approach to learning where knowledge is constructed through social interactions with knowledgeable individuals including families, friends, teachers, and peers (Bates, 2016). Around the same time that Vygotsky was developing his sociocultural approach to cognitive development, John Piaget, a Swiss psychologist, started a systematic study of cognition by observing his own three children (McLeod, 2018). Piaget's job at the Binet Institute was to develop French versions of questions for English intelligence tests (McLeod, 2018). While analyzing the incorrect answers to the tests, Piaget got intrigued by the differences in thinking between adults and children (McLeod, 2018). His main contribution included the four sequential stages of cognitive development in children (sensorimotor, preoperational, concrete operational, and formal operational) and their impact on learning outcomes (Berkeley Graduate Division, n.d.-a). The basic principle underlying Piaget's theory was how the cognitive development of children (including both intellectual and affective development) progresses towards increasingly complex and stable levels through a process called equilibration (Berkeley Graduate Division, n.d.-a). Piaget believed that learning happens when new information is associated with an already learned material or point of reference, a term called "schema" (McLeod, 2018). When individuals encounter a new phenomenon, they compare it to an existing schema (David, 2015). Every time a person reads, listens, observes, or experiences a new activity, new schemas are created (assimilation), and existing schemas are updated (accommodation) (Pritchard, 2014). While Vygotsky believed that the cognitive development of learners varies across cultures because learning was dependent on social interactions, Piaget focused on the unobservable mental activities of individuals that lead up to a learning response (McLeod, 2018). In Piaget's cognitive paradigm of learning, teachers considered themselves facilitators of instructions to help students activate prior knowledge and make learning relevant for them (Berkeley Graduate Division, n.d.-b).

Cognitive Development Theory Addressing Learner Differences

Jean Piaget's four-stage cognitive theory is a landmark contribution to developmental psychology (Cherry, 2020). According to Piaget, children grow within four stages of cognitive development, and each stage is characterized by how children understand the world (Ghazi et al., 2014). Children who are in the first stage of sensorimotor development acquire knowledge through sensory experiences and manipulating objects (Cherry, 2020). At this stage, children's outlook on the world is egocentric, and they are unable to understand others' points of view (Berkeley Graduate Division, n.d.-a). Children who are in the second pre-operational and the third concrete operational stages begin to learn symbolically by using words and pictures to represent objects (Cherry, 2020). Children in this stage require more structure in their learning as opposed to asking them to think out of the box (Cherry, 2020). Children who are in the highest fourth stage of formal operation begin to think logically and reason from specific information to a general principle (Cherry, 2020). At this stage, children learn abstract concepts without referring to concrete objects and begin to appreciate others' points of view as much as their own (Berkeley Graduate Division, n.d.-a). According to Piaget, no stage can be skipped, and there are individual differences in the rate at which children progress through each stage (McLeod, 2018). Piaget argued that intelligence is not a fixed trait; instead, cognitive development is considered a process that occurs due to "biological maturation and interaction with the environment" (McLeod, 2018, p. 1).

Piaget's cognitive development theory is evident in special education through the components of cognitive assessments, task analysis, accommodations, and scaffolding (Ertmer & Newby, 2018). Hence, a crucial area of focus for special education teachers is to facilitate students' cognitive and behavioral development by adapting to the environment that they interact with (Snowman & McCown, 2015). When students with disabilities encounter new experiences that they are unfamiliar with or absent in their current schema, then adaptation is necessary (Snowman & McCown, 2015). Special education teachers play a major role in understanding the cognitive abilities of their students as they have the responsibility to facilitate the assimilation of new experiences through a process called accommodation (Cherry, 2020). One of the other implications of Piaget's cognitive development theory in special education is the presentation of knowledge in multiple modalities including verbal, mathematical, experimental, and imagery (UK Essays, 2018). Learning modalities are the sensory channels or pathways through which individuals give, receive, and store information (Reiff, 1992). Most students learn with all their modalities, but some students with disabilities, specifically those with VI, may have unusual strengths and weaknesses in particular modalities (Hood, 1995). For example, students strong in the visual modality will be frustrated or confused with just verbal explanations. Similarly, tactile learners who are blind might not be able to access visual content when auditory descriptions of images are not available. Cognitive development theory acknowledges these learning differences of students with disabilities including those with VI (McLeod, 2018).

Cognitive Development Theory and Experiences of Students with Visual Impairments

Thinking about how Piaget's cognitive development theory relates to this study, several factors influenced the experiences of students with VI in general education classrooms. They are:

(a) Cognitive development theory emphasizes the role of educators in understanding the cognitive abilities of their students and how educators facilitate learning by providing accommodations and modifications that keep students with VI engaged in their learning process. When educators choose accessible technologies in classrooms, then they are not only facilitating learning for students with VI, but also greatly influencing the experiences of students with VI with such technologies.

(b) Piaget's theory highlights the importance of learning content presented in multiple modalities (auditory, visual, and tactile) so that all students can access such content equitably based on their cognition and learning media preferences. When classroom technologies have multiple options in which students can access them, then the divergent access needs of students with VI are met. This seamless access to technologies, irrespective of the mode in which they are presented, will certainly influence the experiences of students with VI when using such accessible tools.

(c) Students with VI are expected to complete learning tasks in classrooms just like their sighted peers. Piaget's cognitive development theory calls attention to how a process called task analysis influences the learning of materials presented in classrooms. Task analysis is breaking down a skill to be learned into smaller steps that can be easily understood and learned by students, especially those with disabilities. Technologies presented in classrooms should have the ability for educators to break down a skill into multiple steps that will keep students with VI not only engaging but also participating equitably with their peers. The guiding principles of Piaget's cognitive development theory helped in understanding individual differences in how students learned and their implications in educational practices.

The next section will discuss UDL. Universal design for learning is an approach for educators to prepare and design their curricula to address their students' wide range of ability levels and instructional needs (International Resource Information System Center, 2022c).

Universal Design for Learning

While learning theories do not give an epistemological perspective, an educator's theoretical view has strong implications for the types of support provided to learners (Frey, 2018). Although Piaget did not explicitly relate his theory to education or instructional practices, researchers have explained how features of Piaget's theory can be applied to teaching and learning (McLeod, 2018). One such report that was strongly influenced by Piaget's theory was the "Plowden" report, which reviewed primary education in the United Kingdom (McLeod, 2018). Plowden report's recurring themes included "individual learning, flexibility in the curriculum," the influence of the environment, and the importance of understanding children's cognitive development and progress (McLeod, 2018, p.1). When the education reforms moved away from behaviorist approaches and moved to cognitivist themes, several learning models developed towards transforming the education systems to reach all students and emphasize inclusive education (Opertti et al., 2014). One such pedagogical framework that was developed to counteract the one-size-fits-all approach in the broad education system is UDL (Rose & Meyer, 2000).

The Origin of Universal Design for Learning

Universal design for learning is based on the concept of universal design (UD), developed in the 1980s by a group of architects and engineers (Connell et al., 1997). The original UD model challenged designers of architectural spaces to create their products with all people in mind rather than adapting the design on a need basis (Connell et al., 1997). In 1998, following the reauthorization of the IDEA, researchers at the Center for Applied Special Technology (CAST) developed the UDL model by extending the UD principles from the physical environment to the learning environment as a way to provide students with disabilities access to the general education curriculum (Griful-Freixenet et al., 2020). The most common example used to describe UD principles is the provision of a ramp or “curb cut” in a physical environment (Thibodeau, 2021). A curb cut is an incline built into most sidewalks that allows individuals with disabilities on wheelchairs to easily navigate the transition from a curb to a street without a problem (Thibodeau, 2021). However, the “curb cut” turned out not only good for someone in a wheelchair, but a person on a bike or a person pushing a baby stroller can all benefit from the same design (Thibodeau, 2021). Hence, the concept of UDL originated with the idea of “what was essential for some is good for all” translated into learning environments and revolutionized the way all students can access UDL content regardless of any disabilities that they may have (Thibodeau, 2021, p. 1).

Principles of Universal Design for Learning

The main goal of the UDL framework is to expand and improve the learning outcomes for all learners. Using a cognitivist lens, where all children interact with content differently, UDL encompasses three core principles that educators ought to consider when they are designing their curricula (Griful-Freixenet et al., 2020). These core principles are: (a) multiple means of representation; (b) multiple means of action and expression; and (c) multiple means of engagement (Griful-Freixenet et al., 2020). Multiple means of representation propose that educators present information and content in multiple ways by enabling varied options for how learners acquire and comprehend information (Moore, 2017). Multiple means of action and expression signify that the curricula should differentiate the ways that students express what they know by enabling multiple options for how learners interact, communicate, and express their knowledge (Fry, 2021). Finally, multiple means of engagement suggest that lessons should engage all students by tapping into learners' variable interests by providing appropriate levels of learning tasks (Moore, 2017).

Universal Design for Learning and Cognitive Brain Research

The principles of UDL were developed based on the neuroscience of how children learn. In a cognitivist approach, individuals are active learners who are capable of building their knowledge (McLeod, 2018). Piaget's theory of cognitive development changed how people viewed the child's world and their methods of studying children (McLeod, 2018). Rose and Meyer (2002) used brain research and explicitly linked it to UDL principles in education by explaining the three networks of the brain: (a) the recognition network, (b) the strategic network, and (c) the affective network. The recognition network controls the "what" of learning or how people recognize patterns with their senses (Thibodeau, 2021). Although humans share the same brain structure and recognize things in roughly the same way, their recognition networks come in many different sizes, shapes, and patterns (Rose & Meyer, 2002). For example, students with sensory disabilities, learning disabilities, and cultural differences may approach their learning content differently because they vary in the ways they make connections to information presented to them (Center for Applied Special Technology, 2011). Hence, to compensate for these differences, educators should focus on providing multiple means of presentation that trigger more than one sense to reach a greater number of students (A Study on Universal Design Learning, n.d.).

The strategic network controls the "how" of learning or how people identify a goal, devise a plan, execute the plan, monitor progress, and make changes to the plan when necessary (Rose & Meyer, 2002). For example, students with physical impairments and executive function disorders differ in the ways that they navigate their learning process and express what they know

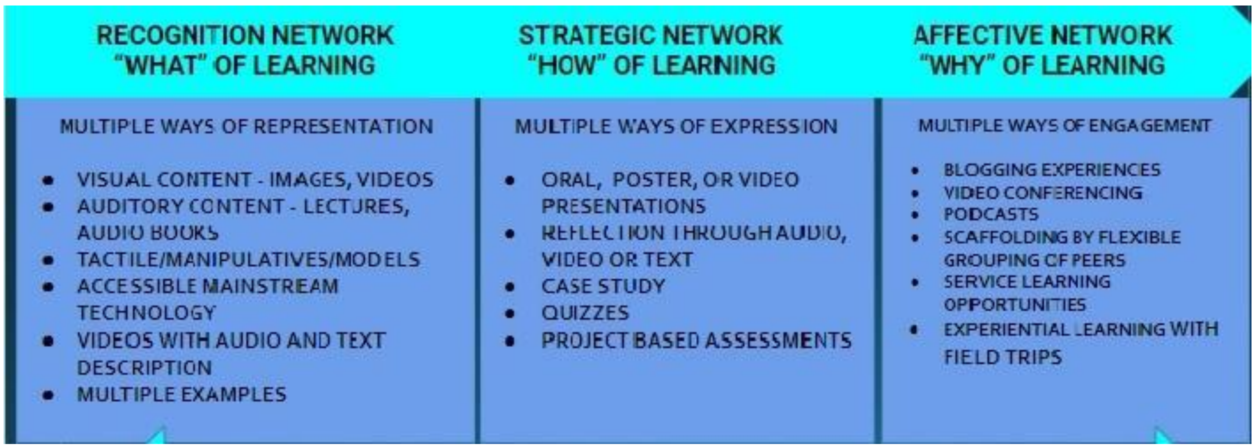
(Center for Applied Special Technology, 2011). In some cases, as argued by Piaget's learning theory, students' efforts are awarded as much as their achievements (McLeod, 2018). Hence, providing multiple means of action and expression is essential for students to benefit from any kind of learning task.

The affective network controls the "why" of learning or the things that excite students to learn (Rose & Meyer, 2002). Students vary markedly in the ways they are engaged or motivated to learn (Center for Applied Special Technology, 2011). Factors such as culture, personal relevance, subjectivity, and background knowledge influence individual variation in engagement (Center for Applied Special Technology, 2011). For example, some learners might like to work alone, while some prefer group activities (Center for Applied Special Technology, 2011). Increasing the engagement of students by interacting with peers, co-constructing content, and providing opportunities for students to think critically, receive critique, and benefit from it are some of the core instructional practices developed from cognitivist learning theories (Barak, 2016). Hence, educators should provide multiple means of engagement in their learning activities to compensate for varying student levels of motivation and preference.

Neuroscience has also shown that learner variability is the rule rather than the exception (Thibodeau, 2021). Related to classroom technologies, educators can support the affective, recognition, and strategic networks of diverse learners by using technologies that have features facilitating multiple means of engagement, representation, and expression. I have listed some of the tools that can be used to support learner differences based on UDL and cognitivist brain research as shown in Figure 2. For example, to trigger the recognition network of the brain (the "what" of learning) of students, curricula can be presented in multiple ways such as videos, images, lectures, audiobooks, models, tactile manipulatives, accessible mainstream technologies, and multiple examples.

Figure 2

Cognitivist Brain Research and UDL



The Implication of Universal Design for Learning on Students with Disabilities

Universal design for learning addresses the educational needs of all students including students with disabilities by: (a) reducing the number of barriers to learning; (b) "providing challenging, salient, and age-appropriate materials to students with a varying range of abilities"; (c) allowing students to learn content that is aligned with their learning style; and (d) "creating alternate ways for students to both receive and deliver information" (International Resource Information System Center, 2022c, p. 1). Both UDL and differentiation of curriculum share the same goal of helping children to have successful learning outcomes and both are models derived from cognitivist theoretical paradigms of customizing the curriculum to fit students with differing abilities (Griful-Freixenet et al., 2020). While differentiation or individualization of the curriculum emphasizes formative assessments to inform educators of constant adaptation of instruction to meet all student needs, UDL builds a curriculum that anticipates student needs and incorporates modifications into the curriculum from the outset (Griful-Freixenet et al., 2020). The traditional curricula itself is disabled in who, what, and how they can teach all students in general education classrooms (Center for Applied Special Technology, 2011). Students with disabilities often bear the brunt of curricula that do not account for learner variability, are constructed primarily around print-based media, and that have limited instructional options (Center for Applied Special Technology, 2011). In the discipline of special education, existing inflexible "one-size-fits-all" curricula are made more accessible by incorporating appropriate accommodations and modifications. The term UDL is often mistakenly applied to such after-the-fact adaptations (Center for Applied Special Technology, 2011) in special education. However, UDL refers to a process by which a curriculum is intentionally designed from the beginning to address learner differences (Center for Applied Special Technology, 2011).

When UDL is achieved in classrooms, meeting the needs of students with exceptionalities does not add significant time to the teacher and it does not need to take instructional focus away from the whole class to accommodate a single student's accessibility needs (Siu & Presley, 2019). As UDL plays to diverse learning styles and cognitive abilities, it helps maintain high expectations and standards for students with exceptionalities by expanding the way objectives are met using different tools and approaches (Moorman & Escayg, n.d.). Universally designed mainstream technology applications allow students with disabilities to access and meaningfully engage in 21st-century classrooms that are flooded with digital information. Digital texts presented in classrooms could now be easily highlighted, magnified, converted to speech, and translated into another language, thereby supporting learners with diverse needs (Siu & Presley, 2019).

In the field of VI or blindness, TVIs often retrofit and fix the curriculum to be accessible for their students (Hartmann, n.d.). Additionally, TVIs are given the curriculum that is often used in a typical classroom with sighted students (Hartmann, n.d.). They constantly change the curriculum into a format more accessible for their students with VI and teach the skills needed for accessing the information presented to them (Siu & Presley, 2019). The UDL framework challenges both general education teachers and TVIs to think about developing and implementing a curriculum that is accessible to everyone from the very start (Hartmann, n.d.). Instead of going through the process of retrofitting, which can become tedious and time-consuming, educators can think about incorporating multiple means of representation, multiple means of expression and action, and multiple means of engagement from the very beginning of designing their lessons (Hartmann, n.d.). Technology tools designed by utilizing the concepts of the UDL framework and cognitivist theory of learning will not only help students with VI access such tools but will also create more inclusive practices in schools. In the next section, I will review the literature on barriers to learning and including students with VI in general education classrooms. Barriers to the inclusion of students with VI provided the basis for this study and its significance in the discipline of educating children with VI in public schools.

Barriers to Inclusion of Students with Visual Impairments in General Education Classrooms

Accessibility is fundamental for the inclusion of students with VI and it is likely the most prominent hurdle in school settings where inaccessible technology is used (Siu & Presley, 2019). All around us, people are learning from new technologies that allow them to decide what they want to learn, when they want to learn, and how they want to learn (Collins & Halverson, 2018). The majority of schools in the U.S.A. follows a “transfer/acquisition” model where knowledge is considered a discrete entity and learning is the transfer of those entities into the minds of learners (Donaldson & Allen-Handy, 2020). According to Resnick (2014) in his talk on “Rethinking Learning in the Digital Age,” schools still tend to use technology in a traditional way assuming that students learn by the “transfer/acquisition model.” In many schools, instead of transferring knowledge from “teachers” to students, knowledge is being transferred from “technologies" to students (Resnick, 2014). Resnick (2014) argued that technology must be used in classrooms following Piaget’s cognitive development theory where students construct their knowledge and express their knowledge in creative ways based on their experiences and interaction with the content. This also means that when schooling follows the assumption of the “transfer/acquisition” metaphor of learning, technologies used in classrooms are for more “uniform learning” than “customization” (Collins & Halverson, 2018). Inaccessibility or inequities of access to “any part of the digital landscape in schools directly limits” students with VI access to information (Siu & Presley, 2019, p. 5).

Inaccessibility of Online Platforms

Park et al. (2019) conducted a study to identify the needs and barriers that learners with VI face when learning with mobile devices in massive open online courses (MOOC). The study was conducted in two phases. Phase 1 was a user study with three university students with VI who were asked to perform tasks related to using MOOCs on three widely used MOOC platforms (EdX, Coursera, and Khan Academy) (Park et al., 2019). The students in the study were also interviewed about the barriers to learning using MOOC platforms and the pedagogical usefulness of mobile MOOCs (Park et al., 2019). In Phase 2 of the study, five evaluators who had extensive experience in designing mobile applications conducted a heuristic walkthrough to identify accessibility problems in the MOOC platform, Coursera (Park et al., 2019). At the end of their study, Park et al. (2019) derived key findings that will help design MOOCs more accessible using the UDL principles. A significant barrier identified by the study was that learners with VI were not fully participating in MOOC activities because the screen readers (an assistive technology used by students with VI) were not able to read the information in dropdown menus and because of the lack of alternate texts in non-texts or images in these platforms (Park et al., 2019). Students with VI in the study even had difficulties participating in simple activities on these MOOC platforms such as writing in discussion forums (Park et al., 2019). Overall, the results of their study indicated that serious accessibility issues exist in MOOC platforms preventing learners with VI from fully participating in learning activities (Park et al., 2019).

Intending to examine the most successful learning MOOC platforms in the U.S.A. and Germany, Bohnsack and Puhl (2014) completed an evaluative study on the accessibility of five MOOC platforms (Udacity, Coursera, edX, OpenCourseWorld, and Iversity). The study used protocol observation as their research design where a person who is blind was asked to select and enroll in a random course in the MOOC platforms in the study (Bohnsack & Puhl, 2014). Bohnsack and Puhl (2014) found that none of the five MOOCs were accessible to individuals with VI and particularly to those who were blind. The study concluded that MOOCs, despite their original intent to be open to everyone, currently exclude individuals with VI (Bohnsack & Puhl, 2014). The issue of accessibility is exacerbated in blended or online learning environments where videos are the main information delivery mechanism causing students to be dependent on accessible instructional videos to understand the content of lessons (Brame, 2016). Existing practices in schools indicate that for instructional videos to be meaningful and engaging, educators are creating videos that have more visual cues and they minimize the use of on-screen text that can be read with a screen reader (Ibrahim et al., 2012).

As there is very limited research to date in the discipline of accessibility of online learning platforms for students with VI, research studies conducted a decade ago seem relevant and highlight that accessibility is still in its infancy (Zhang et al., 2020). Muwanguzi and Lin (2010) conducted a qualitative study to examine the challenges faced by individuals with VI when they use and access the online learning environment, particularly the study focused on the usability and accessibility of Blackboard (an online course management system). Five students of ages ranging from 18 to 31 with varying visual impairments were selected as participants in the study (Muwanguzi & Lin, 2010). Four primary themes emerged from the data, namely: poor accessibility and usability, frustration and motivation, marginalization and optimism, and training and improvement of Blackboard design (Muwanguzi & Lin, 2010). Participants reported failures to locate and process materials to solve their respective problems (Muwanguzi & Lin, 2010). All participants complained about navigation difficulties of animations and color themes in Blackboard (Muwanguzi & Lin, 2010). Participants emphasized the frustrations caused while performing tasks in Blackboard resulting in loss of time and lag in academic progress (Muwanguzi & Lin, 2010). However, the frustrations only delayed them and not derailed them from completing the task because students were motivated to attain their academic goals (Muwanguzi & Lin, 2010). Based on the results of the study, students who are blind experienced several accessibility and usability challenges with Blackboard, which impeded their academic success (Muwanguzi & Lin, 2010). Data also showed that blind students were motivated and optimistic about their academic success despite the frustrations and marginalization that they experienced at the university (Muwanguzi & Lin, 2010). The study recommended software developers and web designers work jointly to ensure universal access to Blackboard by all students (Muwanguzi & Lin, 2010). Hence, the findings of the study conducted by Muwanguzi and Lin (2010) can be used to ensure some degree of standardization across all online learning environments for universal access.

Digital inaccessibility has become evident during the Coronavirus (COVID-19) pandemic, more so than ever before (Katz, 2020). The rapid shift from in-person instruction to online learning has disproportionately impacted students with disabilities who were already experiencing social and educational inequalities (United Nations Educational Scientific and Cultural Organization, 2020). In two recent surveys conducted nationwide, the impact of COVID-19 on students with VI ages birth to 21, their families, and professionals in the U.S.A. and Canada was examined (Rosenblum et al., 2020; Rosenblum et al., 2021). Results of the two surveys suggested that 85% of TVIs who had students in general education classrooms reported having at least one student with an online accessibility issue (Rosenblum et al., 2020; Rosenblum et al., 2021). With a similar goal to understand the experiences of professionals who work with students with VI during the early days of the COVID-19 pandemic, Correa-Torres and Muthukumaran (2021) conducted a qualitative study. Fifteen educators of students with VI (TVIs) participated in this study (Correa-Torres & Muthukumaran, 2021). Participants were asked to share their experiences when providing services to students who are VI during the first nine months of the COVID-19 pandemic (Correa-Torres & Muthukumaran, 2021). Apart from students facing accessibility issues during remote instructions, TVIs reported troubleshooting technology issues virtually with students, implementing workarounds for accessibility issues, keeping up with constant technology changes, and frustrations around inaccessible mainstream platforms as the hardest tasks during the pandemic (Correa-Torres & Muthukumaran, 2021). The

TVIs in the study also reported that many of the mainstream platforms used by school districts were not accessible to students who were blind (Correa-Torres & Muthukumaran, 2021). With "pop-ups, chats, and online quizzes that are easily accessed by sighted peers, TVIs had to create workarounds for their students by collaborating with general education teachers" (Correa-Torres & Muthukumaran, 2021, p. 7).

Lack of Teacher Proficiency in Access Technology

One other significant barrier to including students with VI in a general education setting is related to the proficiency of educators in using accessible technology in classrooms. A recent study was conducted by Fernández-Batanero et al. (2022) that aimed to identify the degree of training and technological knowledge of university faculties of education in Spain in the use of information and communication technology (ICT) to support people with disabilities. The study used a questionnaire which was a modification of the battery of items of the instrument developed by Cabero-Almenara et al. (2021) that measured the ICT resources to serve students with disabilities including those with VI at the university level (Fernández-Batanero et al., 2022). The sample for the study consisted of 2072 university teaching faculties of education in Spain (Fernández-Batanero et al., 2022). The study found that university teachers had a significantly low level of technological competencies in using access technologies for students with disabilities including those with VI in higher education (Fernández-Batanero et al., 2022). University educators have a very low level of knowledge regarding the use of digital resources for people with disabilities (visual, hearing, motor, cognitive), and they also seem to have a very low degree of knowledge regarding how to create accessible materials for these people (Fernández-Batanero et al., 2022). The result of this study most certainly presses the need for educators to be trained in the subject of accessibility and in providing technologies that can be seamlessly accessed by students with disabilities (Fernández-Batanero et al., 2022).

Related to research conducted in K-12 settings, Ajuwon et al. (2016) examined assistive technology utilization and competencies of TVIs in the nation. Results from the quantitative analysis of two national studies found that over half of the TVI participants reported a lack of confidence in instructing students with VI in the use of assistive technology (Ajuwon et al., 2016). The qualitative analysis of the same national studies suggested that many educators need professional development training to meet the instructional needs of diverse learners through technology (Ajuwon et al., 2016). Moreover, TVIs' deficits in accessible and assistive technology proficiency negatively affected students with VI by stunting the development of their technology skills leading to poor post-secondary education and employment outcomes (Siu & Morash, 2014). Although TVIs are often seen as accessibility facilitators, the use of inaccessible mainstream technologies in classrooms by general education teachers makes it very hard for TVIs to adapt and modify learning content in a timely and equitable manner for their students (Siu & Presley, 2019). Additionally, as digital practices in schools and the nature of information advance rapidly, TVIs often lack access to ongoing professional development to keep up to date and remain savvy about what technology tools are available for supporting their students (Siu & Presley, 2019). The lack of empirical research on this topic is further exacerbating the problem of the inaccessibility of technologies used by students with VI in general education classrooms.

Ever-Changing Nature of Technology

According to Edyburn (2013), there is often a "satiable" appetite to chase what is new concerning technology. Constant changes and innovations in technology use in classrooms will not only be frustrating, but such changes will also increase the "inaccessibility" of such tools for students with VI (Edyburn, 2013). A popular education software tool “Scratch” created by the Massachusetts Institute of Technology (MIT) Media Labs that helps students “code” and improve their programming and problem-solving skills is not accessible to students with VI or blindness (Discuss Scratch, 2018). In a survey of 25 award-winning companies that produce pre-college instructional software, only 2 of the 19 specified that they were aware of accessibility issues (Access Computing, 2023). Innovative technologies that have no research evidence concerning their effectiveness often reach the educational school systems making it particularly challenging for educators to keep up with them (Edyburn, 2013).

Divergent Access Needs of Students with Visual Impairments

According to accessibility experts, equivalent access is the ability of students with VI “to independently realize the same benefits as sighted peers for the same cost within the same amount of time” (Siu & Presley, 2019, p. 234). To provide equivalent access to students with VI, the degree of vision loss plays a role in determining if they will need tactile, enhanced-visual, or auditory access to content curricula (Siu & Presley, 2019). Oftentimes, general education teachers are not aware that students with VI are entitled to the provision of accessible materials in any format that is determined as their primary mode of access by their TVIs (Willings, n.d.-b). Technologies for accessing print and digital text may be very different for a tactile user as compared to a visual user. In theory, the presence of accessibility features in mainstream technologies should make digitized content equally accessible as the oriented word on a screen, a braille word on a display, and an audible voice on a speaker (Taylor, 2016). However, in reality, students with VI face a myriad of difficulties while navigating technology-rich classrooms (Taylor, 2016). For example, a student who is blind and who uses a screen reader cannot collaborate with peers on a presentation, as the images chosen for the presentation may not have words describing them. Similarly, a high school student with VI who uses a screen reader to listen to graduation announcements posted on her school website will have difficulty finding where the announcement is located if the website is not formatted for screen readers to access (Kimmons & Smith, 2019). A staggering example is that nearly two-thirds of the K-12 school websites nationwide failed to meet at least one of the existing web accessibility guidelines (Kimmons & Smith, 2019). It should be noted that the content on any webpage must be formatted for accessibility and multimodal access as per the 2017 Web Content Accessibility Guidelines (Allan et al., 2016). When even the majority of K-12 school websites do not meet the accessibility standards, the expectation of students who are blind to complete online research projects at the same time as their peers using the same technologies is certainly leading to more segregation than inclusion.

In the dissertation study completed by Johnson-Jones (2017) that looked at the experience of students with VI in general education settings, one of the emerged themes was the dependency on structures of support that included the usage of assistive technology by students with VI based on their diverse vision access needs. The dissertation was a qualitative case study on three students with VI ages ranging from 9 to 13 in a rural, southern Mississippi community (Johnson-Jones, 2017). Observation of the three students revealed that none of the three students were using assistive technology devices during classroom instruction based on their divergent vision needs even though such devices were part of their accommodation stated in their IEP (Johnson-Jones, 2017). The TVI participants in the dissertation expressed how assistive technology devices were essential for their students with VI, but not all teachers provided or utilized access in their instructions through these assistive technology devices in their daily classroom routines (Johnson-Jones, 2017).

Lack of Research in Access Technology

One of the most significant barriers to the inclusion of students with VI in general education classrooms is that much research and policy analysis is not being conducted on access technology (Edyburn, 2013). According to Ferrell et al. (2014), “Assistive technology for students with VI has not been widely researched, and the literature is limited to product reports and case studies” (p. 43). Lack of research on technology accessibility in K-12 schools leads to educators having negative connotations on how they perceive the relationship between a minoritized demographic and its equitable access to information (Siu & Presley, 2019).

Considering the limited research related to the accessibility of technologies in general education classrooms by students with VI, I broadened my search to look for literature on the access to classroom technology by students with disabilities. The barriers to include students with disabilities in technology-rich classrooms were very similar to what I found for students with VI. Okolo and Diedrich (2014) conducted a large-scale study in a single state by surveying 1,143 educators to provide a snapshot of factors affecting the use of technology that can be accessed by students with disabilities. The key barriers to integrating accessible technology in classrooms for students with disabilities were: (a) lack of teacher knowledge about technology and (b) issues to learn and integrate technology tools including lack of teacher time and restrictions on school-based software applications (Okolo & Diedrich, 2014). In another study conducted by Davis et al. (2013), 163 special education directors were surveyed across the state of Texas in the U.S.A. to examine district-level decision-making regarding assistive technology devices. Apart from how the decision to acquire and implement technologies that benefit students with disabilities in classrooms, the researchers found that students in rural schools have less access to technologies than their peers in urban and suburban areas (Davis et al., 2013).

Similar to the findings of Edyburn (2013) and Ferrell et al. (2014) discussed previously, research lags behind practice in special education technology (Thomas et al., 2019). Keeping pace with innovative technology apps and software that can be used with students with disabilities can be overwhelming (Thomas et al., 2019), and teachers need to know how to make decisions around accessible and meaningful implementation of special education technology for their students (Schmidt et al., 2017). It is also crucial to understand that evidence-based practices involving technologies that include students with high-incidence disabilities in classrooms may sometimes serve as a barrier for students with VI. For example, in a study conducted by Losinski et al. (2016), the researchers found that video modeling allows students with learning disabilities to see others perform tasks successfully and, hence, serves as an accessible learning tool for these students. However, such technologies of using videos without audio descriptions may not be appropriate for students with VI and may even contribute towards excluding them from their learning environments. Hence, the technology used in classrooms should be selected to address the individual needs of students with disabilities to ensure equitable and meaningful access (Thomas et al., 2019).

In the next section, I will discuss the legal basis for inclusive practices for students with VI using technology. I examined the existing laws that can influence the accessibility of technologies used in classrooms by students with VI. I also discuss some prominent case laws and rulings that served as a foundation for accessing educational content with technology by students with VI.

Legal Basis: Equitable Access by Students with Visual Impairments

In this section, I explored the challenge of inaccessibility of educational content through the lens of IDEA, specifically the development of the IEP for a student with VI. I will discuss the various accessibility laws in the U.S.A. that can influence the development of the IEP and the implementation of technology in accessing educational content in classrooms by students with VI. In addition, I will discuss case laws that served as the foundation in interpreting the IEP mandates that not only require access to educational content but also ensure meaningful educational benefits for students with VI.

Legal History and Definitions

Although organizations by and for people with disabilities have existed since the 1800s, they exploded in popularity in the 1900s (Meldon, 2022). Case laws such as *Brown v. Board of Education* (1954) and its decision that school segregation is unconstitutional laid the groundwork for recognizing the rights of people with disabilities (Siu & Presley, 2019). The 1975 Education of All Handicapped Children Act (EAHCA), often referred to as Public Law 94-142, guaranteed children with disabilities the right to public education (Meldon, 2022). In all, the United States Congress passed more than 50 pieces of legislation between the 1960s and the passage of the Americans with Disabilities Act (ADA) in 1990 which is a major civil rights law that prohibits discrimination against people with disabilities in many aspects of public life (Americans with Disabilities Act of 1990; Meldon, 2022). Amendments to the EAHCA enacted in 1990, P.L. 101-476 changed the name of the act to the Individuals with Disabilities Education Act (IDEA) (Yell, 2019).

Individualized Education Program

The IEP developed for a child with a disability is the “modus operandi” of the IDEA (*Burlington School Committee v. Massachusetts Department of Education*, 1985). The purpose of the IDEA is to ensure that all children with disabilities have a free and appropriate public education available to them that emphasizes special education and related services designed to meet their unique needs and prepare them for further education, employment, and independent living (Individuals with Disabilities Education Act of 2004, 2006). The IDEA provides a series of procedural (related to specific processes in developing an IEP) and substantive (related to the adequacy of the individualized instructions and educational supports contained in an IEP) protections for parents and their children with disabilities (Berney & Esquire, n.d.; Individuals with Disabilities Education Act of 2004, 2006). The IEP is both a process in which an IEP team develops an appropriate program and a written document detailing the special education and related services that must be provided to result in meaningful educational benefits for the student for whom it is developed (Yell, 2019). Because the IEP is the foundation of a student's free and appropriate public education (FAPE), it must be individualized and should be developed to meet the unique needs of students with disabilities (Individuals with Disabilities Education Act of 2004, 2006).

Least Restrictive Environment

Least restrictive environment (LRE) requirements of IDEA specify that each public agency must ensure that "to the maximum extent appropriate, children with disabilities, including children in public or private institutions or other care facilities, are educated with children who are nondisabled" (Individuals with Disabilities Education Act of 2004, 2006). As discussed above, most students with VI are educated in inclusive settings with nondisabled peers. Future amendments to IDEA should extend the LRE requirements of IDEA beyond physical environments to digital educational spaces to ensure that students have seamless access to digital spaces like their nondisabled peers.

Substantive Mandate--Content of the Individualized Education Program

The IDEA requires that at minimum, eight components be present in the IEP (Individuals with Disabilities Education Act of 2004, 2006). One of the eight components is the statement of special education, related services, and supplementary aids and services based on peer-reviewed research to be provided to the student and a statement of the program modifications or support for school personnel (Individuals with Disabilities Education Act of 2004, 2006). This means that the IEP developed should cater to the unique needs of students with disabilities and the IEP should ensure that those needs are met with appropriate support and services. Moreover, when an IEP is developed for a student with VI, the IEP must provide instruction in Braille and the use of Braille unless the team determines that instruction in Braille is not appropriate (Individuals with Disabilities Education Act of 2004, 2006).

The critical importance of the IEP and its mandates can be better understood through two U. S. Supreme Court decisions: (a) *Board of Education of the Hendrick Hudson Central School District v. Rowley* (1982) and (b) *Endrew F. v. Douglas County School District* (2017). The Rowley ruling guided the lower courts in determining compliance with the FAPE mandate of the IDEA and directed them to determine if the procedures of IDEA were followed. In the Endrew ruling, courts were directed to determine whether the IEP was "reasonably calculated to enable the [student with disabilities] to make progress appropriate in light of his or her circumstances" (*Endrew F. v. Douglas County School District*, 2017). Acting on the derivatives from the Rowley and Endrew decisions, the content of a student's IEP should be examined to not only provide access to services and supports, but the IEP proposed by the local educational agency should be reasonably calculated to "achieve academic success, attain self-sufficiency, and contribute to society that are substantially equal to the opportunities afforded by children without disabilities" (*Endrew F. v. Douglas County School District*, 2017, p. 1). This means that children with VI, when educated in general education classrooms, should not only be able to seamlessly access technologies presented to them but also such technologies should benefit students with VI in achieving academic success.

Case Laws--Substantive Violations

In *D.S. v. Bayonne Board of Education* (2010), the courts found the IEP inappropriate as the school district failed to provide proper modifications and accommodations including extended time on tests, a highly structured environment, drilling and repetitive practice, and the use of a multi-sensory approach to the petitioner's educational curriculum. Likewise, the Court in *L.R. v. Manheim Township School District* (2008) found a claim regarding the content of a child's IEP to be substantive in nature where the plaintiffs asserted that their child's IDEA rights were violated because the child's IEP did not include sufficient language therapy or an adequate one-on-one aide. Since Rowley, several courts have held that a failure to implement material aspects of an IEP is a substantive violation of the IDEA (Berney & Esquire, n.d.). In *Van Duyn ex. rel. v. Baker School District* (2007), plaintiffs alleged that their child was denied FAPE because the school did not provide the math instruction required by the IEP and failed to properly implement the student's behavior management plan. Although the decisions on these case laws and legislations have transformed opportunities for students with disabilities in K-12 classrooms, there is still much work to be done. To fully understand the experiences of students with VI in general education classrooms, it is critical to understand the established accessibility laws that K-12 schools should comply with in the U.S.A.

Accessibility Law

Laws and regulations provide powerful motivation for all accessibility improvements that have been made in schools (Crossland et al., 2016). All students in an IEP are guaranteed tools and assistive technology if such devices increase, maintain, or improve their functional capabilities (Individuals with Disabilities Education Act of 2004, 2006). Many legal provisions that persist for education and communication technologies use the term “assistive” instead of “access.” However, the intent of such legal mandates remains clear about schools required by law to include students with exceptionalities to the greatest possible extent by guaranteeing access to learning materials enabled by technology (Siu & Presley, 2019). There are five primary laws and regulations concerning assistive technology and accessibility for students with disabilities: (a) The Individuals with Disabilities Education Act (IDEA), (b) The Assistive Technology (AT) Act, (c) Americans with Disabilities Act (ADA), (e) Every Student Succeeds Act (ESSA), and (f) Section 508 of the Rehabilitation Act.

Individuals with Disabilities Education Act

The IDEA is a federal law that ensures FAPE to eligible children with disabilities throughout the U.S.A. and ensures special education and related services to those children (Individuals with Disabilities Education Act of 2004, 2006). There are two parts to IDEA. Part C of IDEA governs early intervention services which include children of ages birth through 36 months and Part B of IDEA applies to services for school-aged children of ages 3 to 21 years of age (Individuals with Disabilities Education Act of 2004, 2006). IDEA Part B defines an “assistive technology (AT) device” as “any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of a child with disability” (Individuals with Disabilities

Education Act of 2004, 2006). This means that any technology or new devices can be included in a child's IEP if such devices are determined by the IEP team to "increase, maintain, or improve" a child's abilities (Siu & Presley, 2019, p. 19).

The 1991 amendments of IDEA included both "AT device" and "AT service," and the accompanying federal regulations included provisions for AT devices and services to be made available to any child with a disability if required as part of the child's special education or related services (Early Childhood Technical Assistance Center, 2023). Assistive technology services are defined in the IDEA statute as "any service that directly assists a child with a disability in the selection, acquisition, or use of an assistive technology device" (Individuals with Disabilities Education Act of 2004, 2006). Inclusion of AT services within the statute means that children with disabilities are not just entitled to the provision of various devices, they must receive services that will allow training or other assistance for the students, as well as the family when appropriate (Siu & Presley, 2019). With the later reauthorization of IDEA in 1997, school districts that receive federal money across the nation are required to consider the need for AT devices and services whenever a child's IEP is developed (Individuals with Disabilities Education Act of 2004, 2006; Early Childhood Technical Assistance Center, 2023).

The Assistive Technology Act

The Assistive Technology Act, often called the Tech Act, was first passed by Congress in 1988 and reauthorized in 1994, 1998, and 2004 (Assistive Technology Act, 2021). The difference between the Tech Act and IDEA is that the Tech Act covers people with disabilities of all ages and in all environments including but not limited to early intervention, K-12 schools, post-secondary, vocational rehabilitation, community living, retirement communities, etc. (Assistive Technology Act of 2004, 2004). Moreover, under this law, each U.S. state and territory receives a grant to fund an Assistive Technology Act project (ATAP) (Assistive Technology Act, 2021). The purpose of these programs is to help individuals with disabilities to lead more independent lives with the help of AT devices and services. For example, the ATAP in the state of Colorado provides an AT clinic where individuals with disabilities can get an AT evaluation, find funding for new and used devices, get training and assistance, and receive resources for employment (Colorado Assistive Technology Act Program, 2022).

Americans with Disabilities Act

The ADA is a civil rights law that prohibits discrimination against individuals with disabilities in all public and private places that are open to the general public (Americans with Disabilities Act of 1990, 1990). The purpose of the law is to make sure that people with disabilities have the same rights and opportunities in employment as specified in Title 1 of ADA, public service agencies in state and local government as specified in Title II of ADA, public accommodations, and entities operated by private entities as specified in Title III of ADA, telecommunications as specified in Title IV, and miscellaneous provisions as specified in Title V (Americans with Disabilities Act of 1990, 1990; Americans with Disabilities Act, 2022). In PreK-12 schools, ADA is a statute that can be beneficial for children who are not eligible for special education services under IDEA, and they may have a right to AT devices and services under Title II or Title III of the ADA of 1990 (Americans with Disabilities Act of 1990, 1990; Early Childhood Technical Assistance Center, 2023).

Every Student Succeeds Act

Concerning education technology, the National Educational Technology Plan (NETP) encompassed in the ESSA ensures equity of access to learning experiences enabled by technology for all students (Every Student Succeeds Act of 2015, 2015; U.S. Department of

Education, n.d.). According to the Office of Educational Technology, NETP is the flagship educational technology policy document for the U.S.A. Apart from acknowledging the need to provide greater equity of access to technology itself, NETP goes further to call stakeholders in American education to ensure equity of access to transformational learning experiences that are enabled by technology (U.S. Department of Education, n.d.). The NETP shares a vision for how schools across America can incorporate innovative universally designed technology to improve equity and opportunity for all students (U.S. Department of Education, n.d.).

Section 508 of the Rehabilitation Act

Another federal policy is the revised section 508 of the Rehabilitation Act of 1973 which requires all federal agencies, including K-12 schools, to make their electronic and information technology accessible to people with disabilities (Information Technology Accessibility Laws and Policies, 2020; Section 508 of the Rehabilitation Act of 1973, 1998). Standards in section 508 were updated and reorganized in 2017 in response to market trends and innovations in technology (Information Technology Accessibility Laws and Policies, 2020; Section 508 of the Rehabilitation Act of 1973).

The pervasiveness and advancement of technology are redefining classrooms across the nation to fit the evolving needs of 21st-century digital learners (Sutherland, 2020). As technology in classrooms constantly changes the way students engage with educational content and materials, what represents FAPE in the (LRE will look very different in physical and virtual classrooms (Crossland et al., 2016). All staff including educators and administrators should be aware of accessibility legislation so that they understand their legal responsibilities and thereby commit to implementing universally accessible and compatible technologies and educational content for all students in their classrooms. The IDEA and the IEP developed guarantees access to assistive technology devices and services (Individuals with Disabilities Education Act of 2004, 2006). However, just the provision of AT devices and services will not be enough for equal access for all students with disabilities unless IDEA amends its legal standards. Until that happens, school teams can develop IEPs that are governed by accessibility laws as mandated by AT Act, ADA, ESSA, and Section 508 of the Rehabilitation Act. In the next section, I will review existing universally accessible technology tools and evidence and research-based practices that ensure students with VI have equitable access to general education curricula as required by the accessibility laws discussed previously.

Universal Accessible Technology for Students with Visual Impairments

Students with VI differ in how they access curriculum content through braille, print, or auditory modalities (Miller, n.d.) or a combination of these modalities. Apart from the digital environment providing this multi-modal access, students with VI should also be competent in their skills to navigate such environments to gain a sense of independence and self-determination (Siu & Presley, 2019). Powerful digital technologies applied with UDL principles enable easier and more effective customization of curricula for all learners (Center for Applied Special Technology, 2011) including those with VI. The focus of this section will be the discussion on technologies that allow universal accessibility and the possibility of customization of digital environments rather than the skills needed by students with VI to access such environments. Under the purview of the various accessibility laws in the U.S.A., it is not only important to recognize that students with VI are entitled to these various technologies, but also as the awareness of digital accessibility of mainstream platforms increases, these students will continue to experience improved access to a greater number of mainstream options (Siu & Presley, 2019).

In their book “Access Technology for Blind and Low Vision Accessibility,” Siu and Presley (2019) propose four categories in which technology can be considered for students with VI within a context of meaningful and purposeful use in K-12 school settings. The four categories are: (a) technologies for accessing print; (b) technologies for accessing digital text; (c) technologies for authoring; and (d) technologies for producing alternate media (Siu & Presley, 2019). For each of these categories, the following section will discuss how these technologies will allow students with VI to access information using UDL principles of multi-modal access including visual, tactile, and auditory.

Technologies for Accessing Print

Visual Access to Print

For this section, “print” refers to printed or handwritten text, small objects, images such as photographs, drawings, diagrams, graphs, and maps. Depending on the near visual acuity needs of individual students, the level of magnification varies. If the magnification is not enough or if the distance at which the print is accessed is very close to the eyes, visual fatigue and related headaches may lead students to be frustrated with the print activity (Barclay & Chu, 2022). Commercially available large-print materials and books are printed in either 16 pt. or 18 pt. or 24 pt. print font (National Library Service for the Blind and Print Disabled, 2023.). Large-print textbooks can get very expensive and are “often too large to fit” classroom desks or backpacks (Siu & Presley, 2019, p. 38). The common way that many students with low vision access print is by using non-optical and optical video magnifier devices. Magnification devices are single-function specialized technologies designed for the sole purpose of magnification for any printed text shown under the device (Siu & Presley, 2019). Another universal way to access print is to convert them to digital formats. This can be done by scanning the printed copy or using the digital version of the print or converting the printed copy to a digital copy by taking a picture using a tablet or a phone. The advantage of digital print is that it can be accessed in any font size and image size (Siu & Presley, 2019). Using a digital version of the enlarged print will also create a non-isolating experience for students with VI as opposed to using multiple large-print volumes of the physical text or using magnification devices (Harman, 2018).

Auditory Access to Print

One other way that students with VI or blind access print is by using tools that can convert visual content into auditory information. Depending on the educational task at hand, students may be more efficient in having auditory access to printed materials than using their visual access (Siu & Presley, 2019). For example, some students use auditory access for completing lengthy reading assignments, as it may be more time-consuming and visually fatiguing to read using magnification or braille. One common tool for auditory access is talking or audiobooks (Siu & Presley, 2019). Several mainstream apps now provide instant access to audiobooks. These apps are universally designed, so both sighted and non-visual learners can enjoy them. These apps are designed to be integrated with the built-in screen readers in Apple's iOS products and Android products making them seamlessly accessible to students with VI (Willings, n.d.-a). Apart from accessing audiobooks from public libraries, individuals with VI have free access to audiobooks from non-profit organizations such as Bookshare, Learning Ally, and the National Library Service for the Blind (Willings, n.d.-a.). Other methods that support auditory access to print in school settings are scanning and Optical Character Recognition (OCR), text and image recognition using artificial intelligence, talking apps such as calculators, dictionaries, rulers, protractors, thermometers, and talking global positioning system (GPS) devices (Siu & Presley, 2019, p. 73). Using mainstream technology tools such as text-to-speech will allow students to be successful in understanding content at a much faster speed and with very little visual fatigue. According to Summers (2018), students with VI or blind should master text-to-speech software by reading at nearly 600 words per minute to succeed in the digital knowledge economy.

Tactile Access to Print

Braille is an essential tool for students who primarily use the sense of touch to access print (Miller, n.d.). Despite the many accessible technology tools and devices available today, there is no substitute for the ability to read and write and, therefore, there is no digital alternative that can replace braille competency (Index Braille, 2014). “Knowledge of braille is the cornerstone of literacy, educational achievement, and successful employment for many students and adults with VI or blind” (Siu & Presley, p. 67). Tactile graphics, 3D models, raised-line measuring tools, and Cranmer Abacus for computing calculations are some of the other assistive technology tools that allow students with VI or blind for tactile exploration (Siu & Presley, 2019). Some examples of mainstream devices that allow users to receive tactile feedback such as Appolo’s wearable wellness device, Droplab’s EP 01 haptic shoes, and Audi’s E-Tron haptic steering wheel are very limited leading to haptic technology waiting for its breakthrough (Xu, 2021). Moreover, haptic technology tools are yet to be fully utilized in K-12 education, the main barriers being the cost of the devices and the specialized programming skills required to produce such applications in classrooms (Darrah et al., 2014). Until haptic technology becomes more mainstream, students who access print with touch need to use specialized devices and technologies that can emboss print into raised formats for access.

Technologies for Accessing Digital Text, Images, and Videos

Digital text in our current world is ubiquitous and becoming more prevalent as technology and digital media fill many of our daily tasks (Feingold, 2019). As seen in the use of technologies for visual access in the previous section, converting print to digital content can provide multi-modal access to information with much greater efficiency, flexibility, and portability (Siu & Presley, 2019). In the K-12 setting, online learning platforms such as Google Classrooms have become more prevalent in the last decade (Heggart & Yoo, 2018). When instructional materials are prepared and delivered in digital media through online platforms like Google Classroom, such content can be easily customized based on the learning modalities for students with VI (Kharback, 2022). For example, students with low vision can effortlessly magnify the digital text or access it through text-to-speech tools. Similarly, students who do not have any vision can access digital media through screen readers or by connecting braille displays to their devices. Digital media empowers all learners with and without disabilities to work across a multitude of devices, "utilize their tool of choice at any given point in time, and have maximum independence and flexibility to change their method of access" instantaneously (Siu & Presley, 2019, p. 95).

Having access to digital content is very different from having access to accessible digital content (Karlen Communications, 2021). For any digital content to be universally accessible, four main principles from the 2017 Web Content Accessibility Guidelines called POUR must be met (Allan et al., 2016). The acronym POUR stands for Perceivable, Operable, Understandable, and Robust. For digital content to be perceivable, it should enable multi-modal access, which means videos must have captions for users who are deaf and hard of hearing, audio files must have transcripts for users who are deaf, images must have alternative text describing the images, and texts should be readable by any text-to-speech technologies (Web Accessibility, 2022). "Operable" means that the user interface of digital technologies can be used by everyone, including people who navigate the web without using a keyboard and a mouse (Web

Accessibility, 2022). "Understandable" means that the users must be able to understand the digital content and how information is laid out, regardless of the user's modality of access (Siu & Presley, 2019). Finally, "robust" means that the websites are functional across current and future devices and operating systems (Web Accessibility, 2022). Therefore, students should be able to access digital learning websites and software using braille displays with the same efficiency and accuracy as they would with a screen reader or visual means.

One of the mandated aspects of POUR is including audio descriptions in videos. Audio description, which is sometimes referred to as video description, is a technique that allows videos are accessible to individuals with VI. According to the American Council for the Blind, audio description (AD) is "narration added to the soundtrack of videos to describe important visual details that cannot be understood from the main soundtrack alone" (American Council of the Blind, 2023, p. 1). Although audio descriptions are a mandated aspect of disability inclusion, it is markedly underdeveloped and underutilized in our classrooms (Kleege & Wallin, 2015). A recent study was conducted by Ferrell et al. (2017) on the comprehension scores under conditions with and without audible descriptions in abbreviated tests by elementary grade three to eight students in three western states in the U.S.A. Results from their study indicated that students who are braille readers were more likely to perform better when audible image descriptions accompanied questions in standardized assessments (Ferrell et al., 2017). Even elite and technologically advanced universities such as Harvard and MIT have been sued particularly over the provision of audio description and video captioning to online materials (McKenzie, 2019). The use of digital content that is designed using the POUR guidelines in K-12 classrooms can empower students with VI to access information independently using any of their senses including visual, auditory, or tactile.

Technologies for Authoring and Producing Alternate Media

To author text, drawings, graphs, maps, or digital media, students with VI should have multi-modal access to tools that are based on their primary learning modality (Giudice et al., 2021). Students with VI can author content: (a) visually using pen and paper under a video magnifier, or by typing on large-print keyboards; (b) tactually using braillewriters or slate and stylus or braille displays (braille computers); or (c) aurally using speech-to-text technologies, audio recording, and screen readers (Siu & Presley, 2019). The advantage of authoring digital text is that it can be shared across multiple devices in an instant and that all students can access them regardless of how the content was created. For example, a student who uses a braille display can write on a Google Doc and share that content with a sighted user for feedback. Unlike the braille on paper that needs to be inter-lined by a certified braillist or a TVI, digital text that is brailled can be accessed by teachers and peers for immediate feedback. Another authoring skill that is required by students with VI is notetaking (Willings, 2018). Several different popular mainstream apps allow multimodal notetaking such as Apple Notes, Good Notes, Notability, and Microsoft OneNote (Siu & Presley, 2019). These notetaking apps allow users to gather information in many different ways--writing, typing, recording audio, or video (Coles, 2018). It is also imperative to understand that students with VI should have access to a wide variety of universally designed authoring and note-taking technologies to accomplish a range of tasks and no single technology can meet all the authoring needs in a classroom (Siu & Presley, 2019).

Despite the existence of access technologies discussed in the previous section for multimodal access for students with VI, the low prevalence of the nature of sensory impairments has resulted in a lack of research and evidence-based practices using such technologies (Ferrell et al., 2014). The limited research on the use of universally accessible technology for the inclusion of students with VI will be discussed in the next section.

Evidence-Based Practices in Technology-Rich Classrooms

According to Ferrell et al. (2014), there is limited research on the topic of integrating technology-based instructional practices for students with VI. Although there are numerous articles and promising descriptions of practices involving technologies described by practitioners in the field of VI and technology, there are very few controlled studies (Ferrell et al., 2014). Evidence-based practices related to technology for students with VI as discussed in a U.S. Department of Education report by Ferrell et al. (2014) are: (a) including digital technologies in braille instructions to younger students; (b) providing image descriptions in all statewide assessments; (c) including audio descriptions to instructional media; (d) training pre-service TVIs in specific technologies including screen reading software, electronic notetakers, screen magnification software, library braille translation software, optical character recognition, etc.; and (e) considering the provision of school-purchased technology tools for home use.

Digging deeper into the studies reported by Ferrell et al. (2014), few of them were relevant to this study. In a promising alternating-treatments research design, Bickford and Falco (2012) measured the oral-reading fluency and word-writing fluency of students with VI when using two instructional mediums (traditional paper and electronic braille notetaker). Bickford and Falco (2012) found no difference between younger students reading braille from traditional braille paper and using an electronic braille notetaker. Although the study did not reveal any difference between the use of braille technology and traditional braille paper, the findings suggest that students with VI will be motivated to use braille technology and may show improved braille reading fluency over time. In a study conducted by Carver et al. (2012), answers given by students with VI in standardized language arts, mathematics, and science tests were examined when image descriptions were provided. The quantitative conclusions of the above study revealed that braille readers were more likely to respond accurately when image descriptions without tactile graphics were provided during test administration (Carver et al., 2012). The same study also found that non-braille readers were equally likely to select the correct answers whether the image description was given or not (Carver et al., 2012). Hence, providing image descriptions in standardized assessments will be an unbiased accommodation that will make content more accessible for students with VI without giving them an unfair advantage over sighted peers (Carver et al., 2012). With the purpose to identify the self-reported knowledge skills related to assistive technology by TVIs, Zhou et al. (2012) completed an online survey with 840 TVIs in the U.S.A. They found that TVIs are more confident and more likely to teach technology to their students when (a) they completed a course related to assistive technology for students with VI and (b) when their knowledge of assistive technology skills was reviewed periodically through professional development (Ferrell et al., 2014).

Although these practices established more access to students with VI in general education settings, the study by Taylor (2016) examined the development of a political science course through the specific cognitive lens of UDL. Taylor (2016), in his study "Improving accessibility of students with visual disabilities in the technology-rich classroom," examined the development of a political science course through the cognitive lens of UDL. His study included both male and female students with vision disabilities ranging from low vision to blindness. Taylor (2016) highlighted the ways that UDL can assist faculty in improving accessibility for those with vision disabilities by mapping the student comments from the focus group to the UDL principles. The accessibility tools that were used by the students in the study were refreshable braille displays, screen readers (e.g., Nonvisual Desktop Access (NVDA), Job Access with Speech (JAWS), etc.), and text magnification tools (e.g., ZoomText) (Taylor, 2016). Based on the first principle of UDL, multiple delivery methods, any image presented to students should be annotated to provide a description that can be read through the screen reader (Taylor, 2016). Digital versions of annotated images and texts will allow students with VI to participate in classroom lectures in the same manner as other sighted peers (Taylor, 2016). The focus group of students in the study indicated that visual presentation tools such as PowerPoint often work poorly with screen readers and that text files using Word software are more reliable (Taylor, 2016). Hence, educators should provide lesson materials in multiple formats as an easy way to ensure equitable access (Taylor, 2016).

The use of screen readers and braille displays changes the way students interact with learning materials. Assessing student performance through traditional term papers and open-book written exams is time-consuming and difficult for students with vision disabilities (Taylor, 2016). Hence, providing flexibility in the timing of assignments and using a combination of assessment instruments within a lesson (e.g., oral presentations or group projects) will align with the second principle of UDL, which is the provision of multiple ways to demonstrate competency (Taylor, 2016). For example, in addition to printing the quiz, administering quizzes orally by reading the questions aloud to all students will alleviate the problem of accommodating the quiz specifically for students with vision disabilities (Taylor, 2016). Students with VI communicate and participate in the same manner as other students when they are provided access to content before class sessions (Taylor, 2016). This is because exposure to a topic or background knowledge of instructional materials is critical to successful learning outcomes (Taylor, 2016). Having a digital library of lesson topics before the school year will enable all students to access units whenever and however they need (Taylor, 2016). This is aligned with the third principle of UDL which is providing multiple means of engagement for students. Tapping into prior knowledge through peer interactions in group projects will not only stimulate the engagement levels of students with VI but also result in the student feeling included in the classroom (Taylor, 2016).

Albeit the limited research on how best students with VI can access technologies in general education classrooms, there are several articles and resources that provide a description of practices to make technological tools accessible to these students. For example, the Office of Special Education (OSEP) has developed a website containing checklists and guidance for developing and assessing if portable document format (PDFs), Word, PowerPoint, and Excel documents, websites, and other media meet the Federal government standards such as Section 508 for accessibility (Office of Special Education Program, n.d.). Portable document formats, Word, and PowerPoint documents are commonly used in several K-12 classrooms. If general education teachers are aware of these resources, they can follow the checklist and ensure they meet the Section 508 standards for accessibility irrespective of whether they have students with VI in their classes or not. Following UDL principles and being proactive in designing accessible technologies will help to seamlessly include students with VI in classrooms.

Conclusion

As discussed in this chapter, although there is some literature on promising descriptions of practices involving technology for students with VI, there are very limited research studies related to how students with VI experience technology in general education classrooms. Moreover, most of the research in the discipline of accessibility has been focused on university curriculum or university students with VI or adults with VI and not on K-12 students in general education classrooms. Several barriers to the inclusion of students with VI in technology-rich classrooms and online classrooms have been identified by research despite the protection provided by existing accessibility laws pertaining to technology in school settings. The purpose of my study was to understand the experiences of students with VI when they are presented with technologies in K-12 classrooms. Acknowledging that students with VI have divergent accessibility needs as theorized by Piaget's cognitive development theory, the goal was to understand how general education teachers and TVIs help support students with VI in their classrooms. I described universally accessible technologies and evidence-based practices that help students with VI access print, digital texts, media (video and images), and author content in general education classrooms. In this study, I examined how technologies are being experienced by students with VI in classrooms in the U.S.A. I hope the findings of this study will contribute to the limited research in this discipline and help identify strategies that not only include students with VI in general education classes but provide insights into how students with VI can access and learn from classroom technologies seamlessly without having to be dependent on their teachers or peers to access such technologies.

CHAPTER III

RESEARCH METHODOLOGY

The primary purpose of this study was to understand the experiences of middle school students with VI when accessing and using technologies in general education classrooms. Specifically, this study focused on students with low vision, who do not have other identified disabilities, and who spent 80% or more of their time in general education or inclusive settings. Research on this topic helped shed light on what works and what does not work when it comes to technologies used in middle school classrooms in the U.S.A. for students with VI. The results of this study will potentially help educators in understanding strategies and successful methods in implementing educational programming involving technologies. By understanding the barriers or benefits of technologies used in classrooms, the results of this study will help support successful educational outcomes for students with VI. The following research questions helped me gain an understanding of the experiences of students with VI in accessing technologies in inclusive middle school classrooms in the U.S.A.

Research Questions

Q1 How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms?

Q2 How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms?

Q3 How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms?

Philosophical Worldview

This case study was intended to understand the perceived experiences of middle school students with VI and their educators in the use of technology in inclusive classrooms. The study was neither intended to test an established theory nor generalize the findings to a larger population. Hence, I approached this study from a constructivist viewpoint. The goal was to understand experiences and identify patterns or themes that are grounded in the views of the participants in the study, through the interpretation of their shared meaning and experiences. The underlying assumption of constructivism is that one cannot transfer or acquire knowledge from another, but new knowledge is created through discovery or experiences with pre-existing knowledge (Creswell & Plano Clark, 2017). Because constructivists claim that there is no single truth or reality, it is assumed that the findings provided multiple perspectives and versions of reality that were constructed by the participants in the study. As the study intended to understand the subjective interpretations of the participants, a constructivist approach was the theoretical stance that I took to conduct my research. A constructivist approach was justified in this study because the goal was to "rely as much as possible on the participant's views of the situation being studied" (Creswell & Creswell, 2018, p. 8). In this paradigm of thinking, I must recognize my background and personal, cultural, and historical experiences that shaped my interpretation of the meaning I generated in this study. In my 11th-year career as a TVI, I have had experiences of my students with VI not being able to access mainstream technologies in classrooms in an equitable manner as their sighted peers. The study was conducted with the underlying assumption that there were biases in the interpretation of the findings because of my direct positive and negative experiences with technologies used in middle school classrooms for students with VI.

Researcher: Personal Experience

My journey to becoming an educator was unconventional. I was born and raised in India, 8,000 miles east of the U.S.A. In India, many pursued engineering or medicine after high school. I was one of them. A large international bank recruited me to work as a software developer. Although I earned well and had a secure job, I was unhappy, probably because I did not value the work I was doing. All through my high school and college years, my parents were members of many non-profit organizations. As a family, we would volunteer in these organizations twice a year, summer and winter holidays. In one of the sessions with a school for the blind, I read English books to a group of middle school girls. As I was reading, the girls followed along with their hands. That was my first exposure to braille! I was fascinated and wished I knew how to read braille. Years later, many events occurred in my family life: marriage, move to the U.S.A., and the birth of my children. I decided to quit my job to take a break from my professional life and take care of my children. The first month after I quit, I was watching an Indian movie called "Black," based on a story about Helen Keller. There was a scene in the movie where a teacher shows a little girl to use her hands to read braille. That was the moment that made me think of the day in the school for the blind when I wished I knew how to read braille.

For the next three years, my curiosity to learn braille led me to pursue an online master's program for becoming a certified TVI. I had no experience in the U.S.A. neither as a student nor as an educator. Everything I learned in the master's program was new to me. I graduated from the program and got a job as an itinerant TVI in a large district. I was finally happy to start my career in the social sector as an educator!

I had many mentors in the discipline who guided me with the nuances of being an itinerant TVI. I have gained experience based on the students in my caseload. During my second year of teaching, I worked with a high school student who had low vision. She was a dual learner (print and braille) and was very motivated to use technology devices to access her learning environment. She used many tools such as braille note-takers, screen readers, iPad, talking calculators, and voiceovers to access the general education curriculum. As most of these tools were unfamiliar to me, I learned to use them with her. As with any technology, there were days when my student accessed her classroom activities efficiently and there were days when she could not access them at all. As her teacher, I was desperate to find ways in which she could be fully included in a general education classroom. I looked for resources related to assistive technology and accessibility for students with VI in general education classrooms but found very few. I even reached out to technology companies such as Google and Apple to solve some of the accessibility issues she faced in classrooms. Seeing students with VI limited in their access to a technology-rich world, I decided to explore how students with VI experience technology in inclusive settings. As one of the primary assumptions of a constructivist paradigm, the interpretation of the results of this study was shaped by my own experiences and background in supporting students with VI in technology-rich classrooms.

The way I confronted the bias that I may have regarding student experiences with technologies in inclusive classrooms is through the process of bridling. According to Vagle et al. (2009), bridling is explained as the process

> Wherein a researcher, similar to the way an equestrian uses the bridle to guide the horse by tightening and slackening the reins, examines how his or her assumptions and pre-understandings guide the research by tightening and slackening the development of his or her intentional relationship with the world or the research subject. (p. 349)

In this study, throughout my research journey, I reflected on and scrutinized my understanding of the investigated phenomenon and the meanings that evolved as I collected, analyzed, and interpreted data. I conducted the act of bridling by maintaining a reflexive journal so that I "do not understand too quick, too careless, or slovenly, or in other words, that [I] do not make definite what is indefinite" (Dahlberg, 2006, p. 16).

Qualitative Research

Qualitative research is an "approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell & Creswell, 2018, p. 4). I chose to use a qualitative research approach as it allowed for intersubjectivity which is the ability to stand in someone else's shoes and see the social world from their perspective (Remler & Ryzin, 2015). Using a constructivist paradigm, qualitative research allowed me to study the experiences of middle school students with VI in accessing and using technologies in inclusive classrooms by constructing knowledge via multiple perspectives and versions of reality as observed or described by the participants in the study. Apart from the assumptions of a constructivist paradigm, another theory that was key to understanding the experiences of students with VI in using classroom technologies was Piaget's cognitive development theory which was described in Chapter II. Piaget's cognitive development theory acknowledges differences in how students learn, and it conceptualizes equitable access to technologies used in inclusive classrooms through the model of UDL.

Research Genre: Case Study

Merriam (1988) defined a case study as a holistic description of a single phenomenon. Creswell and Creswell (2018) described case studies as

> Design of inquiry found in many fields in which the researcher develops an in-depth analysis of a case, often a program, event, activity, process, or one or more individuals. Cases are bounded by time and activity and researchers collect detailed information using a variety of data collection procedures over a sustained period of time. (p. 14)

According to Stake (2003), the purpose of a case study was not to generalize or represent the world, but to give a holistic picture of the particular case studied. Hence, the inquiry and single-minded focus of this type of research were on the case, however simple or complex it may be. Stake (2003) defined three types of case studies: (a) an intrinsic case study in which the researcher wants a better understanding of a “particular” case and the purpose of such a study is of intrinsic interest and not to understand abstract construct or a generic phenomenon; (b) an instrumental case study in which a particular case was examined mainly to provide insight into another issue or line of inquiry; the case itself was still looked at in-depth, but the purpose of studying the case was to understand other phenomena that are external to the case; and (c) a collective case study in which an instrumental study extended to several or multiple cases; in this type, a researcher may study multiple cases to investigate a phenomenon that may be external to the cases studied and that may manifest some common characteristics or patterns.

This was an educational collective case study where I used multiple cases to understand the challenges and successes that middle school students with VI face while interacting with classroom technologies in inclusive settings. A collective case study is sometimes referred to as a comparative case study (Merriam, 1998; Stake, 2003). According to Merriam (1998), in a comparative case study that involves collecting and analyzing data from multiple cases, “the more cases included in a study, and the greater the variation across the cases, the more compelling the interpretation is likely to be” (p. 40). The case study genre fit this study for several reasons. First, the goal of the case study research design was to seek a greater in-depth analysis of a case (Stake, 1995); the cases or objects of interest in this study were middle school students with VI. Second, case studies focus on one specific phenomenon of interest and study that phenomenon in-depth (Merriam, 1988). The phenomenon that I was interested in studying was the experiences of middle school students with VI while engaging and learning with technologies used in inclusive classrooms. My line of inquiry involved an in-depth analysis of the case which was critical in explaining the phenomenon of interest explored in this study. Finally, according to Yin (1989), “case studies are the preferred strategy when ‘how’ or ‘why’ questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon with some real-life context” (p. 13). In this study, I focused on how middle school students with VI perceived their experiences with technologies in inclusive classrooms. In addition, a constructivist approach lent itself to a case study genre where meaning was created from the perspectives of multiple participants in this study.

Research Methods

The study protocol is illustrated in Table 1 below. It is detailed in the next few sections.

Table 1

Study Steps and Procedures

Step	Description/Data Collection	Research Question(s) Addressed
1. Approval from the University of Northern Colorado Institutional Review Board (IRB)	I obtained approval for the study by submitting the required documents to the University of Northern Colorado's Institutional Review Board.	
2. Participant recruitment	I recruited using purposeful selection by specifying inclusion and exclusion criteria. An email was sent to TVIs in the state of Colorado seeking the nomination of students that satisfy the inclusion and exclusion criteria. Interested TVIs sent me an email if they had students that could participate in the study. I sent consent forms for families to the TVIs. TVIs reached out to families to get consent. If families had questions, they reached out to me directly via email mentioned in the consent forms.	
2. Consent for participation sent and demographic data collection	TVIs sent the consent to participate form and demographic data form to parents/guardians of three identified students. I sent consent forms and demographic forms to TVIs. Assent forms were sent to student participants for their consent. After consent from participants was received, principal permission or school district IRB approval was also obtained at this stage. *Data:* Consent forms were stored and demographic data were analyzed for understanding the experiences of participants using classroom technologies.	
3. First observation of three students	I observed each student in their general education setting for an entire school day. *Data:* Field notes of observations.	Q1. How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms?

Table 1 (continued)

Step	Description/ Data Collection	Research Question(s) Addressed
4. Interview the three students, their general education teachers, and their TVIs	After the first observation, based on my professional judgment of the observation and suggestion of TVIs, I reached out to three general education teachers. I sent them consent forms and demographics. I added specific questions based on field notes of observation to the interview questionnaire. I interviewed the three students, their general education teachers, and their TVIs to corroborate the observed experiences in step 3. *Data:* Interview responses.	Q1. How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms? Q2. How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms? Q3. How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms?
5. Review of IEPs, class/school records..	I obtained the redacted version of educational documents from the TVIs for each student: IEPs, functional vision and learning media assessment reports, school records were collected to get a holistic picture of the cases in the study. *Data:* Functional vision assessment report data, learning media assessment report data, IEP goals, accommodations, modifications related to technology, and school records for academic progress in general education classrooms.	Q1. How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms? Q2. How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms? Q3. How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms?

Table 1 (continued)

Step	Description/ Data Collection	Research Question(s) Addressed
6. Second observation of three students	I observed each student again in their general education setting for an entire school day. The second observation was used to get a holistic picture of the cases in the study and to corroborate findings from the previous observations, interviews, and review of documents. *Data:* Field notes of observations.	Q1. How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms?

Recruitment Procedures

I recruited participants after receiving approval from the University of Northern Colorado Institutional Review Board (IRB) in November, 2022. The approval from IRB is attached in Appendix A. The Exceptional Student Services Division of the Colorado Department of Education (specifically, the director of access, learning, and literacy for students with VI in the state) assisted me with the recruitment process. The director of exceptional student services sent a recruitment email specifying the purpose of the study along with inclusion and exclusion criteria for participants to the Colorado TVI email distribution list. A copy of the recruitment email is attached in Appendix B.

I received one nomination for a potential participant from a TVI on the same day the recruitment email was sent. However, I did not get any further nominations from TVIs until two weeks later. I reached out to our director of access to send out the email to TVIs for the second time. In the meantime, a TVI colleague in my district reached out to me and said that she had a student who would fit the criteria for my study. As I did not get any further nominations from other TVIs, I decided to accept the nomination and report any bias I may have because of the familiarity I may have with the district or the TVI. I got my third participant a few weeks later with the help of one of my committee members who worked part-time as a TVI in a public school district in Colorado. Even though I got the IRB approval in November, the identification of three potential participants was completed only at the end of January.

After receiving the nominations, I sent the consent forms and a questionnaire containing demographic information to the TVIs who assisted me in sending these forms to parents/guardians of students. The consent forms for parents and educators are attached in Appendices C and D. After receiving the consent forms signed by the parents/guardians of nominated students, I followed the procedures required by the participants' school districts to seek permission to conduct research. Getting approval from the school districts was harder than I thought it would be. For the first participant, when I reached out to the school principal, he said that he would have to get approval from his district and asked me to fill in an application. For the second participant, as I worked in the same district, getting the approval was slightly easier by scheduling a meeting with the Chief Learning Service Officer. For the third participant, as I was only observing one student for two school days, I did not have to go through the entire research approval process required by the district. I got an approval email from the district's special education coordinator. I got all three approval letters within a couple of weeks after I approached the districts. A copy of the form I used to obtain permission from the principal or district is attached in Appendix E. Prior to my first day of observation, I met each of my student participants in their schools, explained the purpose of the study in a simple format, and received their consent. The minor assent form is attached in Appendix F. After my first day of observation, I reached out to one general education teacher to be interviewed. I chose the general education teacher based on two factors: (a) my professional experience working as a TVI supporting students with VI in academic general education classrooms; and (b) asking the TVIs as to who they thought would be appropriate to interview for my study. I asked each of the general education teachers and TVIs open-ended questions to understand how they supported the technology accessibility needs of their students with VI in their classrooms.

Participants

According to Stake (2000), one of the unique characteristics of a qualitative case study is the selection of who is to be studied. Case study research “requires researchers to purposefully select information-rich cases, as they will allow researchers an in-depth understanding of relevant and critical issues under investigation” (Wan, 2019, p. 47). Many qualitative researchers choose their participants using non-probability sampling which means the chance of being selected in the study is not known or not random (Creswell & Creswell, 2018). In this study, I used purposive sampling which was a type of non-probability sampling where participants are chosen based on desired and specific characteristics that were important for the study. Based on my own experience as a TVI for over a decade, secondary students are exposed to more technology than elementary students. I chose middle school students with VI for this study because middle school students are exposed to more technological tools in classrooms, but they have not gotten many opportunities to learn and practice their access skills in elementary learning environments. The number of participants to choose for a qualitative study does not follow a straightforward approach. However, from a review of several qualitative research studies, Creswell and Creswell (2018) estimate that qualitative case studies include about four to five cases or participants. In this study, apart from observing and interviewing middle school students with VI about their experiences using and accessing classroom technologies, I also interviewed general education teachers and TVIs to get a holistic picture of the technology accessibility needs of students with VI. Hence, observing three middle school students with VI along with nine interviews with students, their general education teachers, and TVIs was an adequate sample to provide insight into the problem investigated in this study.

Three middle school students with VI attending general education classes in the state of Colorado participated in this study. As the purpose of the study was to examine the experiences of middle school students with VI in general education classrooms, participants in the study were selected using the following inclusion criteria: (a) had a visual impairment with a distance visual acuity of 20/100 or worse as determined by a medical authority; (b) had an IEP qualified under the category of "Visual Impairment and/or blindness"; (c) chronological age ranging from 11 to 14 years; and (d) placed in inclusive setting spending 80% or more of their instructional time in general education classrooms in a public school. Apart from the above inclusion criteria, I selected the participants using the following exclusion criteria: (a) did not have any other disability other than visual impairment; (b) was not completely blind; (c) reading level was not more than two years behind their grade level; and (d) was not enrolled in a residential school for the blind. Their general education teachers and TVIs also participated in this study.

Demographic Data

Along with the consent forms, I sent demographic forms to be filled out by participants of the study. The demographic forms for students were filled out by their parents. The data from demographic forms from students informed of their visual conditions, age, number of years in a public school setting, their skill level with technology tools, and motivation level in using and accessing technology tools.

Students

There were two girls and one boy who participated in the study. To protect the privacy of students, the pseudonyms of the students are Luke, Zoe, and Ella. All three of them attended schools in large suburban public school districts in the state of Colorado. According to Merriam (2009), individual cases studied in a multiple-case study should be categorically bound together and should share a common condition. In this study, all three participants were sixth graders, had visual impairments, attended 80% of their time or more in general education classrooms, and did not have any other identified disability. Luke and Ella were of Caucasian ethnicity, and Zoe was biracial. On a scale of 1 to 5 (1 being low confidence to 5 being high confidence), all three parents rated 4 or more in how they thought their child was independent in using technologies in accessing mainstream and social media platforms. Luke has been receiving services from a TVI the longest (seven years). Zoe has been receiving services for the last four years, and Ella started receiving services from a TVI only for the last two years. Luke was the only participant who received direct services from a certified orientation and mobility specialist. All three students attended a public school since Kindergarten. The highest education level in families of student participants varied. Luke's family's highest education level was a Master's, Zoe's was a Bachelor's, and Ella's was a High School/Associate's. The sample demographic form for students that was filled in by parents/guardians is attached in Appendix G. Table 2 shows the demographic data collected for student participants.

Table 2

Demographics of Students

Demographic information	Luke	Zoe	Ella
Age	11	12	12
Gender	Male	Female	Female
Ethnicity	Caucasian	More than one	Caucasian
Visual Diagnosis	Leber's Congenital Amaurosis	Stargardt's Disease	Corneal Ulcers
Any other medical condition	No	No	No
Number of years receiving services from a TVI	7 years	4 years	2 years
Receiving direct or consultative services from a certified Orientation and Mobility Specialist	Yes	No	No
On a scale of 1 to 5 (1 being low and 5 being high), how independent was the student in using technologies to access mainstream and social media platform according to parents?	4	5	5

Teacher of Students with Visual Impairments

Three TVIs participated in the study. The data from demographic forms for TVIs informed me of their age, the number of years of teaching experience, and their skill level with technology tools. The sample demographic form sent to TVIs is attached in Appendix H. I sent the demographic forms to each of the TVIs along with the consent forms. All three TVIs who participated were female. Other than Zoe's TVI, the other two TVIs were Caucasians. Zoe's TVI was multiracial. Luke's TVI was the youngest of the three TVI participants. Ella's TVI had the longest number of years teaching students with visual impairments (21 years) and got her

Master's in 2003. Luke's and Zoe's TVI got their degrees in 2018 and have been working in their school districts for the past five to six years. All three TVIs rated their comfort level in using technologies to support students with VI accessing their general education learning environment as 4 on a scale of 1 to 5 (1 being low confidence and 5 being high confidence). Table 3 shows the demographic data collected from TVIs.

Table 3

Demographics of Teachers of Students with Visual Impairments

Demographic information	Luke's TVI	Zoe's TVI	Ella's TVI
Age	26-35 years	36-45 years	36-45 years
Gender	Female	Female	Female
Ethnicity	Caucasian	More than one	Caucasian
Number of years teaching students with impairments	5.5 years	6 years	21 years
List of teacher certifications	Certified special education: Blindness/Low vision	Special education generalist; Special education visual impairments	Special education: visual impairments; Orientation and Mobility certification; Cortical Visual Impairment (Perkins) Endorsement.
Highest Education Level	Master's	Master's	Master's
Year TVI degree was obtained	2018	2018	2003
Number of students in caseload	18	20	20
On a scale of 1 to 5 (1 being low and 5 being high), how comfortable is the TVI in using technologies to support students with VI in accessing their general education learning environment?	4	3-4	4

General Education Teachers

Three general education teachers participated in the study. Luke's Language Arts (LA) teacher, Zoe's LA teacher, and finally Ella's Math teacher participated in the study. The data from demographic forms for general education teachers informed me of their age, the number of years of teaching experience, the subject area, and their skill level with technology tools. The sample demographic form sent to general education teachers is attached in Appendix I. I sent the demographic forms to the general education teacher participants along with the consent forms. All three general education teachers who participated were Caucasian females. Ella's Math teacher was the youngest of the three general educator participants. Zoe's LA teacher had the least number of years teaching in middle school and she was the only doctorate in this study. Both Luke's LA teacher and Ella's Math teacher had 15-16 years of experience teaching in middle school. On a scale of 1 to 5 (1 being low confidence and 5 being high confidence), all three general education teachers rated their comfort level to be lower than 4 in using technologies to support students with VI accessing their general education learning environment. All three general education teachers rated their confidence level lower than what the TVIs rated themselves. Ella's Math teacher reported the lowest confidence of 1 in using technologies to support students with VI in her classroom. Luke's LA teacher rated a 5 when she needed to support Luke with the Google platform, but if it was anything else, she rated 2 to 3. Zoe's LA teacher rated a 3 for her confidence level in using technologies to support Zoe in accessing her classroom content. Table 4 shows the demographic data collected from the general education teachers.

Table 4

Demographics of General Education Teachers

Demographic information	Luke's LA teacher	Zoe's LA teacher	Ella's Math teacher
Age	46-55 years	46-55 years	36-45 years
Gender	Female	Female	Female
Ethnicity	Caucasian	Caucasian	Caucasian
Number of years teaching in middle school	15.5 years	8 years	16 years
Subject area	Language Arts	Language Arts	Math
Highest education level	Master's	Doctorate	Master's
Year teacher's highest degree was obtained	2001	2019	2010
List of teacher certifications	Secondary Language Arts; K-12 Reading Endorsement	Early Childhood, Elementary Social Studies	Curriculum and Instruction; National Board Certified
On a scale of 1 to 5 (1 being low and 5 being high), how comfortable was the teacher in using technologies to support students with VI in accessing their general education learning environment?	5 – Google Platform; 2-3 Anything else	3	1

Setting

Observation of the three students occurred in general education classrooms in the public schools the students attended. General education classrooms were all settings in the school that included same-age sighted peers. As students with VI had assistive technologies that were used to access mainstream technologies, I observed the seating of the students in various classes. The seating arrangement was especially important for students with low vision as it informed me of how they accessed their classroom learning environment from where they were seated. The seating arrangement of students also informed me of how educators were supporting students with VI in their access to learning content presented in their classrooms.

Data Collection

After selecting potential participants and receiving consent forms and demographics, I began collecting data. According to Yin (2018), the use of multiple sources to collect data will provide a more "convincing and accurate" case study. The design of a case study is more robust and compelling when evidence is collected from multiple cases (Yin, 2018). In this case study, several data collection types were utilized. The types of data collection used in this study that included materials adapted from Bogdan and Biklen (1992), Creswell and Poth (2018), and Merriam (1998) were: (a) observations, (b) interviews, and (c) educational documents. In addition, data recording procedures differed with the type of data collected in the study. Hence, I followed specific protocols that outlined the data recording procedures I used when collecting data during the observation of students and interviewing students and educators.

Observations

According to Murphy and Dingwall (2007), direct observation of participants is described as the gold standard among qualitative data collection techniques. Observation in natural environments will debunk problems arising with self-reported accounts (Mays & Pope, 1995) and will reveal insights not accessible in other data collection methods including behaviors that the observed participants may be unaware of themselves (Furlong, 2010). Four levels determine the extent to which the researcher may participate in and interact with the setting of the research: (a) complete participant--researcher is the participant and takes a central role; (b) participant as an observer--researcher spends significant time in setting but does not assume a role; (c) observer as a participant--researcher visits the setting typically a few occasions and make observations; and (d) complete observer--researcher attempts to remain unobtrusive and does not interview or engage with the people in the setting (Remler & Ryzin, 2015). In this study, I observed the three middle school students with VI as a “complete observer.” This means I observed without participating. I chose this method of observing because I wanted to explore the topic of “accessibility” without interfering with the participants’ abilities to complete the class activities and tasks. I faced challenges in scheduling my observation days with students. Out with COVID-19, tummy bugs, and field trips were some of the reasons for which I had to reschedule my originally planned days of observation. Although I observed Luke and Ella for two entire school days which was 14 hours, due to snow-related delays, I observed Zoe for only 12 hours on my second day observing her.

As I observed the students, I recorded information as field notes. After every day of observation, I also wrote in a reflexive journal reflecting on the observed student’s experience with classroom technologies. Each student was observed twice, once before interviewing educators and students and once after the interviews. After the first observation, I added specific questions to the interviews that I had based on what I observed regarding the experiences of technology accessibility of students with VI in classrooms. After the interviews, I reviewed the educational documents that I collected for each student. I ended the data collection for each student by observing the student for the second time for an entire school day. The reason for the second observation was to corroborate my findings from the first observation, interviews, and review of educational documents.

The observation protocol is described here**.** As I observed three students, I followed an observational protocol for recording information while observing. The observation protocol included: (a) demographic information about the time, place, and date when the observation took place (Creswell & Creswell, 2018); (b) reflexive notes (my thoughts, such as "speculation, feelings, problems, ideas, hunches, impressions, and prejudices") (Bogdan & Biklen, 1992, p. 121); and finally (c) accounts of particular events and activities. The outline of the observation protocol is attached in Appendix J.

Interviews

Interviews allow researchers to "build the intensive, thick description of a case study" (Merriam, 1985, p. 206). Students, general education teachers, and TVIs were interviewed in this study. One-on-one interviews were conducted via Zoom, a virtual meeting platform, at times that were scheduled based on the availability of the participants. All interviews were conducted after the first day of observation of students. Interviewing after the first day of observation allowed me to add specific questions to general education teachers, students, and TVIs based on the field notes of observations. Each participant was interviewed once, and each interview lasted approximately 60 min. Interviews were semi-structured with open-ended questions. According to Remler and Ryzin (2015), open-ended questions "cannot be answered with a limited set of possible answers and gives the person answering the opportunity to choose what information to provide" (p. 564). New ideas and topics related to the study were encouraged and explored during the interview. Before each interview, participants were asked to give verbal consent to audio-record the interview. All interviews were audio-recorded and transcribed into texts using

Zoom's auto-transcription software. I then listened to all the auto-transcribed texts of interviews and made corrections if any of the content was not accurately transcribed. Data collected from the interviews allowed me to understand how students with VI experienced and were supported in their classrooms when various technologies were used. The interview data provided me with both direct and indirect information about student experiences filtered through the views of interviewees. The interview with common open-ended questions for students, general education teachers, and TVIs are attached in Appendices K, L, and M. More questions were added to each of the interviews based on the field notes after the first day of observation of students.

The interview protocol is described here. I used an interview protocol when I interviewed students, general education teachers, and TVIs. The interview protocol included: (a) basic information about the interview such as time, date, place, length of the interview, the name of the digital copy of the audio recording, and transcription; (b) introduction--a statement of how I introduced myself and the proceedings of the interview; (c) opening question--an ice breaker question to ease into the interview; (d) content questions--these were the open-ended questions relevant to the research topic and the interviewee; (e) used probes--reminders for the researcher to ask for more information, or to ask for an explanation of ideas; and (f) closing instructions--thanked the interviewee and explained follow-up procedures (Creswell & Creswell, 2018). The interview protocol used in this study is attached in Appendix N.

Educational Documents

According to Creswell and Creswell (2018), "Documents enable a researcher to obtain the language and words of participants. Documents can be accessed at a time convenient to a researcher--an unobtrusive source of information" (p. 188). In this study, two types of educational documents were collected for each student: (a) the IEP, and (b) academic progress reports from the previous school year. I obtained the redacted educational documents from TVIs. The consent to share these student documents was obtained as part of the consent forms signed by parents/guardians. In each of the IEPs obtained, I recorded any data related to technology access. Data from the IEP related to technology and access included their latest functional vision assessment results, present levels, learning media, accommodations, modifications, goals, services, and assistive technology needs. For Zoe alone, I had to obtain the FVA and LMA report separately as they were not written part of her IEPs. Also, for Zoe, there was no academic progress report as of the school year 2022-2023. This was because Zoe attended sixth grade in an elementary school and as part of their protocol, general education teachers did not provide progress reports until the end of the school year. The snapshots of academic grades for Luke and Ella from February 2023 are reported in Table 5 and Table 6, respectively. The grade term "approach" in Ella's progress report means that she was approaching grade level expectations, and "meets" means that she had met grade level expectations for the corresponding subjects. The IEPs and academic progress reports are protected educational documents that are unavailable to the public. Hence, any personally identifiable information in these documents was not recorded. Both the IEPs and the academic progress of students were reviewed by me after the first observation and interview of students and educators. I did not review educational documents before the first observation and interviews purposefully to prohibit me from forming assumptions and ideas about the accessibility needs of students. As I am an experienced TVI who has preconceived notions about technology accessibility, exposure to IEPs before the first observation and interviews may lead to preconceived notions of how such needs should be addressed in classrooms. As part of the interview process, I also stated to my interviewees that I did not review any of the educational records related to technology accessibility and clarified the biases that I had upfront before every interview.

Table 5

Snapshot of Luke's Academic Progress Report--February 2023

Subject	Luke's grade
Computer Science	A (100%)
Creative Writing	A (96.92%)
Language Arts	A (90.90%)
Math	B (86.85%)
Social Studies	B (83.04%)
Science	B (88.66%)

Table 6

Snapshot of Ella's Academic Progress Report--February 2023

Subject	Ella's grade
Spanish	Meets
Language Arts	Approach
Reading	Approach
Math	Approach
Choir	Meets
Physical Education	Meets
Science	Approach
Social Studies	Approach
Academic Support Resource	Pass

Reflexive Journals

In qualitative research, the researcher is considered part of the research instrument (Wa-Mbaleka, 2019). The self-awareness of the researcher throughout the research process is critical for the credibility of a qualitative study (Mantzoukas, 2005). A reflexive diary will provide the rationale for decisions made, instincts, and personal challenges that the researcher experienced during the research (Primeau, 2003; Rolfe, 2006). In this study, I maintained a reflexive journal throughout the research process. I recorded detailed descriptions of my research processes including the challenges I faced that allowed me to critically analyze and interpret the data collected during the study. According to Yin (2018), the desired characteristics of the case study researcher when collecting evidence are: (a) making judgment calls with minimal bias, (b) asking good questions and being a good listener, (c) staying flexible, (d) having a good grasp of the topic of study, and finally (e) conducting research ethically. I used reflexive journals to help me adhere to the above attributes throughout my research journey.

Data Analysis Procedures

According to Creswell and Creswell (2018), "data analysis in qualitative research will proceed hand-in-hand with other parts of developing the qualitative study, namely the data collection and the write-up findings" (p. 192). "There is no particular moment when data analysis begins . . . Analysis goes on and on" (Stake, 1995, p. 71). Data analysis was a process of sequential steps that I followed to make sense of the data collected. There were multiple levels of analysis from the specific to the general (Creswell & Creswell, 2018). In this multiple case-study qualitative research, data analysis approaches involved two major sequential steps: (a) within-case analysis, and (b) cross-case analysis. I conducted "narrative analysis" for within-case analysis and "thematic analysis" for cross-case analysis. For both these steps, I followed the sequential steps of data analysis as recommended by Creswell and Creswell (2018, pp. 193-195) that is detailed below:

Step 1: Organized and Prepared the Data for Analysis

This step involved transcribing interviews, typing up field notes, sorting, naming, and arranging the data for each case in the study in separate digital folders. As there were multiple cases in the study, it was very important to organize the digital files so that I did not get overwhelmed by the depth and breadth of data collected.

Step 2: Read, Familiarized, or Looked at All the Data

This step involved getting a general sense of the information and an opportunity to reflect on its overall meaning for each case in the study. As I was reading the data collected for each case, I recorded my thoughts into notes that I used at a later stage of data analysis.

Step 3: Coded All the Data

"Coding is the process of organizing the data by bracketing chunks (or text or image segments) and writing a word representing a category in the margins (Rossman & Rallis, 2017, p. 193). As part of the coding process, I first organized chunks of texts collected into initial categories, and then worked systematically through the data and added more to existing topics or created new ones. Specific coding procedures that I followed for the data collected from interviews are described below:

I followed specific coding procedures by Tesch (1990) as recommended by Creswell and Creswell (2018) when I coded the interviews of students and educators. Table 7 describes the steps recommended by Tesch (1990) and how I implemented those steps in this study.

Table 7

Tesch (1990) Steps for Coding Qualitative Data

Step	Coding description
1. “Get a sense of the whole.”	I read all the transcripts carefully. As I read, I jotted down ideas as they came to my mind.
2. “Make a list of all topics and cluster topics.”	After completing the reading and jotting down topics for all participants, I made a list of all topics and clustered together similar topics. I identified 21 topics.
3. “Abbreviate the topics as codes.”	I abbreviated and organized 21 topics into codes/phrases.
4. “Turn the most descriptive wording into a category.”	I looked for ways to reduce my total list of codes by grouping topics that related to each other and assigning the most descriptive word to a category. I grouped similar topics/codes into categories. I identified 11 categories and assigned the 21 codes into the 11 categories.
5. “Make a final decision on the abbreviation for each category and alphabetize these codes.”	I finalized the 11 categories and assigned them to 4 major themes.
6. “If necessary, recode existing data.”	Instead of me re-coding, I used a peer coder to review the transcripts. Peer and I compared and analyzed our findings together. Identified 4 major themes and 11 categories.

Note. Steps adapted from “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches” by J. W. Creswell, and J. D. Creswell, 2018, p. 196.

Step 4: Generated Description and Themes

“Description involves a detailed rendering of information about people, places, or events in a setting” (Creswell & Creswell, 2018, p. 194). This type of data analysis is particularly useful for qualitative case studies where detailed descriptions of cases from the data collected will help create a holistic picture of the case and help in answering the research questions. I generated a “code” or “theme” for each description that I identified in the data collected for all the cases. For "within-case" analysis, beyond identifying the themes during the coding process, I interconnected the themes into a storyline as narratives for each case or student.

Step 5: Represented the Description and Themes

This step involved how the description and themes obtained in the previous steps were conveyed in the final report. For within-case analysis, information on the description of each case was conveyed in the form of a story. "Emphasis is on the stories people tell and how these stories are communicated--on the language used to tell the stories" (Merriam, 1998, p. 157). After developing the themes and descriptions for each case, I compared the themes by identifying common characteristics and differences between the cases.

Within-Case Analysis—Narrative Analysis

According to Merriam (1998) for within-case analysis, "each case is first treated as a comprehensive case in and of itself. Data are gathered so that the researchers can learn as much about the contextual variables as possible that may have a bearing on the case" (p. 195). To conduct the within-case analysis, I became familiar with each case by: (a) reading the observation field notes and categorizing them into descriptions, (b) completing the coding process for the interviews obtained for each case (student, general education teacher, and TVI) by following the eights steps recommended by Tesch (1990), (c) reviewing documents for each case in the context of the codes and descriptions obtained through interviews and observations, (d) read reflexive journals noted down for each case and added my thoughts into the analysis of the data collected for each case, and finally (e) represented the descriptions obtained on the account of the experience of using technologies in general education classrooms for each case in the form of a narrative story.

Cross-Case Analysis--Thematic Analysis

According to Merriam (1998), when a researcher conducts a cross-case analysis, "the level of analysis can result in little more than a unified description across cases; it can lead to categories, themes, or typologies that conceptualize the data from all the cases" (p. 195). To understand the differences and common experiences of middle school students with VI in accessing technologies presented in general education classrooms, I conducted a cross-case analysis. I particularly read through the stories of each case that I obtained through the within-case analysis and saw how the stories were different and similar in the context of experiences with technologies. I used coded interviews of students, general education teachers, and TVIs to determine how each of the participants in their category differed or was alike in their experiences of access technologies for students with VI. For example: How were general educators different or alike from each other in how they supported students with VI with accessing technologies that they used in their classrooms? I identified common themes from the cross-case analysis. In addition, for cross-case analysis, I went deeper and categorized codes into three main categories as described by Creswell and Creswell (2018): (a) expected codes--codes on the topic that I expected to find (based on literature and common sense); (b) surprising codes--codes on findings that were surprising and that I did not anticipate before the study began; and (c) codes that were unusual or of conceptual interest--I coded unusual ideas that were of conceptual interest to the topic and readers under this category. I reported the information from the cross-case analysis by describing the themes obtained from the analysis.

Qualitative Research Rigor

The framework for determining the rigor of qualitative research was formed by the four criteria proposed by Lincoln and Guba (1985): credibility, dependability, confirmability, and transferability. The following sections describe how I applied rigor to this case study research.

Credibility

Credibility refers to the believability of the findings. Credibility indicates how closely the results reflect what the participants intended (Creswell & Creswell, 2018). In this study, I used five methods to ensure the credibility of my research findings: (a) spending prolonged time in the field, (b) triangulation, (c) member checking, (d) rival checking, and (e) peer debriefing.

Spending Prolonged Time in the Field

According to Lincoln and Guba (1985), persistent observation and prolonged engagement will enhance the credibility of the research. When the researcher develops an in-depth understanding of the study and conveys details about the site and the people, it lends credibility to the narrative account (Creswell & Creswell, 2018). I observed each middle school student for two entire school days. Each school day was approximately 7 hours. Although Zoe's observation hours were slightly less than Ella's and Luke's, I still observed Zoe for 12 hours across two school days. Description of the observation of students accessing technologies accounted for the research being credible and the findings being more accurate.

Triangulation

According to Creswell and Creswell (2018), triangulation uses several "different data sources by examining evidence from the sources and using it to build a coherent justification for themes" (p. 200). Triangulation will enhance the credibility of qualitative research by converging several sources of data or perspectives from participants (Creswell & Creswell, 2018). "The two main purposes of triangulation are to ‘confirm’ data and to ensure data are ‘complete’ (Houghton et al., 2013, p. 13). In this study, the different sources from where I collected data were observations, interviews, and documents. I confirmed the data collected by comparing data from multiple sources to explore the extent to which the data could be verified. To confirm data findings and to ensure data collected were complete, I observed and interviewed students, their general education teachers, and their TVIs. I got a holistic and converging picture of the experiences of classroom technologies by middle school students with VI.

Member Checking

This refers to the researcher taking the data or specific descriptions or themes back to participants and asking them if they feel that they are accurate (Creswell & Creswell, 2018). This is a process to ensure that the data are accurately recorded and therefore credible (Houghton et al., 2013). In this study, I conducted member checking following transcriptions of the interviews and the interpretation of the findings. Participants including students were asked to provide feedback and comment so that a “possibility of misinterpretation of the meaning of what they [participants] said and the perspectives they have on what is going on” (Maxwell, 1996, p. 94). Participants of the study were sent transcripts of the interviews and an accompanying letter with major findings and themes that I identified from the interviews. The participants of the study were given an opportunity to verify the transcripts and to comment on the findings with questions or feedback that they had. Zoe’s and Ella’s TVIs were the only two participants who responded saying that they were fine with the findings and transcripts. Ella’s TVI reported that she found the summary of findings from the interviews of TVIs very interesting.

Rival Checking

In a multiple case study, collected data have "different perspectives that do not always coalesce," hence "discussing contrary information adds to the credibility of an account" (Creswell & Creswell, 2018, p. 201). According to Yin (2018), providing contradictory explanations in rival checking in case study research helps in achieving a level of statistical relevance and establishes the research to be more realistic and valid. In this study, I demonstrated the alternate explanations to themes that had emerged by presenting my reflexivity on the bias that I had and by acknowledging any current predispositions that I had on the experiences of students with VI accessing technologies in classrooms.

Peer-Debriefing

To enhance the accuracy of the interpretation of data, peer debriefing was used in this qualitative research. In this study, I located a peer who was enrolled in the doctoral program in the field of special education and who had experience with qualitative research and data analysis. The peer was contacted after all the interviews were completed. Only the interview data were shared with the peer to complete coding. My peer reviewed all three interview transcripts of students, TVIs, and general education teachers. She then completed the detailed coding of the transcripts. After each category of participant interviews (students, general education teachers, and TVIs) were coded, the peer debriefer and I met via a virtual platform to compare and analyze our findings. After the coding of all interviews was completed, we then compared and analyzed our findings together and came up with codes that both of us agreed on. Although the specific names of some codes used by the peer-debriefer were different from what I coded, we agreed that the interpretation of the codes was the same. For example, I would use the code name "frustration around inaccessibility" and she would code it as "teacher inaccessibility." During our meetings, I would then explain the purpose of my study and then we would agree on names that directly related to the experiences of students with technologies in classrooms. After deciding on the codes that both of us agreed on, I sent a summary of the findings under each of the themes to the peer debriefer via email. She agreed with the final summary of the themes found in the study. Peer debriefing involves an "interpretation beyond the researcher" and "it adds validity to an account" (Creswell & Creswell, 2018, p. 201).

Dependability and Confirmability

In comparison to the reliability of data collected in quantitative research, dependability refers to how well others perceive the researchers have interpreted the data they collected (Creswell & Creswell, 2018). Dependability refers to how well the researchers document the steps of the research procedures so that others can follow the procedures (Yin, 2009). Confirmability is the level to which the results reflect what the participants were thinking and feeling rather than the researcher's ideas and beliefs (Shenton, 2004). Confirmability refers to the accuracy of the data and is closely related to dependability. In this study, I used audit trail and reflexivity to ensure the dependability and confirmability of the data collected.

Audit Trail

Audit trail refers to the maintenance of comprehensive notes "related to the contextual background of the data and the impetus and rationale for all methodological decisions" (Houghton et al., 2013, p. 15). Audit trails can enhance the rigor of the research by providing a comprehensive trail of decisions made during data collection and analysis (Houghton et al., 2013). Interview transcriptions, observation field notes, and document analysis were used as an audit trail in this study to ensure dependability and confirmability. I also provided detailed descriptions of how I collected data, conducted observations, interviewed participants, and analyzed data to help readers believe the decisions I made throughout the research process. The audit trail served as a guard for me for not interpreting findings that were not based on the perceptions of just one person but rather confirmed "that a number of participants held the same opinion" (Houghton et al., 2013, p. 15).

Reflexivity

The researcher is considered part of the research instrument in qualitative research (Houghton et al., 2013). To ensure that decision trails were not stripped of my personal contribution as a researcher, I maintained a reflexive journal throughout the research process. This reflexive journal "highlights how the researcher's history and personal interests brought them to the research and demonstrate how the theoretical perspective affected data collection and research" (Houghton et al., 2013, p. 15).

Transferability

Transferability is the level to which the findings of the completed study can be obtained when conducted in another similar context or situation, while still preserving the meaning and inferences from the completed study (Houghton et al., 2013). In this study, I used rich and thick descriptions to ensure the transferability of the research methods and findings.

According to Creswell and Creswell (2018), providing thick and rich descriptions "may transport readers to the setting and give the element of shared experiences" (p. 200). I provided a detailed description of how I collected, analyzed, and interpreted data to help readers make informed decisions on the transferability of the findings of this study to their own contexts (Houghton et al., 2013). Direct quotes from participant interviews and detailed descriptions of the setting were used to make the findings realistic and rich.

Ethical Considerations

Receipt of IRB approval through UNC's Office of Research and Sponsored Programs confirmed the ethics of this study. Additionally, as the research involved children in public schools, I followed the permission protocols or IRB process as required by school districts to protect the research participants. Creswell and Creswell (2018) recommended addressing anticipated ethical issues in different phases of the research process. Based on the recommendations by Creswell and Creswell (2018), the list below describes how I addressed the ethical issues in different processes of my research.

1. Before conducting the study--I obtained IRB approval from UNC and permissions from school districts.
2. Beginning of the study--I obtained consent from participants. The consent form informed the participants of the general purpose of the study and how the research problem was identified to benefit participants. I also let the participants know that participation was completely voluntary and that they did not have to sign the consent if they were not interested in participating in the study. I obtained consent from the parents of participants who were children. I also obtained consent from children using participant assent forms.
3. Collecting data--During interviews, I avoided asking leading and intimidating questions. I withheld sharing my personal bias and impressions. I involved participants as collaborators and avoided disclosing sensitive information. I stuck to the interview and observation protocol that I developed.

4. Analyzing data--I reported multiple perspectives and contrary findings. I assigned pseudonyms to all participants and across all findings, participants were referred to only by their pseudonyms.
5. Reporting, sharing, and storing data--I used APA (7th edition) guidelines for crediting authorship of any work referred to in my research. I provided copies of the final report to all the study participants and stakeholders. I planned to store all data and materials related to research for 5 years (American Psychological Association, 2019). As part of sharing my findings, I used member checking to determine if the findings I interpreted were accurate according to what the participants wanted me to perceive. I reported honestly and gave credit for ownership to myself, the participants, and my advisers.

Conclusion

In Chapter III, I provided the details of the research methodology I used to conduct my study. The purpose of this study was to understand the experiences of middle school students with VI when accessing and using technologies in general education classrooms. I used a qualitative multiple case study research study to answer my research questions. I recruited participants by sending an email to TVIs in the state of Colorado and asking them to nominate three middle school students with VI for my research. I obtained consent from parents/guardians of students, general education teachers, and TVIs. I addressed all ethical considerations of the study by obtaining IRB approval and permission from both my university and the school districts of the student participants. I analyzed data by conducting both within-case and cross-case analyses. I reported my findings narratively as stories of students about their experiences with technologies in classrooms and as common themes that I found from interviews with students, general education teachers, and TVIs. I ensured the rigor of the study by incorporating triangulation, member checking, rival checking, audit trail, reflexivity, and providing rich, thick descriptions of the research processes.

CHAPTER IV

RESULTS

The purpose of this study was to understand the experiences of middle school students with VI when accessing and using technologies in general education classrooms. The research questions explored in this study were:

Q1 How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms?

Q2 How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms?

Q3 How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms?

This chapter will describe the experiences of Luke, Zoe, and Ella, three middle school students with VI in their general education classrooms. We will be spending 2 days in their middle school with them. Data included in the stories were my interpretation of student experiences collected from their demographics, educational documents, interviews, and observation field notes. Each student's experiences will be narrated as a story and will include: (a) how they saw the world; (b) one day in their school; and (c) how their ideal world compared to their real world. Common themes that emerged from cross-case analysis of the interview data collected are also discussed in this chapter. As a researcher, the goal for me was for the readers to understand how middle school students with VI experience technology in their general education classrooms. This chapter will hopefully give readers a glimpse of a technology-rich low-vision world.

Luke: Lover of All Things Technology

The one thing that stood out to me when I first met Luke was his independence. It was 8:55 AM on a beautiful winter Thursday morning. Luke entered his Social Studies class, folded his cane and kept it to the side of his chair, got his Braille Note Touch (BNT, Braille Note Taker) out, and got ready to begin his day. He was humming and had a smile on his face. Luke was a smart and charming sixth grader who attended a public middle school. Luke had been identified as gifted and talented. He was twice exceptional, a term used when a student was in special education and was gifted, having identified needs in both areas. He loved participating in the Robotics Club in school and enjoyed exploring different operating systems such as Apple, Windows, and Linux. According to his TVI, he came from a household where both his parents set very high expectations of him and would not engage in activities that made him dependent or different from his sighted peers. Luke participated in running and hockey when he was not playing video games in his free time. In his IEP, Luke's mom shared that his favorite things were listening to books, YouTube Tutorials, and music.

How Did Luke See the World?

Visual Diagnosis

Luke had a visual diagnosis of Leber's Congenital Amaurosis (LCA) and Nystagmus. LCA is a condition that is present from birth (congenital). Luke's visual diagnosis was progressive which means that he would lose more vision as he grew old. To understand Luke's visual condition, one needs to know the parts of the eye. Retina is a specialized tissue that is in the back of the eyes. The retina has specialized cells called rods and cones which detect light and color respectively (Leber Congenital Amaurosis, 2022). Leber's Congenital Amaurosis impacted the function of rods and cones in Luke's eyes causing difficulty in seeing different colors and seeing in settings with little to no lighting. This means that when the lights go off in his classroom, he had little use for his vision. According to his mom, Luke had difficulty getting around in the dark due to night blindness, and it took time for him to adjust to changes in lighting. While LCA is also known to cause issues with color vision, according to his previous educational reports, when presented with construction paper with various shades, Luke identified them accurately. However, Luke struggled to identify the colors of everyday objects such as glue sticks and markers in his educational environments. He also had Nystagmus which caused his pupils to involuntarily move, especially when he was tired, trying to visually focus, or when he was stressed. According to Luke, “When I focus on something for too long, it might get blurry, or it might like move around for some reason. It’s just hard to focus on stuff.” Luke had no other medical diagnosis that impacted his access to his learning environments.

How Did Luke See Distant Targets?

According to Luke’s latest eye report, his distance acuity was 20/300 in both his right and left eye. This means that what a person with 20/20 or perfect vision could see at 300 feet, Luke saw the details of the same target only when he got as close as 20 feet. Based on his functional vision assessments completed by his TVI in 2021, “He has difficulty identifying common objects even at short or intermediate ranges without having to move the item closer to his eyes and/or tactily engage with an item.” His TVI reported that while Luke was able to read the 20/200 line in the distance acuity chart in 2019, he was not able to read any lines on the chart in 2021 even when the chart was moved to a closer distance. This was indicative that Luke was losing his vision. The most common distant targets in classrooms that Luke would have to access are smartboards or whiteboards. Considering Luke’s distance acuity, even if Luke sat right in front within 2 feet of the board, he would not see the details that were projected on the board.

How Did Luke See Near Targets?

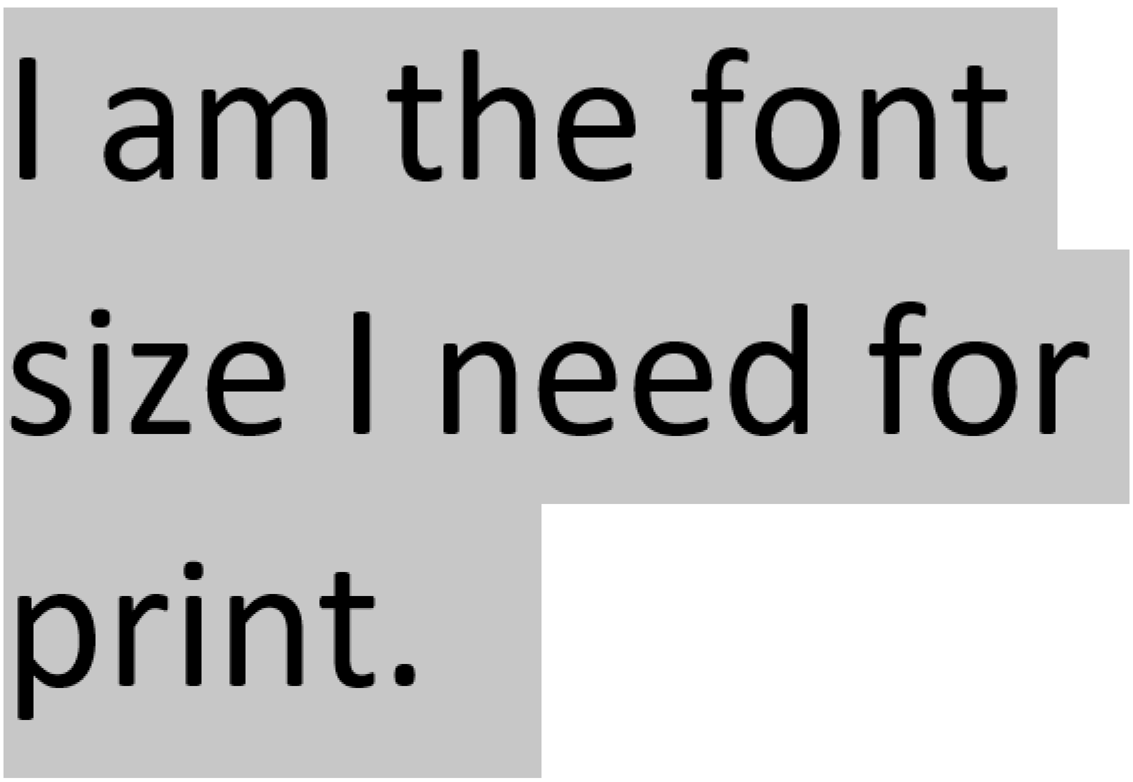
Near visual acuity affects one's ability to read and distinguish objects at a near distance. For low-vision learners, the font size of the print is determined based on their near visual acuity. According to his functional vision assessment, the smallest font size that Luke saw was 24-point font at a distance of 4 in from his eyes. At a comfortable reading distance of about 12 in, Luke needed 72-point font of print. Figure 3 shows the 72-point font that Luke needed to visually access print. Considering the magnification that Luke needed to access print and that he was losing his vision, Luke was a tactile or braille learner. All of Luke's classroom materials were adapted to braille/tactile format. Luke had a BNT which is often referred to as a braille computer. The BNT converts all digital text to braille. Luke's BNT helped him access his digital learning materials in braille. Hence, as a primary access method, Luke used his BNT to access all digital text. Luke's secondary access method for digital text was through a screen reader, a program in the computer that reads out the contents of the screen to the user. The TVI reported that Luke was "unable to efficiently access his computer monitor without the use of screen reading software for academic purposes." While Luke had shown his TVI that he could create and play video games on his laptop using his vision, visually accessing learning content was not efficient for Luke. His TVI also noted that Luke was learning to use three screen readers (JAWS, NVDA, and ChromeVox) so he could become proficient at using his computer without the use of his vision.

> I try to teach them all three major screen readers because you're more sellable to the workplace. . . . If you go into workplace and you say, "Oh, I need you to buy me JAWS and I find out their software doesn't work with it." I want them to have a backup plan and be a very sellable potential employee.

For materials that were not digital, Luke used adapted braille/tactile graphics for accessing print materials in his classes. To summarize, Luke accessed all his print materials in either of the following three ways: (a) physical printed copy of text/graphics accessed with an equivalent copy of braille/tactile graphics produced by his TVI; (b) digital text accessed in his BNT; and (c) digital text accessed using screen readers.

Figure 3

Luke: 72-Point Font Size Required for Print Access

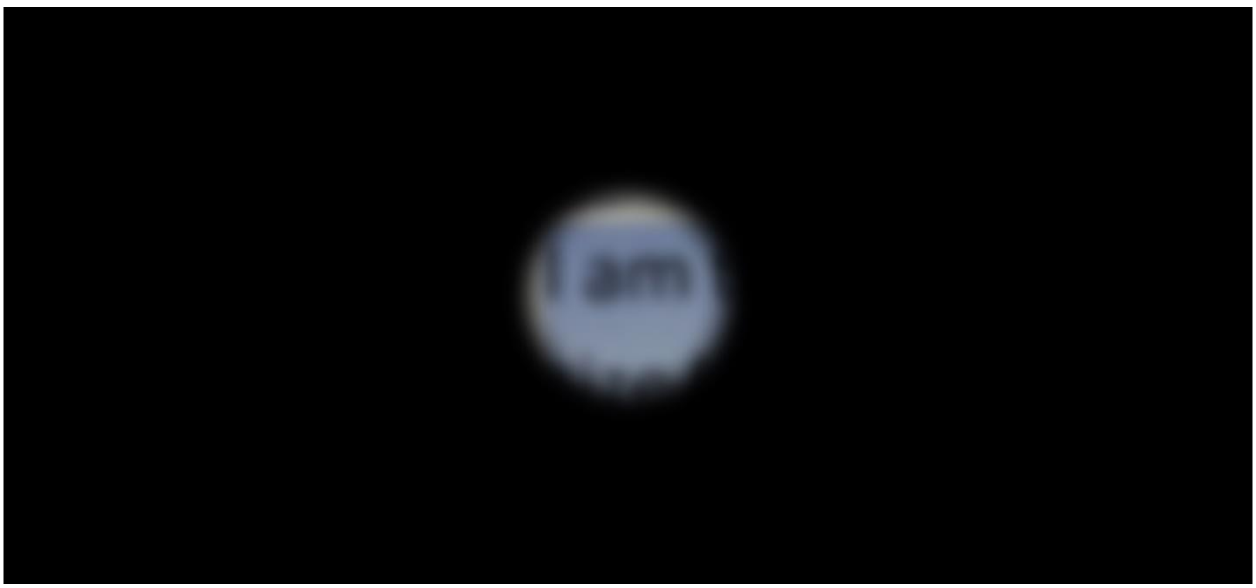


Simulation of Luke's Vision

As a TVI, people often ask me to tell them what and how my low-vision students see. We often do simulation exercises as part of "in-service" sessions at the beginning of a school year to educate peers and teachers about our students and how they see their world. As I was looking for resources to help readers of this dissertation understand how Luke was seeing his world, I came across a free iOS app called "Thru My Eyes." The app simulated the view from the phone's camera as seen by an individual with a visual diagnosis; LCA was one of the visual conditions that the app simulated. I pointed the camera to the text in Figure 3 and chose "LCA (moderate severe vision)." Figure 4 shows the digital text as seen by Luke having LCA with moderate to severe vision loss. While this simulated vision might not perfectly represent what all individuals with LCA see, it is a fair representation of the visual loss for the general public to understand the condition.

Figure 4

Approximate Simulation of Digital Text as Seen by Luke



As Luke got closer to the screen, the letters would become clear to him. But how long could he read text sticking his nose to the screen and constantly moving his eyes and head to scroll through?

One Day in Luke's School

Before we follow Luke in all his general education classes, we need to understand the accommodations he was entitled to according to his IEP. Also, we need to understand how his educators were collaborating to ensure his access to classroom materials at the same time as his sighted peers. Table 8 lists the accommodations from his IEP and a description of where such accommodations could be used.

Table 8

Luke's IEP Accommodations

Accommodations	Description of places of use
Check with Luke for understanding. Directions are given when lessons are highly visual.	When teachers are using smartboards and/or whiteboards for instructions.
Check with Luke to make sure he knows where to locate his adapted materials.	Teachers give directions on the name of files and digital locations of adapted classroom materials.
Pre-teach highly visual concepts.	Pre-teaching visual materials that are not limited to maps, mathematical concepts, and science lessons.
Access to a Cranmer Abacus, talking calculator.	In math class for completing computations. The Cranmer Abacus is equivalent to paper and pencil that sighted children use to do computational problems.
Access to braille writer and braille paper.	Classes where he cannot use his computer to voice-type, or his BNT to braille.
Space in the classroom dedicated to the storage of braille materials	All classes where physical braille textbooks, braille writer, brailled lessons, and tactile graphics need to be accessed.
General education teachers provide a plan in collaboration with the TVI to determine how Luke will turn in work. General education teachers meet with TVI to ensure the accessibility of the coming week's materials	All general education teachers do not understand braille. Hence collaborating with the TVI, they should provide a plan if Luke will turn in work through his BNT as digital text or by using a braille writer to physically emboss on paper. Support from the TVI may be weekly or less depending on the level of support needed.
Call on Luke in class to answer questions about the lesson being given to check for engagement and understanding. Provide an individual verbal prompt before giving those directions to the whole class.	In all general education classes where Luke's access is different from his sighted peers.
Provide flexible seating.	In classes where Luke needs to go in front or stand during different tasks to support his access.

How were Luke's Teachers Making Content Accessible for Him?

Being a sixth grader in a middle school, there were several general education teachers for Luke. His TVI expressed that general education teachers often felt that Luke "is missing out because he's not getting to see everything." His TVI continued:

> There are some teachers who I explained. Yeah, he can access pretty much anything on a Google Doc, except you have to take out tables and a couple of different things you need to tweak and those teachers have just run with it and figured it out. There's other teachers who [I] have to definitely meet more often… science is a great example. – Luke's TVI

According to Luke, the teachers adapted content by typing onto a Google Doc which could be accessed as braille on his BNT or they had his TVI adapt to braille documents. The school used an online learning platform called Schoology which was not accessible to Luke in his BNT. So, the folders created in Schoology were replicated as Google Drive Folders with the same name. Google Drive was fully accessible to Luke in his BNT. He loved the fact that he could "do the learning at the same speed as everybody else." Apart from using his BNT for most of his classes, Luke sometimes used his iPad to watch videos, browse a website, or have a second document open to complete his work.

Luke's favorite general education class was Language Arts (LA) because it had been the most accessible to him from the start of his school year. Luke's LA teacher described her experience working with Luke as "eye-opening." She expressed that Luke's love for learning makes him a "perfect student to have had for this first experience." The LA teacher also reported that she collaborated with his TVI when she needed guidance to teach standards that were very visual in nature. Now that we understand how Luke saw his world and how his teachers were collaborating to make content accessible to him, let's visit his general education classes.

Social Studies

Luke enters his Social Studies class and sits on a chair that is at the back of the class, 20 feet away from the smartboard. The teacher projects the agenda on the smart board. The agenda and the day's class work were already uploaded to the Social Studies Google folder in Luke's BNT. Luke takes out his BNT and types the answer to the warm-up question by brailling. As the teacher has access to the Google folder, she will get to see his answers the same way as she would for her other students. After the warm-up, the teacher projects a presentation slide on the smartboard. The slide contains passages and visuals for the topic "The Columbian Exchange." As the teacher is instructing, she is writing and highlighting text on the smartboard. The students who have access to the passage in their Schoology folder as PDF documents are highlighting and following along. Luke cannot see the smartboard. When Luke was asked about his feelings on not having visual access to the highlighting on the board, he said "It's not great . . . and usually they're speaking what they do on the board. So, I just listen to that." Students are expected to complete classwork based on the passage that the teacher explained. After reading the passage, the teacher plays a video relevant to the topic. The video does not have audio descriptions. Luke listens to the video. The teacher then asks the students to go to their "assignment" folder and said, "If you have your highlights open, you should be able to answer the assignment." Luke opens his "assignment" folder in his BNT but completes his assignment with just the content that he heard. The teacher asks the students to "submit" their answers and informed them that their quiz on Friday will be based on the passage that they just read.

On the second day, the teacher gives a blank paper to all her students, except Luke. She asks Luke to go to a Google Doc called "Important Concept" in his BNT. The teacher demonstrates how the rest of the class should fold the blank paper to make 16 sections (a grid with 4 rows and 4 columns). Using a slide projected on the smartboard, students copy the headings of the columns and rows onto their paper. Luke completes this activity by brailling the same content of the grid on his Google Doc using the BNT. Instead of filling the rows and columns of the grid, he writes as separate sentences for “Important Concept.” For the final activity, students are expected to complete a “summative assessment” which has a combination of multiple-choice and matching questions. While the rest of the students complete the assessment using the Schoology platform, the teacher adapts the assessment as a “Google Form” for Luke. He completes the assessment by reading the braille on his BNT.

Science

Luke is quick to transition to his next class, Science. He sits in the last row which is approximately 20 feet from the smartboard. He takes his BNT out and switches it on. The agenda for the class is projected on the smartboard. The first activity is to build a puzzle on the topic of “Pangea.” In their Schoology account, the students have access to a presentation slide showing a map of the “Old World.” The activity is to digitally re-organize the countries from the “Old World” to create the “New World” by reading clues. The teacher demonstrates the activity in the Schoology platform. Luke just listens. The teacher gives Luke separate directions to go to his science folder in his BNT, read the instructions, and then build a tactile puzzle. The science teacher collaborated with the TVI in obtaining a tactile puzzle with pieces of the continents prior to this lesson. On a separate note, the Science teacher explained to me that the “digital puzzle” activity was part of the Science curriculum called DiscoveryEd which is purchased by the district for a lot of money. DiscoveryEd includes assignments, classwork, assessments, and activities that can be completed digitally by Luke’s sighted peers. Unfortunately, Luke cannot access any of the activities in DiscoveryEd because the program is not screen reader friendly and includes several visual components that are not described for him. As part of the puzzle activity, students were expected to answer related questions and submit their answers to the teacher digitally. Luke completes the activity by brailling his answers on his BNT while building the tactile puzzles. He raises his hands several times to ask questions about the clues required for the activity.

The next day, the teacher plays a video on “Continent’s Adrift” that will help them complete an activity of filling in a chart related to the topic. For Luke, the teacher says that she found two great videos on “Continent’s Adrift” on Described and Captioned Media Program (DCMP); DCMP is a website where there are several educational videos that have been audio-described. Luke gets his iPad out. With the help of his teacher, he uses the DCMP website and accesses the videos. He then gets his headphones and listens to the audio-described videos. The teacher then asks the students to go to the “Purple” folder in their Schoology called “Seafloor Spreading and Subduction,” and she tells Luke that his folder in his Google Drive has the same name. The teacher verifies if he has opened the document while projecting the chart on the smartboard for all the students. The teacher then plays a YouTube video that is not audio-described. Luke listens to the video and completes the activity on his BNT using a Google Doc.

Language Arts

According to Luke, LA is his favorite class as he thinks that the teacher “gets” it! The agenda is projected on the screen. The teacher reads every single piece of information on the board aloud to the entire class. She then tells the class that they will be completing “Unit 4: Reading Summative” today. She then says, “If you normally listen to a story, use your headphones.” As part of the summative assessment, after reading the story, “A Girl’s Best Friend,” students are expected to answer questions about the story. The teacher then provides clarification about answering a specific question. “When a question in the assessment indicates says paragraph 37, you don't need to count the paragraphs. I will project paragraph 37 on the board for you to quickly have access to." She tells Luke that she will copy and paste paragraph 37 on his Google Doc where he will be brailling his answers. After they finish the summative, students need to complete the "Pop goes the verb" worksheet that is placed on the table in front of the class. She tells Luke that he can find the worksheet in his "Practice" folder on his BNT. Luke continues reading the story in braille on his BNT while the rest of his class is reading or listening to the story on their computers. As Luke did not complete the assessment until the end of the class, he did it during library time the next day. According to the teacher, Luke takes a lot of time reading "because he is reading the braille."

The next day, the teacher says that they are starting a new standard "RL 6.7 Compare Contrast--Visual to Text." Before this class, the teacher met with Luke's TVI to discuss how best to make the visual content accessible to him. The teacher explains to the whole class how they will be watching video clips and reading the text of the same video clips. The goal of the standard is for students to write and explain which impacted them more and why: reading the text or listening to/seeing the same text as a video/audio. The teacher gives an example by playing a silent video on "Old Movie Collector." She describes what is happening in the video to the entire class. The teacher says, "Sorry, Luke, for my pretty bad description," and one of the students in the class says, "It was pretty accurate." She then projects the texts associated with the video. She explains by talking about the similarities and differences between reading and watching a video. After the example activity, the teacher says that she will pass on a piece of paper with a poem written on it. She tells Luke that he doesn't need the poem in braille and she is just going to have him listen to it. The teacher reads the poem in a monotone or using none of the language expressions. Then the teacher plays a video on the smartboard. In the video, the same poem is being read and performed by the poet who wrote the poem. The teacher asks her students to notice the voice modulation of the poet. As the video was not audio-described, Luke missed some of the visual aspects such as the poet almost “spitting” on the microphone or the level of engagement the poet had with his audience. After the video, Luke listens to his peers discussing their thoughts on similarities between reading the poem and the video. He closes his BNT and gets ready for his next class.

Math

Luke enters his math class. There is a table set up in front of the class. On the table, there is a braille writer, a box of braille papers, and a talking calculator. Luke grabs his braille writer and sets it on his table with the paper. A girl sits at a table right next to him. Luke has his TVI supporting him in this class. The teacher says that they will be taking a quiz today. All of Luke’s peers are using their Chromebook and calculators to answer the quiz. Luke gets a braille copy of the test. Luke does not use his calculator and completes the problems in his head. Luke gives his answers to his TVI who writes the answers in print. Luke then hands over the braille test paper with his answers to his teacher. The teacher then says that she will put them in random groups of four and they will work on “Percent Problems.” The teacher assigns groups and then hands over a set of 10 cards having percent problems to each group. For each problem, the group members take on a role of a solver, writer, or reader. After every problem, they switch their roles. While the teacher was explaining the activity, Luke’s TVI types the problems on the cards on a Google Doc and shares it with Luke. By the time the groups were assigned and they were given specific positions in the room to work on, the TVI lets Luke know that he can access the problems on a Google Doc in his BNT. Luke assumed the role of a “reader” for the first card in his group. The rest of his group members assumed the roles of writer and solver. As Luke’s group was located near the smartboard, the writer in his group chose to write the answers on the smartboard that Luke cannot see. At one point in the group activity, the teacher asks Luke's group if they are including him. Luke takes the role of a "solver" for a few problems and uses his talking calculator with headphones to figure out the answer. Luke never assumes the role of a "writer" in this activity.

The next day, the teacher passes the "Summative Assessment" tests that they took the previous week. Luke gets his brailled assessment along with comments and scores. Luke sees his score by looking very closely at the paper. The teacher then projects a few of the problems on the smartboard that several of the students missed in the quiz. The teacher is using the board to explain the conversion of decimals or fractions to percentages. On the board, the teacher is drawing curves to move place values, uses different colors to order the numbers, lines the numbers vertically, and circles the numbers. Luke just listens. The teacher then says that she was surprised by the bad performance on another quiz that the students took the previous day on "Area of Composite Figures." She hands over their quiz papers along with the brailled copy for Luke. The teacher explains how dotted lines can be extended from composite shapes to determine the area of the figure. She shows this by doing a few examples on the board. Luke's TVI explains by showing the same thing on his "tactile graphics." She allows him to understand the complexity of the shapes with his fingers by showing the various components such as the dotted and solid lines and how they should be interpreted. The teacher then reads out the correct answers to the quiz and the students mark the correct answers on their returned papers. Luke just reads his answers and does not write anything on his paper. As the final activity, the teacher does a quick "Blooket" activity. Luke gets his iPad out and his TVI helps him log in by entering the "code" projected on the smart board. They start the game, and his TVI reads the problem to

Luke, he tries to answer, and the TVI types the answer for him on the iPad. The smartboard displays the live game and the scores, both of which Luke cannot see.

Spanish

Luke sits next to a girl on the third row, approximately 15 feet from the smartboard. The teacher uses a document camera to project a paper with pictures of fruits and vegetables with Spanish names. Students are expected to write the English word associated with each picture. Luke switches on his BNT and opens the appropriate Google Doc. As Luke does not have access to the pictures, Luke completes this activity with the help of his peer. In his interview, Luke explained that the websites that the teacher uses in this class were very hard for him to access through the technology tools he had: “In Spanish, we use a website and some of the things you have to do on that website are like to match the picture with the Spanish word and I can’t as it doesn’t describe the images.” He asks his peer sitting next to him for the English word equivalent to the Spanish word. For words like “el mango” or “el melon,” Luke writes the corresponding English word (mango or melon) without the picture clue. However, for words like “la ciruela” which is a “plum,” Luke needs his peer’s help. The next activity was to make a chart in their notebook to understand the different color words in Spanish. The students need to write the name of the fruit or vegetable name under the appropriate color column. As his friends were completing the activity, Luke continues to complete the first activity on his BNT. The teacher tells them that after they finish writing on the chart, they will draw on their notebooks to make a picture dictionary. As Luke cannot do a picture dictionary, after completing his first classwork, he asks the teacher if he can listen to music on his iPad. He gets his headphones and starts listening to music.

How Did Luke's Ideal World Compare to His Real World?

With TVI support, his BNT, and his IEP accommodations, Luke accessed most of the learning content in his general education classes. The main challenges related to his access to content were: (a) the use of learning platforms such as Schoology and websites which were not screen-reader or BNT friendly; (b) the explanation of content in smart boards without describing the visual aspects; (c) the use of activities such as filling in digital puzzles, charts, and making picture dictionaries, and finally (d) the use of supposedly fun and engaging digital educational games that were often used as filler activities or to encourage student participation. In an ideal world, Luke would have: (a) all his general education teachers using and choosing accessible websites and videos that were audio-described; (b) multiple activities for learning content that children could choose from (for example, students could make picture dictionaries, or they could play a memory game with their friends or they could do a puzzle); and finally (c) the district chose learning platforms and curriculums that had UDL components embedded in them. If Schoology was accessible or if the school district used "Google" as their learning platform, the teachers would not have had the need to convert all the documents to a Google platform. To get closer to an ideal world for Luke, there certainly needed to be a lot of structure, coordination, and collaboration amongst all his teachers so that he could complete activities at the same time as his sighted peers. And the most important factor to aspire to be in an ideal world was to be a student who was a lover of all things technology. Luke had the buy-in for using accessible technology tools. He loved the fact that he could access the content at the same time as his peers. He felt that efficient use of technology was going to help him in his workplace.

Zoe: The Social Butterfly

On a cold winter morning, I met Zoe for the first time. She was a genuinely happy and sociable girl. Zoe reported that her friends were her favorite part of her school. Zoe's braillist reported that Zoe loved talking, hugging, and playing with her friends and called her a social butterfly! According to Zoe's teachers, she was a kind, friendly, and active young lady who had the desire to succeed. Zoe attended sixth grade in an elementary school in the district where I worked. Although I had been working in the district for the past 11 years and knew how things generally work in classrooms, this was the first time I was seeing Zoe's school and meeting her general education teachers. Zoe had recently moved from another state and enrolled in this school in November, 2021. In her short time in this school, Zoe had become well-liked by her teachers and peers. Zoe did active cheerleading outside of school. In her latest IEP, Zoe's teachers reported that she persevered and had grit in developing proactive skills in getting her work completed. Apart from discussing how Zoe saw her world, the following paragraphs narrate Zoe's experiences with technologies in general education classrooms dissected by the various activities Zoe completed during the 2 days I observed her.

How Did Zoe See the World?

Visual Diagnosis

Zoe had a visual diagnosis of Stargardt's Disease which was a genetic eye condition that caused progressive vision loss. Typically for individuals diagnosed with Stargardt's Disease, a fatty yellow pigment builds up in cells underlying the macula, an area in the eye that is responsible for central vision (Foundation Fighting Blindness, 2023). Apart from the loss of clear central vision, Stargardt's Disease also affected Zoe's ability to see colors. According to her eye report, Zoe was color blind. However, as per her latest functional vision assessment, Zoe identified all the colors of the rainbow when shown a garland of flowers. Zoe's experience with colors was different from that of typically sighted students. Zoe also had other eye conditions including exotropia, amblyopia, hypertropia, myopia, and astigmatism which affected her eyes working together, causing blurry vision for distant and near targets. Zoe recently got surgery to correct her hypertropia, a form of strabismus or eye misalignment. According to her eye report, the surgery was successful and helped her slightly with visual fatigue.

How Did Zoe See Distant Targets?

According to the latest functional vision assessments conducted by Zoe's TVI, her distance acuity was 20/200 using both her eyes. This means that what a person with 20/20 vision could see at 200 feet, Zoe saw the details of the same target only when she got as close as 20 feet from the target. Zoe identified everyday objects such as pencils, rulers, and markers when she got as close as 1 foot from the objects. According to her reports, Zoe's distance vision did not allow for significant visual discrimination, and she missed details when she did not have magnification aids. Additionally, her visual diagnosis was progressive, and she was at risk for greater vision loss as she aged. Zoe used a portable video magnifier called Jupiter to access distant targets. The camera in the device could be adjusted to point to distant targets such as the smartboard or whiteboard to follow along with instructions. However, Zoe did not choose to use her Jupiter to access distant targets in any of the classes. She often used her iPad to take a picture of a distant target and looked closer at the picture. Zoe expressed that one of her favorite technologies to access distant targets was the Document Camera. In her previous school, using the Document Camera, Zoe was able to see the projected content on the smartboard by connecting her computer to the teacher's computer so she could see up close. According to Zoe's TVI, they tried to implement the same setup using the Document Camera in Zoe's current school. However, the setup did not work for Zoe's access to the smartboard because the magnification obtained through the Document Camera was not sufficient for Zoe. For accessing distant targets such as an assembly, Zoe reported that she just listened: "For assemblies and stuff, I can't see what they're doing. I can only really kind of like see a bit of outline like moving on stage. So, I honestly just listen instead of watch."

How Did Zoe See Near Targets?

Zoe required a 90-point font size to access print at a reading distance of 6 in from the print. Zoe was not able to sustain reading print for lengthy passages or a book. According to her TVI, "Due to Stargardt's, Zoe lacks clear central vision which greatly impacts her ability to interpret her environment and recognize details to aid in her visual comprehension of what she is seeing." Zoe felt that visual fatigue certainly affected her access to technology tools in class, but it used to be worse before her Strabismus surgery. "It used to be much worse. . . . I could barely read anything online, I would get massive headaches . . . because my eyes would try to work together, but they couldn't." Considering the progressive nature of Zoe's visual diagnosis and the visual fatigue when she accessed magnified print, Zoe started learning braille in January, 2022. Figure 5 shows the 90-point font size that Zoe needed to see print. Zoe used the following tools in her classrooms to access print: (a) text-to-speech features built-into programs in her computer; (b) Jupiter that magnified any printed paper to the 90-point font that she required; (c) touchscreen Chromebook or iPad to magnify digital text; and finally (d) beginning level braille to complete simple homework sheets. Overall, based on her eye report, functional vision, and learning media assessments, Zoe best accessed her near targets primarily by listening or using her auditory sense and secondarily using her vision.

Figure 5

Zoe: 90-Point Font Size Required for Print Access

I am the font size I need for print.

Simulation of Zoe's Vision

Although I did not find an exact simulator for Zoe's visual condition(s), considering that Stargardt's disease caused gray, black, or hazy spots in the center of one's vision (Foundation Fighting Blindness, 2023), and Zoe's distance acuity being 20/200 which caused blurry vision, Figure 6 shows two approximate simulations. The simulations were obtained from two vision simulator websites, FeelGoodContacts.com and MyEyeDr.com. The picture on the left in Figure 6 approximately portrays how Zoe was accessing her distant targets at 20/200 acuity. The picture on the right in Figure 6 approximately portrays how Zoe was accessing near targets with gray spots in her central vision making the picture somewhat blurry. While this simulated vision might not perfectly represent what all individuals with Stargardt's see, it is a fair representation of the visual loss for the general public to understand the condition.

Figure 6

Approximate Simulation of Distant and Near Targets as Seen by Zoe

One Day in Zoe's School

Before we follow Zoe in her school, we need to understand what accommodations she was entitled to according to her IEP. Also, we need to understand how her educators were collaborating to ensure her access to classroom materials at the same time as her sighted peers.

Table 9 lists the accommodations from her IEP and a description of where such accommodations could be used.

Table 9

Zoe's IEP Accommodations

Accommodations	Description of places of use
Verbalize as you write on the board, Portable Electronic Video Magnifier for viewing distance targets, and use dark-colored markers on the board.	Smartboard or whiteboard instructions that Zoe needs to access.
Use of built-in accessibility features (speech-to-text, text-to-speech, magnification); quieter space for voice typing as needed.	Classrooms where desktop computers and touchscreen devices such as Chromebook or iPads are used.
Access to auditory materials.	In all of her classes where there are reading books and printed passages.
Access to personal copies of instructional materials (either paper or electronic).	Classes where digital and non-digital instructional materials are given. Example: handouts and class notes.
Access to large print keyboard/keyboard stickers.	In classes when Zoe is not voice-typing and is using a computer with the keyboard to complete writing activities.
Shortened, prioritized assignments, extended time, testing over multiple days, visual break after 20 minutes of sustained visual attention.	For all assignments and tests.
Prompting Zoe to use devices/technology. Allowing work to be completed independently by utilizing her resources than having a peer or adult complete portions of the assignments for her.	Classes where Zoe is expected to complete her work independently using her technology resources.
Note-taking device/software.	Classes where Zoe is expected to take notes.
Access to tactile/braille materials as appropriate.	In general education classes where content can be adapted to a level of braille that Zoe can read.
Extra space for materials and assistive technology integrated into the classroom seating arrangement. Access to space for charging devices.	In all classes, Zoe should have space to store and charge her devices and preferential seating.

How were Zoe's Teachers Making Content Accessible for Her?

According to Zoe's LA teacher, the support she received from the TVI was very important. "It is an important relationship obviously. . . . It is a good relationship and about once a week we at least touch base and figure out what is going on, what we need to work on, and what is coming up." Apart from working collaboratively with the vision teacher, Zoe's IEP accommodations were being followed to make content accessible for Zoe. She had access to touchscreen devices, built-in accessibility tools such as text-to-speech and speech-to-text, and other accommodations as described in Table 4. Zoe also had access to a portable video magnifier called Jupiter that she could use to complete near and distance activities. Jupiter was set up on a table in her homeroom, and Zoe charged it every day before she left school. When asked how she felt about using vision-specific tools such as the video magnifier, Zoe said

> At first, I was really embarrassed, especially when I moved here mid-year, 'cause no one have seen that before . . . but then people get used to seeing you like that . . . they like stare at me . . . but after a while, they just acted like that wasn't even there.

Even though Zoe reported that she had gotten over being embarrassed about the VI-specific tools, Zoe still chose not to use her tools when she needed them. Her TVI reported concerns about how Zoe accessed her tools.

> I wish that she would use the tools that are available to her on a consistent basis. I wish she would use them unprompted. . . . I would really love to see her take full ownership of learning and accessibility. . . . It is self-advocacy.

As Zoe was attending an elementary school as a sixth grader, the traditional middle school schedule was not followed. Zoe had four classrooms that she went to on a typical day; LA, Math, Homeroom (where Science or Social Studies was taught), and an elective (PE, Spanish, or Art that rotates every week). Zoe had a “braille class” during which she learned braille and other related technology tools for access. Because of Zoe’s non-traditional schedule, the next few paragraphs narrate my interpretation of Zoe’s experience with technologies in general education classrooms by the activities she completed during the 2 days I observed her.

Group Work

Zoe starts her day in her homeroom, Mr. Robert’s class. Today, Mr. Robert in collaboration with other sixth-grade teachers will be starting the “Exhibition Project.” Zoe’s school is an International Baccalaureate (IB) school. According to the school website, IB means the educational methods used in the school help students explore topics at a deeper level and make connections to the world around them. As part of the IB curricula, sixth graders in the school learn about a world problem and present their findings to the entire school as an exhibition, similar to a science fair. Students are placed in groups, and they get to choose the topic they want to study from a list of topics given to them. Apart from working towards the final exhibition, each group collaborates with teachers in the school and presents their findings to younger students. Although the majority of the project is completed as a group, each individual in the group writes an essay on the researched topic.

Exhibition Project Research. Zoe is the only girl in her group of four boys. Zoe’s group will be researching the topic of “Vaping.” All students are working on their computers and accessing resources from Google Classroom. Zoe has her touchscreen Chromebook in front of her. The teacher gives instructions to the entire class on the steps to conduct research. There are five main steps that their group will be doing: (1) in the Google Doc, “Student Exhibition Handbook,” they have to type “Essential Agreements”; (2) in the same document, they have to type 10 questions they want to research under “Line of Inquiry”; (3) they have to match their questions from “Line of Inquiry” into the categories of form, function, causation, change, connection, perspective, or responsibility; (4) they will decide on three questions that they all want to investigate; and finally (5) they each will choose one of the three questions and do research. For the first step, Zoe opens her Google Doc on her Chromebook. She is looking very closely at the screen. Her eyes are approximately 2-3 in from the screen. She tries to locate the “Essential Agreements” section. As the group is working on the same Google Doc, Zoe is visually following along with the digital text when it is being typed by her group members. When Zoe scrolls down the page, she “minimizes” the print and when she is reading, she “zooms in.” For the second step, Zoe types “Where do minors get vapes?” But, by the time she types that question, the rest of her group members type 9 other questions. Zoe types by looking very closely at the keys and at the screen.

For the third activity, the teacher explains the key concept categories by placing paper copies of each concept on the whiteboard using a magnet. Zoe cannot see the board, and she just listens. They have to place their questions under the relevant key concepts in the Google Doc. Instead of copying the questions from the “Line of Inquiry” section and pasting them under the appropriate “Key Concepts” section, Zoe chooses to re-type the questions. When the boy sitting next to her told her that she could copy and paste the questions, Zoe says, “No.” After slowly typing one question, “How do vapes affect the brain?” under the category of “Function,” she looks for the key “?” on her keyboard. The boy next to her told her to use the “shift” key. She types one more question and then starts talking about “Harry Potter” with one of the group members. When they had to decide on the three questions to do in-depth research, Zoe tells her group that the question she wrote, “How do minors get vapes?,” should be researched further. The group agrees on the three questions including Zoe’s and they each choose which one they want to research. For the final activity, Zoe opens “Google.com” on a web browser and types her question on how minors get vapes. She zooms into the results. She sees the search results 2-3 in from the computer screen. She fetches a paper and pencil from the front of the class and writes the title of the Google search. She writes by sticking her nose to the paper. Fifteen min into the research, Zoe opens a Google Doc and starts “voice-typing.” She voice-types her sentence, enlarges it, and then reads what she types. When it is time for her next period, she closes her Chromebook. As she lines up to go to specials, she hugs a friend on the way!

Exhibition Project Presentation. Two weeks into the exhibition project, Zoe’s group created a PowerPoint presentation with the information they researched on vaping. Today is the day when they will be presenting their findings in four 5th-grade classes. Zoe is very excited about the presentations. However, due to the snow-related “delayed” start, the original schedule for the presentations had to be changed. Zoe is quick to visit the four 5th-grade teachers to re-schedule her group’s time slot and to inform the changes to her group. Zoe’s group is given printouts of the PowerPoint slides along with notes that they wrote to help with the presentation. Zoe takes a picture of the printed paper of her slide using the iPad. Zoe’s group presents in four fifth-grade classes. When her turn comes for presenting, Zoe reads and scrolls through the picture of the text from her iPad. The text is magnified to more than the 90-point font size. Zoe is slow when she is reading from the iPad. However, when she starts talking about the research without looking at the iPad, she is very quick and smooth. Zoe is in her comfort zone when she is answering questions from the fifth-grade audience. She tells her younger peers, “Guys, be careful, there might be somebody trying to sell drugs outside our school too.”

Partner Activity in Spanish. In Spanish class, Zoe participates in another group activity. In this two-partner activity, Zoe quickly pairs up with her friend. The activity involves one partner reading a card with a Spanish word, and the other partner listening and writing the heard word. They then take turns being a reader and writer for the cards. Zoe takes a picture of the card using her iPad and zooms into it when she is reading. When she is writing, she writes using a pencil 2 in from the paper. Zoe and her friend are having fun with the activity. Sometimes, when Zoe is writing, her friend helps her with the spelling.

Artwork--Making a Stencil

The activity in art is to make a stencil, a collage picture using that stencil, and paint the picture with watercolors. The stencil is first made by drawing on a 6 x 6 inche postcard. Zoe draws a heart on the postcard using a pencil. Zoe is bending over and her eyes are 2 in from the paper. After drawing, the teacher cuts the heart stencil for her. Zoe then uses the stencil to draw a picture on paper. While doing the activity, she talks with her friends. The class gets over before Zoe finishes her picture.

Independent Activity

Zoe worked on two independent activities during the days I observed her. Her braillist supported her during both of these activities. Zoe stepped out of the class for the independent activities and sat next to her braillist in the hallway.

Essay Writing. For the exhibition project, each student should complete an essay on the topic their group investigated. The essay is completed on a Google Doc that is shared with the LA teacher. In her Chromebook, Zoe opens the Google Doc that has examples of what each paragraph of the essay should contain. Zoe listens to the examples by using the text-to-speech extension on her Google platform. The example document also contains “outline” sentences that students can use to frame their introductory paragraphs. Zoe asks the braillist, “How do I copy and paste this because I don’t want to re-type it.” The braillist teaches Zoe to first highlight the sentences that she wants to copy and then do a Ctrl+C for copy and Ctrl+V for paste. After copying and pasting the "framework" sentences onto a new Google Doc, she then voice-types a few of the words to complete her sentences. As she voice-types, she gets frustrated and says, "I want to throw this computer outside." The braillist tells me later that Zoe got frustrated with the activity because when she zoomed in and out to read what she was voice-typing, the document froze on her. After voice-typing two sentences, Zoe says that she doesn't want to look at the screen anymore.

Online Reading Assessment. Zoe completes an online reading test from Wonders, a reading curriculum developed by McGraw-Hill. Her LA teacher helps Zoe log into the test from the school website. The test requires students to read a passage and answer comprehension questions. Zoe magnifies the passage and is looking very closely at the screen, about 2-3 in from it. Zoe takes visual breaks by looking away from the screen every 2 or 3 min. She is leaning forward to see the digital text. She tells the braillist that her neck and back are hurting. Seeing Zoe hurt and fatigued, the braillist checks with the LA teacher if she could read the passage to Zoe. The LA teacher agrees, and Zoe listens to the passage being read to her. After the passage is read, the braillist reads the multiple-choice questions and clicks the answer that Zoe chooses. After completing 10 questions, McGraw-Hill logs Zoe out. The LA teacher helps Zoe log back in and she resumes the test. After completing 11 questions, the braillist leaves. The LA teacher shows Zoe how to highlight portions of the passages and click on a button to listen to the passage. The teacher also tells Zoe that she may have to highlight only one paragraph at a time to listen. Moreover, according to Zoe's TVI, even though the online passages in McGraw-Hill allowed for the passages to be read to Zoe, one could adjust the playback speed and it tended to be very slow. As Zoe is listening to the passage, McGraw-Hill logs her out again. The LA teacher tells Zoe that she will take care of it the next day.

How Did Zoe's Ideal World Compare to Her Real World?

In an ideal world, classroom activities would not have been visually exhausting for Zoe. Throughout her day, Zoe used only universally accessible mainstream devices such as the iPad and her touchscreen Chromebook. She used voice-typing, spell check, and magnification features in her mainstream devices to access digital print. She did not use her video magnifier to access the distance targets such as the whiteboard and to complete near activities like writing or drawing. Zoe should have been able to complete independent activities without the help of her peers or teachers. Although Zoe knew how to use her technology tools, she chose not to use them for various tasks. In an ideal world, Zoe would use features such as speech-to-text, text-to-speech, zoom, spell check, and copy-paste consistently to access digital print. She would use her video magnifier to follow along with classroom instructions on smartboards or when she needed to complete near activities. She would advocate getting personalized digital copies of classroom notes and classroom assignments. But all the failures of access were not only due to Zoe's lack of self-advocacy skills. Other factors beyond her control caused Zoe to be dependent on her peers and adults. The use of inaccessible online learning platforms, websites, and assessments was highly frustrating for a student like Zoe who wanted to be no different from her peers. Zoe had the desire to succeed. However, her inability to access classroom materials due to her vision loss caused her to be distracted and impacted her academic performance.

Ella*:* Motorized Scooter Rider

It was Valentine's Day when I met Ella for the first time. Ella was a sweet and shy girl. The first thing I noticed about Ella was that she did not want to stand out or be different from her peers. She was super conscious about her environment, and she wanted to blend in. Teachers in her school reported that outside of school, Ella was fearless when she rode her motorized scooter. Ella loved spending time with her sisters, especially doing crafts with them. Ella was interested in reading, collecting fidgets, drawing, and dogs. According to her prior reports, Ella's favorite classes at school were Art, Social Studies, and Science. Apart from discussing how Ella saw her world, the following paragraphs narrate Ella's experiences with technology in general education classrooms dissected by the type of digital and non-digital activities she completed during the 2 days I observed her.

How Did Ella See the World?

Visual Diagnosis

Ella was new to the low-vision world. When she was in fifth grade, she was referred for special education due to a visual impairment that was affecting her access to the general education setting. Ella had a history of an eye condition called Staphylococcal Blepharitis which is a staph or bacterial infection that caused inflammation of the eyelids. In the year 2015, when Ella was 3 years old, she was diagnosed with corneal ulcers due to her staph infection. Corneal ulcers are open sores on the clear front surface of the eye (Knobbe, 2019). Corneal ulcers often cause eye pain, redness of the eyes, sensitivity to light, and blurry vision (Knobbe, 2019). According to Ella's medical history, Ella started having ulcers in her left eye in 2015, and by March, 2019, she had corneal ulcerations in both her eyes. Although Ella's vision in her left eye was significantly impaired from the beginning, she went from having a perfect vision of 20/20 in

2018 to having 20/230 in her right eye. Ella had been continuing her treatment for the staph infection since 2018. In April of 2022, Ella stated that her eyes were worse in the morning with increased light sensitivity and blurred vision. Ella experienced light sensitivity when she was outside, especially when it was snowy and sunny. According to her TVI, when Ella could not see the information, she often played with her fidgets and “zoned out” in classes. Her visual attention was improved with one-on-one instruction and when she could see learning materials that were being discussed. Ella also struggled with contrast sensitivity. As per reports, Ella was able to identify the boldest line in the Lea Hyvarinen Test of Contrast and she accessed the next line with hesitance. Despite her difficulties with distance vision and light sensitivity, teachers have reported that Ella swiftly zips her way out of the school parking lot on her motorized scooter! Ella had no other concerns or disabilities that impacted her access to the general education curriculum.

How Did Ella See Distant Targets?

Ella’s distance visual acuity was 10/400 which was equivalent to having a distance acuity of 20/800. This means what a person with 20/20 vision saw at 800 feet, Ella saw the details of the same target only when she got as close as 20 feet from it. Ella needed to be as close as 3 feet from people to understand facial expressions. Ella used a portable video magnifier called the CloverBook to access distant and near targets. When Ella did not have her CloverBook, she could not see anything at a distance of more than 3 feet from her, causing her to quickly lose engagement.

How Did Ella See Near Targets?

Ella needed her print to be in 36-point font to efficiently access it without any eye fatigue. Figure 7 shows the 36-point font size that Ella needed to access her print. In addition, Ella’s ability to read a smaller font (18-point font or Large Print) improved with reverse contrast (light letters against a dark background). Figure 8 shows the 18-point font that Ella could read when the contrast was reversed. When Ella was doing any near tasks such as reading and writing, she needed access to a video magnifier, hand-held magnifier, and/or printed learning materials that were magnified to 36-point font. Ella also required magnification to access digital print. She visually oversaw mistakes in her typing when the digital print was not magnified enough. Although Ella could see better in reverse-contrast settings and she had been taught how to turn on the reverse contrast on her computer, Ella never used them. Similarly, Ella’s Math teacher reported how Ella preferred her homework sheets to be magnified on the same size of paper given to her peers rather than on a bigger paper.

> We did also find out that we were copying her worksheets like bigger and she hated that. So we copied it bigger on the same size paper and so it took us a little while to figure that out. So I think she doesn't like that it's so glaring that it is different.

Figure 7

Ella: 36-Point Font Size Required for Print Access

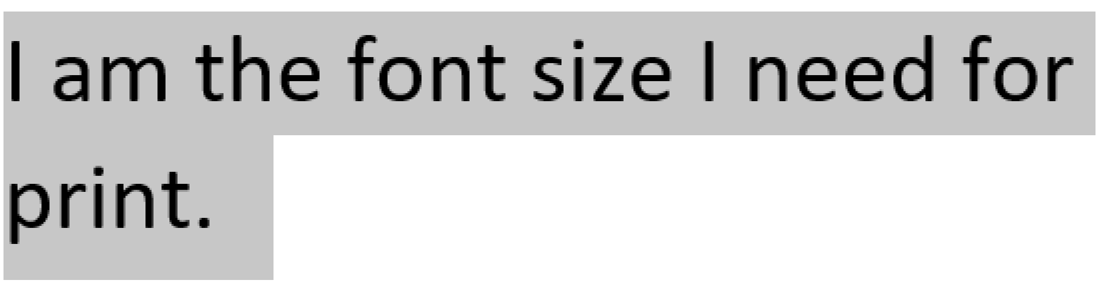


Figure 8

Ella: 18-Point Font Size in Reverse Contrast

Simulation of Ella's Vision

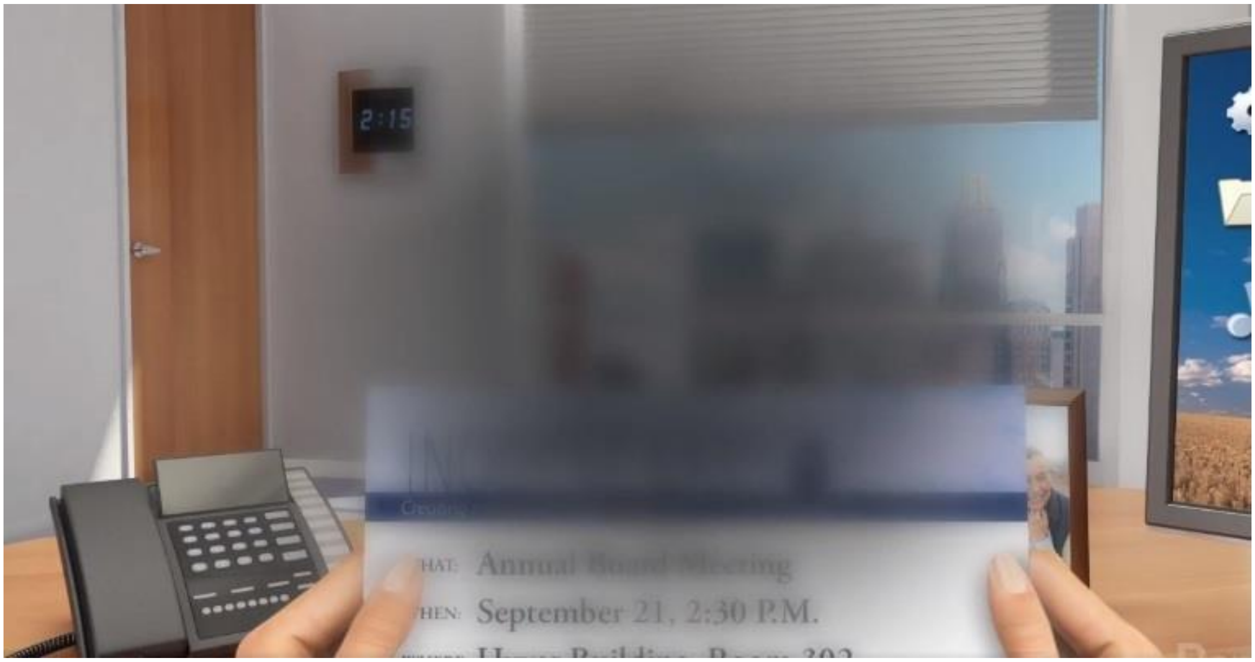
While researching for simulations for corneal ulcers, I found a video on the website of an eye center, Bennett and Bloom, located in Kentucky. From taking snapshots from the simulation video, Figure 9 and Figure 10 approximately describes Ella's visual world. Figure 10 shows an approximate distance and near view that Ella saw as compared to the typical view shown in Figure 9. As depicted below, Ella's distance vision was highly compromised due to corneal ulcers. Her near vision with high contrast was comparatively better for her. While this simulated vision might not perfectly represent what all individuals with corneal ulcers see, it is a fair representation of the visual loss for the general public to understand the condition.

Figure 9

Typical View of Distant and Near Targets

Figure 10

Approximate Simulation of Distant and Near Targets as Seen by Ella



One Day in Ella's School

Before we follow Ella in her school, we need to understand what accommodations she was entitled to according to her IEP. Also, we need to understand how her teachers were collaborating to ensure her access to classroom materials at the same time as her sighted peers. Table 10 lists the accommodations from her IEP and a description of where such accommodations could be used.

Table 10

Ella's IEP Accommodations

Accommodations	Description of places of use
Teachers must write on board with thick dry-erase markers; Thick writing utensils (normal sized Sharpie) for writing on paper that will be presented on the overhead; Verbal descriptions of instructions; Provide own copy of materials; Verbal checks for understanding directions.	Classes where instructions are presented on the smartboard or whiteboard.
Appropriate lighting for all academic tasks; Access to a lighted workspace; Preferential seating;	Classrooms where Ella needs to move around the class to view materials
Enlarged materials as needed, 18-point font or larger if she is not using a low-vision tool; Bold line paper and bold writing utensils	When Ella is not using her video magnifier to access near activities, 36-point font of print is recommended. When classwork is expected to be completed on paper, she needs bold/darker writing tools.
Access to audiobooks	In all of her classes where there are reading books and printed passages.
Encourage independence; All teachers (including specials) need to be aware of Ella's visual concerns as they may not be readily observable.	In any setting where Ella needs to be independent.

How were Ella's Teachers Making Content Accessible for Her?

Ella's TVI reported that she sent emails to all of Ella's general education teachers at the beginning of the year to ensure her IEP accommodations were in place in the general education classes. According to her TVI, Ella's Math teacher was the only one who used the vision team to enlarge materials or followed up on visual accommodations for lessons.

> Oh my goodness, I send an email all the time about, I will enlarge stuff, can you please send her stuff digitally, so she doesn't have to read it, she can listen to it. Can you please make sure you're encouraging her to get her device out. . . . Ms. Olivia [Math teacher] is the only one who ever emails me back. She is the only one that uses that enlarged materials for her.

Ella's Math teacher said that every week, the TVI and her assistant took classroom materials from her website, magnified them, printed them, and dropped them off at school. Ella used the magnified classwork and homework the following week. Ella used a video magnifier in all her classes to see the smartboard and whiteboard. However, Ella resisted using any other tools such as magnified print on large-size paper, higher contrast on her computer, or magnified digital print. Ella did not want to look different from her peers and would not advocate for her needs if she was not comfortable in the class. She often faked her vision so that teachers did not notice her difficulties. In discussing Ella's ability to access her classroom content, her Math teacher reported, "I think this is something that I have been very curious about this year. . . . I wonder how much of her difficulties come from accessibility, versus like not understanding the material." Although Ella had improved in using her device since the beginning of the year, she still would not seek out help from her teachers or her peers. Her teachers said that on occasions when Ella whispered to her friend asking a question, they knew that she was engaged in her learning. In the remaining paragraphs of Ella's story, I will discuss my interpretation of Ella's experience with digital and non-digital activities.

Digital Activities

Digital activities are those that require a computer to be completed. During my observation in Ella's school, I noticed that there were very few digital activities in her general education classes. Even though the majority of her general education teachers used the smartboard to project digital media, Ella was presented with paper-based activities in most of her classes. I will narrate Ella's experience with digital media in two contexts, Social Studies and Assembly. These were the only two places where Ella used digital media beyond accessing the smartboard with her CloverBook.

Teaching to Create a Presentation. Ella enters the social studies classroom. She chooses to sit on a chair with her back facing the smartboard. Three other peers sit with her. The teacher tells the class that he will be showing sample slides for their upcoming group presentation on “Central America and the Caribbean.” The teacher switches off the light and projects a sample PowerPoint Slide on the smartboard. Ella does not have her device out. She is leaning over and fidgeting with a candy wrapper. The teacher says, “Everybody’s eyes up here, please.” Ella turns slightly sideways for a minute and then turns around to fidget with the candy wrapper. Within 10 min, two of her peers sitting with her are fidgeting with the candy wrappers too. As the teacher is explaining a slide on “Haiti,” he stops and explicitly turns toward Ella’s table and asks them to put away the candy wrappers and focus. Ella still doesn’t take her device out and chooses to just listen. The sample slide projected on the screen has several visual components that Ella cannot see without her device. One time, the teacher points at a dollar amount on a slide for $161.050. He is pointing at the amount and saying, “Look at this.” The dollar amount indicates the price for a flight ticket to Haiti. The rest of the class went “Ooooh.” Ella has no idea why the class is going “Ooooh.” The teacher then talks about the visual aspects of the slides. He explicitly instructs students to use small font sizes, more pictures, and less text when they work on their slides. Ella doesn’t have access to all the visuals that the teacher was either raving about or complaining about.

Working on the Presentation. After 10 days of group work, students are expected to complete their presentation slides in class. Ella gets her computer and sits on the floor in the back of the classroom. Three other group mates join her on the floor with their computers. After opening the slides on her computer, Ella is looking very closely at the screen. She does not attempt to magnify the print. She then takes her computer and waits in line to ask the teacher questions. When it is her turn, Ella asks the teacher questions. After clarifying her doubts, Ella gets back to the floor near her group. Ella is very engaged with the activity. She seems to be the only one in her group who is working on the presentation. The rest of the group members are throwing paper airplanes and laughing. Ella continues to work on her presentation until the bell rings.

At the Table with Dr. King--Assembly. Ella sits in the second row in the middle school auditorium. The stage is set with a piano and a small white screen. Two women and two men join the stage and take their positions on the stage. The auditorium is loud with sixth graders. The program starts with a video projected on the white screen. The screen is at least 20-30 feet from where Ella is sitting. The video is showing pictures of Dr. Martin Luther King Jr. without any audio descriptions. As the video is playing, the musicians are singing and slowly dancing on stage. Ella just listens. Quotes like “I have a dream,” “Birmingham Church tragedy,” or “What is more empty than a call without a response--Anonymous” are projected on the screen that sighted peers have visual access to. The man on stage asked the audience to stand and dance with him for the last song. Ella stands up and looks at her neighbors dancing. She does not dance or even wave. When the final song ended, she is quick to leave the auditorium to go to her next class.

Non-Digital Activities

During the 2 days I observed Ella, much of the classwork or many class tests were paper-based. Some of the classwork was created by the teachers themselves. It is interesting to note that all of the work was created digitally and then printed out on paper for students to complete.

Vocabulary Unit. In reading class, the teacher asks students to pull out their vocabulary packet, “In-Context Predictions.” Ella gets her packet which is not magnified. The teacher projects the first page of the packet onto the smartboard using the Document Camera. Ella is seeing the smartboard with her device. The paper projected on the smartboard has two black and white pictures (not high contrast) with 10-point font size text. The teacher does not magnify the picture or words during instructions. The activity involves students understanding the meaning of the words using pictures, captions, and sentences. The teacher explains the activity by doing an example on the smartboard. As Ella sees the smartboard with her device, she circles/writes on her paper using a pencil. When she is writing, she bends over and writes 2-3 in from the paper. After the first example, the teacher gives the class 5 min to complete the remaining six words with their table mates. While working with her tablemates, Ella just listens. She is not writing or looking at the paper. The teacher calls out groups to come in front to explain the meaning of the words they worked on. Ella's group comes forward, and one of her peers projects his paper onto the smartboard. They worked on the word "deformed." The picture for the word was a slanted tree. Ella describes the picture, "It looks like something that is not supposed to be." Their group gives their answer as "misshaped" for the word "deformed." Ella uses her device to see the smartboard when other groups present their words. Ella is very close to the screen at 2-3 in. Ella struggles to see even when the vocabulary paper is projected on the smartboard. After all the groups finish presenting their findings, the teacher projects a slide from her computer. The pictures on the projected slide are the same pictures on the vocabulary packet that Ella was working on, except that they have colors, higher contrast, and bigger font. Ella uses her CloverBook to see the projected slides, but she copies the answers onto her packet without using any magnification. By the time Ella tries copying one sentence on her paper, the bell rings.

Sound Unit Assessment. Ella enters her science class and sits on a chair that is 10 feet from the board. The teacher tells the class that they will be doing an assessment on the Sound Unit. The teacher projects a review packet on the smartboard. The review packet was completed by the students a week ago. In the review packet, the font size of the print is very small and the diagrams are very light-colored. Even with the projection of the review packet, it is very hard to see. Ella attempts to use her device to look at the smartboard but then gives up. The teacher says, “This is different from this line,” and Ella just listens not knowing which line the teacher is pointing to. Ella loses engagement. The teacher distributes the assessment paper to all students. Ella’s paper is magnified. Ella starts writing on her paper by leaning in very close to the paper. The teacher stops by Ella’s desk and checks on her. Ella asks him a question and he answers. While working on her assessment, Ella is not referring to the review packet or the checklist that the teacher distributed earlier. About 2 min before the bell, Ella folds her assessment, puts it in the center of the table for the teacher to collect, packs her bag, and leaves the class.

Quiz on the Division of Fractions. In Math class, Ella has her device out with the camera pointing to the smartboard. The teacher sometimes uses the whiteboard, which is to the right of the smartboard, for instructions. The teacher uses multiple color markers when she is writing on the board. Ella changes the camera of her device to either the whiteboard or smartboard according to where the teacher is instructing. The teacher distributes a quiz on “Fraction Division” to all her students. Ella’s copy of the quiz is not magnified. Ella does not use her magnification device to work on the quiz. The teacher helps Ella draw an “area model” on her quiz paper. Ella continues to do the quiz without any magnification and at 2-3 in from the paper.

Parts of Speech Packet. In LA class, the teacher distributes a Parts of Speech packet to all the students. It is an individual activity. Ella’s packet is magnified. Ella is not using her device and writes answers on her packet 2-3 in from the paper. The classroom has several posters on the wall on Parts of Speech (articles, conjunction, verbs, preposition, nouns, adjectives, adverbs, and pronouns). Ella cannot see any of the posters without her device. Ella chooses not to use her device in this class to complete the activity.

How Did Ella's Ideal World Compare to Her Real World?

In an ideal world, Ella would have the same level of engagement in whole group instructions and activities as she had for independent activities. Ella would not feel different when she was using tools that met her needs. Accessing distant targets was the hardest for Ella. Considering her difficulties with distant targets and her preference for not appearing different from her peers, mainstream tools such as an iPad or a touchscreen computer would help Ella have consistent access. An iPad would give her access to distant video demonstrations such as an assembly and would not make her feel different using the device. When digital copies of classwork and homework were shared with her, she could magnify using built-in magnification features on her computer. When teachers used smartboard presentations involving Google Docs or Google Slides, a personal copy of those would help Ella access them on her computer instead of being distracted. Ella's engagement with distant activities was directly related to her struggles with her distance vision. Making sure all of her IEP accommodations of using higher contrast markers on the board, bigger font, and checking in with her about access are the most important steps one could take in Ella's current world.

Experiences in Technology-Rich Classrooms

A cross-case analysis of observation field notes, interviews, and educational documents revealed four broad themes. In this section, an account of the four themes that emerged from the cross-case analysis is presented. My first research question was: How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms? Two main themes emerged regarding how middle school students experienced technology: (1) Technology is imperative in general education classrooms; and (2) Frustrations with accessibility issues in general education classrooms. My second research question was: How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms? The most significant common theme that emerged from observing general education teachers and interviewing three of them was: For general education teachers, it is a learning curve. My final research question was: How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms? The overarching theme amongst TVIs was: The buck stops with TVIs when it comes to access technology. Participants' perceptions and opinions intertwined with my reflections on each of the above four thematic areas are discussed in the next few paragraphs. Table 11 is a quick reference for the four themes, sub-themes, and related research questions that the themes addressed. The graphic for the 4 major themes and the 11 sub-themes is shown in Appendix O.

Table 11

Themes, Sub-Themes, and Related Research Questions

Themes	Sub-Themes	Related research question
Theme 1: Technology is imperative in general education classrooms	The explosion of technology in classrooms Use of mainstream technology Technology provides student choice and advocacy	Q1: How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms?
Theme 2: Frustrations with accessibility issues	Just listening--no visual access Inaccessible classroom activities	Q1: How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms?
Theme 3: For general education teachers, it is a learning curve	Teamwork is critical for access Showing flexibility--willing to differentiate Open to training	Q2: How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms?
Theme 4: The buck stops with TVIs when it comes to access technologies	Minimal training in access technology Frustrations with assessments Need for support in access technologies	Q3: How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms?

Theme 1: Technology is Imperative in General Education Classrooms

The common theme that emerged from all participants (students, general education teachers, and TVIs) was that technology was imperative and allowed access for students with VI in general education classrooms. As stated by Zoe’s LA teacher:

> I mean it is imperative. Technology is absolutely and I honestly don’t know how people would have done it before. It allows us to find ways to accommodate and meet their needs but also in ways that we can understand and we can access it as well. So technology is imperative.

Technology tools such as a braille display gave braille readers access to content at the same time as their peers. In using his BNT in his classrooms, Luke said, “It feels better to be able to do the assignments faster and follow along more." Apart from having access at the same time as sighted peers, technology helped students get access to the same content. Ella's TVI explained:

> It's just an integral part. . . . So like first graders are using laptops, so should our first graders that have visual impairments. They should also be using laptops. So we need to make sure that those are set up and accessible. So they need to be having the same access as everybody else. So technology gives them that access.

The Explosion of Technology in Classrooms

Observation of all three students revealed that technologies such as slides, documents, and videos were used consistently in all general education classrooms. Digital media was used in classrooms as a way to meet the needs of more students. According to Zoe's LA teacher, technology "opens up more possibilities to reach all the kids where they are at and what they need." Luke's LA teacher stated:

> Videos increase student engagement. Interactive things like when they can drag things or highlight things increase student engagement. Flocabulary [vocabulary game] . . . it's a matching kind of game and videos increase student engagement.

During the pandemic, COVID-19, in an effort to share programs that worked for students in an online platform, many teachers created lessons and shared them in social media groups and through relevant learning community channels. For example, Ella's LA teacher said that she started using a math program called DESMOS during COVID-19 which she thought was very effective for her students. She continued to use it in her classrooms even after the pandemic.

> I use DESMOS which is this great online Math tool that kind of build lessons into I want, say slides. . . . It's super interactive. It can be programmed. . . . People have like made

> things that they share. . . . It's kind of like if you were to make an interactive lesson, then upload it to DESMOS. . . . It is just out there for people to use it for free.

Free access to shared technology programs led general education teachers to use digital programs that were more interactive than accessible. Unfortunately, videos that were not described or interactive games that involved matching pictures were inaccessible to tactile or low-vision learners. However, if educators chose programs that were designed to be accessed through visual, auditory, or tactile modes, it would benefit all students. Luke's TVI noted:

> So, I think it's just a matter of teachers considering multiple strategies that cover everybody. . . . To be honest, I don't think they have the time to do it, and I don't. There's no blame there or like high level of judgment. It's just they're doing the best they can with some and the vision stuff is easy. It's visual. Everyone's going to see this and get it, you know.

Use of Mainstream Technology

The most common mainstream technologies used in all general education classrooms were computers. Students with VI preferred using mainstream tools over VI-specific devices because they felt less different and more included. In her interview, Ella's TVI said, "I feel like the isolation comes in if the technology is different than what others are using. I feel like, if it's the same, then it's just there, just included a lot better." Accessing the smartboard was a challenge for all three students. However, if such access was provided through mainstream technology tools such as a Document Camera or an iPad, students seemed to consistently use them more than using VI-specific tools such as the CloverBook or the Jupiter. Zoe used her iPad to take a picture of her board rather than using her Jupiter. Similarly, Ella engaged with Google Slides on her computer rather than using her CloverBook to access slides on the smartboard.

The built-in accessibility features that were most commonly used by all students were magnification, text-to-speech, and speech-to-text. Zoe described her experience with mainstream accessibility tools as:

> Speech-to-text is really helpful for me. I usually use it when I am texting. . . . I've learned that with computers like there is a button so you can do speech-to-text on Google Docs. So that helps me a lot. I could type things or I could do speech-to-text.

All three of them used magnification features when they were accessing digital print either on their iPad or a touch-screen computer. However, magnifying too much or changing contrast, features that made their computer screen look different from their peers, were not used in classrooms even if the students needed them.

Technology Providing Student Choice and Advocacy

Although access to email, slides, documents, and websites were achieved by all three students in different ways, they were still accessing them at the same time as their peers. Luke used his BNT to access his Gmail account to check emails, Google Drive, and Google Docs. Using braille, he accessed all adapted classroom content with Google Docs and classroom tests using Google Forms. On accessing digital content using his BNT, Luke said, "It allows me to work more efficiently and complete assignments, usually more on time than like if I was using a brailler in braille paper or a physical paper." Ella and Zoe accessed all digital media using their touchscreen computer or iPad.

At any given time in general education classes, students had access to several devices that they could choose from to meet their needs. Ella reported, "I have access to the stuff that I need to have access to." Even though there were several choices for devices, students still needed to self-advocate to efficiently access their learning content. Zoe described her situation:

> I usually try to figure it out at first for a few minutes. If I can't figure it out, then I usually go to the teacher and tell them, I say "Hey, I can't work out this machine, so I don't think I'll be able to get this assignment done in class right now. . . . Is there like an alternative that we could use?"

The biggest advantage of having choices was that it gave students more practice in using the preferred method of access. Having tried different access devices, Luke and his teachers knew that the learning platform Schoology was not accessible in his BNT. They had learned that the Google Platform could be accessed using his BNT. Luke had practiced using his BNT to access Google Docs in all his general education classes. "When things are accessible, I can do the learning at the same speed as everybody else." In using a Document Camera to follow along with whole-group instructions on a smart board, Zoe reported "It'd be easier for me to follow along with the lesson." Ella was the most engaged when she was working on her computer on Google Slides in social studies class. Not wanting to be different, Ella preferred mainstream devices that accommodated her needs through built-in accessibility tools such as voice typing. "I like it a lot. It is helpful if my eyes are like tired that day." The use of preferred technology tools created more practice for students and thereby made it more efficient for them to access learning content in their classrooms.

Theme 2: Frustrations with Accessibility Issues

Mostly, students in this study were not observed to be frustrated with accessibility issues in classrooms. They were accessing their general education content using their preferred tools. However, educators, especially TVIs, reported their frustration when they could not help their student access content in their classrooms. Even with IEP accommodations, there were situations where the TVIs felt that their students were not completely included.

Just Listening--No Visual Access

All three students, Luke, Zoe, and Ella, did not have complete access to whole-group instructions involving the smartboard or whiteboard. Luke did not have enough vision to access distant targets. Although Ella accessed the smartboard or the whiteboard using her CloverBook, when teachers did not magnify the projected print, she could not see the details even with her device. Zoe used her Jupiter to access the board, but when she needed to copy something from the board, she had to go back and forth from her device to her computer which made it really hard for her. Due to the above challenges, all three students listened to instructions on the board instead of visually accessing them. In Ella's case, inaccessibility to smartboard instructions kept her disengaged from the learning task. On Luke's access to the smart board, his TVI said:

> There's so much they are doing up on the board and there is so much more content now that is up on the board than there used to be, that there is just not a way to manage to braille all of that for him every single day all the time, and so I worry about my students who aren't strong auditorily.

The majority of the videos used in classrooms were not audio-described. Out of all the general education classes I observed for 6 days, there were only two classes where videos were described auditorily for students. Both of the classes were in Luke's school. Luke's Science teacher chose to use a relevant video from DCMP that was audio-described. Luke's LA teacher described a silent video auditorily when teaching a new standard on visuals. Videos used in assemblies or presentations were not audio-described. For accessing assemblies, Ella said, "Sometimes I can just listen. Sometimes I have to use the device. In assemblies, I don't really have to." When videos and presentations were not audio-described, students with VI could easily lose focus or be left out of the conversation. Ella could have participated more during assembly if only she had access to the videos describing moments in Martin Luther King Junior's life. Not having access to instructional videos or presentations could make the student passive in their learning. Ella's TVI described Ella as "a very passive learner. She has really learned that she can get by just sitting there and then keep moving through the system. Unfortunately, it is really hurting her."

Inaccessible Classroom Activities

Activities that involved inaccessible visuals were frustrating for students with VI. Luke said that it was very hard for him when teachers asked him to match pictures to words when the pictures were not described. Similarly, Zoe described her frustration in accessing maps as:

> She gives us maps. We have to memorize . . . we'd have to do this map thing, these map keepers, and that would be really hard for me because I'd have to go back and forth, try to find the exact spot, have to write it down there. It was really hard for me. . . . I'm not focusing on memorizing it. I'm focusing on getting it done.

Oftentimes, non-digital, paper-based visual activities were not accessible for students with VI. Activities that involved making a stencil in Zoe's art class, a picture dictionary in Luke's Spanish class, or a unit test with pencil and paper in Ella's science class were frustrating for students with VI even with the help of magnification devices. Zoe's LA teacher felt that activities that involved writing on the board were impeding Zoe from learning content in her class. "When we write on the board and do some of the old-school stuff, that is impeding more than anything else."

When classroom activities were not easily accessible, students became dependent on their teachers or peers to help them. Zoe said that she needed help from teachers to login into an application or program on her computer because the buttons on the menu were very small. "They tell me what to press because it's super small. . . . So you are supposed to tap this and then tap it, and then they walk me through it side by side." Ella shared that her friends sometimes helped her write down content from their notebooks when she did not have her device to access the smartboard. Similarly, Luke reported that he needed help from his peers during group projects. "If we are doing a group project, they'll tell me what to write down or they'll tell me what the assignment is titled so that I can see if it is in my Google Drive Folder."

All three of the students in this multiple case study shared that their eyes got very tired after prolonged use of vision. When a website was not screen-reader friendly or could not be magnified, Luke, Ella, and Zoe looked very close at the computer screen leading to visual fatigue. Luke said that it was very hard for him to focus on classroom activities visually for too long because the materials would get blurry. Ella's TVI reported that some online assessments were visually taxing for Ella. "They are very visually fatiguing . . . so that's just going to wear her out." Apart from visual fatigue, classroom activities that were considered to be completed by sighted students without any accommodations were very time-consuming for students with VI. According to Zoe's TVI, "I do not feel that she [Zoe] can complete the volume of work, even with she's got an IEP accommodation of prioritized assignments because they're gonna have to let some of this stuff go." Luke's LA teacher shared that he took a significantly longer time to read braille. "He comprehends everything just fine. I mean he is doing really well in my class. But it takes a lot longer."

Students, general education teachers, and TVIs understood that the IEP was a legal document and schools should abide by them by law. However, none of the participants had any knowledge about accessibility laws beyond IDEA and the IEP. Before becoming a TVI, Luke's TVI used to run a college disability service office. She felt that accessibility laws in K-12 schools were not implemented at all.

> Statewide, we use Infinite Campus . . . a lot of my students within braille readers or low-vision users, they have difficulties with the app. It's not screen-reader friendly. It's not Zoom-Text friendly. I know our websites, our own school district is not accessible.

Apart from limited knowledge of the existence of accessibility laws, both special and general educators did not know how to assess the accessibility of websites, videos, images, or any digital media. The TVIs felt that making websites or digital media accessible was beyond their reach. Regarding her knowledge about accessibility laws in K-12 schools, Zoe's TVI pointed out that "I think a lot of people just don't know where to even go. . . . I'm thinking if someone told me you have to make your website accessible . . . would I know who to reach out to in my district?"

Theme 3: For General Education Teachers, it is a Learning Curve

All three general education teachers who were interviewed for this study had limited experience with students with low vision. Ella's Math teacher described her experience:

> Very limited, I mean other than students who need glasses . . . like you know looking for kids for like squinting, or you know suggesting to parents that they might need an updated prescription, [Ella] is the first student that I've ever had with a visual impairment at her level.

Luke's LA teacher said that Luke was the first student she had with significant VI in her 23 years of teaching career. She has had a couple of students in the past with color blindness and extreme near-sightedness. Although Zoe's LA teacher had worked with a completely blind student 12 years ago, her experience of having Zoe in her class was totally different for her. She felt that the technology that was available 12 years ago had changed dramatically and that she was still learning and exploring different ways to provide access for Zoe.

Teamwork is Critical for Access

All general education teachers depended on their students with VI or their TVIs to understand the accommodations that needed to be implemented in their classrooms. Zoe's LA teacher shared that the relationship she had with the vision team was very important. "It just, it's an important relationship. Obviously, they are wonderful, and they are willing to help me as I ask questions." General education teachers often implemented IEP accommodations without understanding how best to do it. Lack of collaboration could cause inaccessible materials for students with VI. For example, Ella's Science teacher printed out a magnified version of a test he created in Google Docs. If he had collaborated with Ella's TVI, he would have known the benefits of sharing the test in a digital format. Sharing the digital copy of the test with Ella would have helped her access the test better than the printed version. Ella's Math teacher said that her collaboration with the TVI was important to make sure the IEP accommodations were implemented: "There is also like another teacher [TVI] who is like an expert and that support to make sure that the rules of the IEP are being followed." Although Luke's LA teacher met his TVI when she needed her, she felt that the TVI collaborated more in subject areas like science, math, or social studies. "I am a low man on the totem pole. . . . I convert almost everything for him myself."

Showing Flexibility--Willing to Differentiate

All general education teachers were willing to adapt and accommodate to support the inclusion of students with VI in their classes. Ella's Math teacher made things accessible to her as long as it was within her control. "What can we control, we try to make things at a level that are accessible for her so she doesn't choose to opt-out." Luke's LA teacher differentiated her content when the programs she used in class were not accessible.

> Programs that I use are not at all visually impaired-friendly. So, I had to convert a lot of things to Google Docs or I've had to do like a screencast of a video, and then email to him separately, since he can access the program that way.

Zoe's LA teacher reported that she had never discouraged Zoe when she advocated for her needs. "I think I am happy that she is doing that . . . because she's in such a unique place that we need to support her and help her as she begins this journey."

Open to Training

Considering their limited experience in the low-vision world, all three general education teachers were willing to learn new technologies that supported their students. Ella's Math teacher shared:

> We used to have this super robust Ed Tech department and it was amazing and then they got rid of it, and I don't really know why . . . it was a lot more like what can you do for universal instruction, but anytime you had a question about accessibility features . . . like I need help with on specific front, they would be willing to like "Here is the list of tools that you can use."

Zoe's LA teacher said that she learned from her students when she used technology tools that she was not familiar with. "I am not a digital native. . . . So, I love what students bring to me . . . I have learned about a lot of different things out there from the kids like Pick Fix, Canva." If general education teachers were trained on how to make an accessible PowerPoint slide, how to use text-to-speech software to complete a research activity, or how to describe picture images in Google or Word documents, it would have made a huge difference in Luke's, Ella's, and Zoe's access in the general education classrooms. Overall, general education teachers were willing to be trained on access methods that met the needs of their students. Ella's Math teacher said that she embraced any suggestions for access. “Anytime somebody provides a suggestion, you’re like, thank you, let’s try that, and let’s see how that works.” Luke’s LA teacher felt that she was still learning about the efficient use of technology to help support Luke in her class:

> And so every time I have a student that has something that I’ve never taught before, it’s a learning curve, but it’s also an experience, and like I get to push myself as a teacher to make sure that I’m meeting the needs of my students.

Theme 4: The Buck Stops with Teachers of Students with Visual Impairment When it Comes to Access Technologies

In Chapter I, I described my colleagues calling me the “technology guru.” Like me, all the TVIs I interviewed in this study enjoyed problem-solving and providing the right access to their students. Ella’s TVI who had been working in this field for 21 years reported that her favorite part of her job was to problem-solve access for her students. “I like just kind of the problem-solving aspect and making sure that you know that we could figure out ways for kids to have access.” Zoe’s TVI shared that she was making a difference in her student’s life as she provided a service that helped them have full access to their classrooms and beyond. Luke’s TVI loved to see her students grow: “I love seeing my students grow, and especially love seeing when they do things that I didn’t initially think they could do on their own.”

Minimal Training in Access Technology

Despite the “want” to make learning content accessible through technologies, TVIs felt that they were left alone to explore options for their students. In her demographic form, Ella’s TVI wrote, “Technology (thankfully) is evolving. My challenge is simply knowing what is out there for students. Once I obtain the device, I am pretty good at figuring it out and getting it to student’s hands.” Both Luke’s and Ella’s TVI completed their TVI certification program in another state. Both of them reported that they had basic training on various VI-specific devices such as braille displays and screen readers. However, as the technologies had changed so dramatically, they had to do a lot of on-the-job training. Luke's TVI described her training:

> We had a class that was specific to assistive technology. So, we were trained on the basics like the very very basics of screen readers, zoom technology on the computer. And then we were required to go and explore various types of braille displays on our own time. So I have a like decent exposure, and then everything else is on-the-job training.

Zoe's TVI completed her certification program in the state of Colorado and indicated that the minimal training she had at her university was not entirely relevant to what she had to learn for her job.

> I don't think we're given a ton of instruction when you go through the program on using tech. I say this with a little bit of embarrassment. But I have gotten information on how to use the technology through YouTube videos, calling Hotline, calling APH, and everyone is so nice. But sometimes I ask questions, and I feel like "Shouldn't I know, shouldn't I know this?"

One of the biggest struggles that TVIs faced was to help connect VI-specific devices to mainstream applications and programs. Zoe's TVI gave a beautiful example that summarized this struggle. She said that she had to call the American Printing House (APH), an organization that manufactured several VI-specific devices, three times to set up Chameleon (a type of braille display manufactured by APH):

> The first time was to get it connected to our iPad. The second time as to get it connected to the Chromebook . . . when I called the second time, I was told that the built-in screen reader, ChromeVox . . . has its own coding that could be misinterpreting the signals from

> the braille display, so it could be an issue with ChromeVox and not, you know, not the Chameleon itself. . . . So we bring out a Dell. . . . I call back again and she said "Do you have JAWS or NVDA installed on the Dell?" No way!

As technology was playing a very big part, especially post-COVID-19, Luke's TVI said that they had to figure out how to make some of those technologies accessible to her students.

> Especially post-COVID, we have more and more teachers who are using like different apps. Like one that was new to me the other day was something called Padlet . . . a lot of different online learning platforms that they're using. And so it's now trying to figure out how and if some of these are accessible to our kids.

When there was minimal training or support for accessible technologies, TVIs found alternatives to support their students' access. All three TVIs in this study supported their students with VI by seeing them one-on-one outside of general education classrooms for at least 30 min a week. Oftentimes, they explored different technologies for accessing classroom content during this pull-out time. Luke's TVI said that she used her one-on-one time with her students to explore technologies that built independence for them: "Definitely find what's motivating to build independence for them, and then spend that one-on-one time to build the skills there." Even after trying different devices during the one-on-one time, TVIs felt that they could not force their students in using them. Ella's TVI stated:

> I bring in this device. And the kid is like not using it . . . then it's like "What is going on, why don't you like it, come on?" These are some other things. Let's try and bring something else . . . "would you like this one or this one?" . . . they need to have some control over their world, and if they can find another way to access, then I honor that. If

> they aren't finding another way to access, then sorry, we got to figure something out. – Ella's TVI.

Even after TVIs figured out the correct technology that worked for their students, environmental constraints such as space in classrooms impacted their students' access. Although Luke, Zoe, and Ella all had portable devices, desk spaces to place their portable device and sometimes two devices became a limitation for access. Desk space to keep the devices and getting the space in classrooms to charge the devices became critical for students' access. Ellas' TVI noted:

> Yeah. Unfortunately, it's pretty huge, right? And we don't always have the UDL teachers that would be willing to move desks around. So it is nice when you can get a device that can be flexible so that the kid doesn't always have to sit in the center, right in front of the board . . . they can be more flexible.

All three TVIs in the study had added specific accommodations in their students' IEP related to creating space for storing and charging devices in general education classrooms. For example, Zoe had an IEP accommodation that stated, "Extra space for materials and assistive technology integrated into the classroom seating arrangement; Access to the space for charging devices." Luke's TVI stated, "It makes what we're doing a little bit more difficult in making sure they have everything they need in the classroom all the time."

Frustrations with Assessments

When students with VI needed to participate in school, district, or state assessments, TVIs were involved in making sure that the IEP accommodations were appropriate for those assessments. All the TVIs in this study indicated that some of the online assessments were challenging for their students with VI. Ella's TVI described an online assessment that her high school student took as “I think they are really horrible. . . . I have sat with one of my high schoolers and he gets these migraines from doing them because it’s just so visually taxing.” Zoe’s TVI reported that it took Ella multiple days to complete an assessment in iReady, an online testing program used in many school districts. Her TVI had to take pictures of the assessments and magnify them on an iPad for Zoe to be able to see because the test could not be magnified big enough to meet Zoe’s needs. As Luke relied on screen readers and braille, his TVI said that she had to make things on the fly, especially on assessments where the questions changed according to how students answered them. Luke’s TVI described her experience helping him access MAPS, one such dynamic assessment program as:

> Right now, the one that our district uses is MAPS. That one, early on, I would adapt things on the fly with him. . . . So we just kind of do it online and make things on the play. Now he slowly relies on the auditory descriptions that MAPS provides through JAWS. . . . I would say his scores in Math are lower than what they actually are because he doesn’t have tactile access. Reading, he shows up a lot higher, because all he’s doing is listening.

TVIs reported that using a paper version in braille or a regular test under a magnifier was visually less taxing than trying to manipulate online tests for their students. “I do feel that it’s [paper] the best method of access, the paper copy and a video magnifier for a lot of our students.” TVIs also felt that there were not many choices for measurable benchmark assessments for students with VI that weren’t computerized. But for tests that did matter such as the standardized tests like the Scholastic Assessment Tests (SATs) that is given to high school students, Ella’s TVI had used the practice tests to figure out the accommodations that worked for her students with VI.

> We did the practice SAT three times before, you know, we got the accommodations exactly what she needed . . . because it was like too exhausting or too fast, or too slow . . . I do think that there is benefit to figure out what accommodations the kids need for the tests that do matter.

Need for Support in Access Technology

Considering the explosion of technology used in classrooms and the minimal training that educators had received with respect to access technologies, the TVIs in this study suggested the need for support to help them do their job better. Luke's TVI suggested training to include how VI-specific devices work with classroom technologies.

> What do you do when Google Classroom doesn't work with JAWS . . . what's your backup plan? There are the things that I don't think everybody realizes. . . . You're on your own to figure out most of the time.

Ella's TVI expressed that the training she needed was more on "access" rather than "device" support.

> I think it should be presented less about the device and more about access. So this kid needs to have an OCR for near-vision reading. So you know, this is what you could look at for this situation. . . . Rather than going and saying, "Here is the Jordy, this what it does. Here is the CloverBook, here is what it does."

All the TVIs in this study received support with technology issues by seeking out learning communities such as the TVI ListServ, newsletters, or social media. They got their answers to questions by reaching out to other TVIs in the state and in the nation. However, they worried about TVIs who were left alone to serve small communities that weren't resourceful, as Zoe's TVI explained:

> I worry so much about the new TVIs in our state who do not have the benefit of working in a large district. . . . I have talked to TVIs who didn't know there were Quota funds available, had never ordered. And I think that's a huge missed opportunity for some technology that students are entitled to.

Conclusion

This chapter discussed the results of the within-case and cross-case analysis. Experiences of three middle school students with VI in general education classrooms were described. My interpretation of student experiences collected from demographics, educational documents, interviews, and observation field notes was narrated as individual stories. Each student's story included the components: (a) how did they see their world?; (b) how did they experience their school day?; and (c) how did their ideal world compare to their real world? Luke, a lover of all things technology, felt very happy when he was able to access learning content at the same time as his peers. Zoe, a social butterfly, loved to participate in group projects. And finally, Ella, a shy skateboard rider, preferred technologies that did not make her feel different. This chapter also discussed common themes that emerged from the cross-case analysis. I presented themes in alignment with my research inquiry. Four broad themes emerged. The first theme was that technology is imperative in general education classrooms. The use of mainstream technology tools helped facilitate the inclusion of students with VI in general education classrooms. Students preferred the use of built-in accessibility features in mainstream technology as it made them look less different. Using technology in classrooms gave students more choices for accessing digital content. Having more choices in technology allowed students to advocate for their needs using their preferred methods of access. The more students used their preferred technology in classrooms, the more efficient they became in meeting their needs.

The second theme that emerged was frustrations with accessibility issues in general education classrooms. Educators, especially TVIs, expressed more frustrations with inaccessibility than students. Students often just listened to smartboard or whiteboard instructions as they were not able to visually access them. Videos and presentations in classrooms were not audio-described, so students could not follow along in classes. Inaccessible classroom activities were those that: (a) involved visuals, (b) created a dependency on peers and teachers, (c) caused more visual fatigue, and finally (d) were time-consuming. The third theme that emerged was related to the support that general education teachers provided for their students with VI. All participants in this study who were general education teachers expressed that having students with VI in their classrooms had been a learning curve for them. They all had limited experience with students with VI. General education teachers reported that teamwork with TVIs was critical for successful student access. General education teachers were willing to be flexible and to differentiate their lessons to accommodate the needs of students with VI. They were open to more training on technology tools that met the needs of all of their students.

The fourth theme that emerged was related to the support that TVIs provided for their students in accessing and using technologies in general education classrooms. All TVIs expressed that the buck stops with them when it came to access technologies. They were often on their own to problem-solve issues such as how to: (a) access mainstream technology using VI-specific devices, (b) use alternative technologies based on student engagement and accessibility, and (c) solve environmental constraints for best access in classrooms. All TVIs in this study expressed their frustrations around helping students access school-based or district-based online assessments. In this chapter, the readers got a glimpse of a technology-rich low vision world. In the next chapter, I will discuss findings in relation to prior literature and implications for practice.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Intending to understand educational practices in technology-rich classrooms for students with VI, the research questions explored in this study were:

Q1 How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms?

Q2 How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms?

Q3 How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms?

Based on the findings of this study from the cross-case analysis, I will first discuss my reflection on students' experiences with technology and how it intertwines with my knowledge and experiences as an educator in this discipline. Then I will discuss the findings of this study in relation to the current research literature.

Reflection

I used reflexive journals to constantly bridle my bias throughout this research journey. Hence the interpretation of findings in this study is strongly influenced by some of the biases I had due to my background knowledge and experience as a practicing TVI. Moreover, as a TVI, my past experiences with students accessing technologies in inclusive classrooms also strengthened my ability to effectively narrate the experiences of Luke, Zoe, and Ella.

Reflection on Luke's Access in General Education Classrooms

Luke was able to access learning content in most of his general education classes. Classwork and assignments were adapted to a Google platform which allowed him to access them in his BNT. His teachers were providing him with separate directions so that he could complete the class activities at the same time as his peers. Science and Spanish were the two classes where Luke had more visual components to access. There was a lot of pre-teaching and preparation involved in the science class for Luke. The TVI and the science teacher collaborated a week before the actual unit to ensure that the tactile puzzles were made, the Schoology chart was adapted as Google Docs, and comparable videos were chosen from the Described and Captioned Media Program (DCMP) website. In Spanish, making a picture dictionary or completing an activity based on pictures was not accessible to Luke. As a TVI, if I were to support Luke in one class and allow him to be independent in the rest of the general education classes, I would choose Math or Science over Spanish. Hence, TVIs tend to prioritize subject areas for supporting access, which would leave students like Luke not being fully included in general education elective classes such as Spanish.

Luke's LA teacher incorporated several components of UDL in her lessons to the best of her ability. Luke's LA teacher read out the agenda and described videos which gave all her students access to her curricula. His LA class was the best class I have observed where the teacher was trying to incorporate UDL in her lessons that were accessible to students of different abilities rather than providing "modified content" or "different content" for students with individual needs. Luke was the most dependent in Math class. Without the support of his TVI, Luke would not have been able to access any content in his Math class. Apart from making sure

Luke had access to the tactile graphics or the braille copy of classwork and assignments, Luke needed support from his TVI to understand the content of the math. Inferring the steps and diagrams that the math teacher was showing on the smartboard with different colors and sequences and then translating that to a tactile version could not be completed by Luke without his TVI's support in his classroom. Being a "video game" player and technology lover, games such as "Blooket" would have been much more engaging for Luke if only the game had announced the print that was displayed on its screen.

Reflecting on my observation in Luke's general education classes, there were a few situations when Luke seemed to have been at a disadvantage compared to his peers. They were: (a) while the assignment and the passage in Social Studies class were readily accessible to his peers, Luke had to answer the assignment without having access to the highlighted passages; (b) videos used in all his classes except in Science and LA were not audio described; and finally (c) while students had multiple ways by which they were learning content (by folding a paper to create a grid, watching videos, picture dictionary), Luke had only his memory, listening, and advocacy skills to count on while learning new information. However, despite the challenges he faced, I learned from Luke that buy-in from the student, high expectations of the student, and self-advocacy were three important components in making learning content accessible for students with VI in general education classrooms.

Reflection on Zoe's Access in General Education Classrooms

Completing the group exhibition research project seemed like a visually exhausting activity for Zoe. Trying to read magnified digital text at 2-3 in from the screen, writing with pencil and paper, and typing by looking at the keys were all activities that Zoe could have replaced with efficient technology tools. She could have used a text-to-speech built-in accessibility feature while reading information from the screen, voice-typed, or copied digital texts that were repetitive. These are effective technology tools built into mainstream devices such as the Chromebook. Although Zoe knew how to use built-in accessibility tools, she did not apply those technology skills in classroom situations. Similarly, Zoe did not bring her portable magnifier to art class. I do feel that the task would have been visually less fatiguing and more independent if Zoe completed her drawing, cutting, and painting under the magnifier. My observation of Zoe in her classes conferred with the concerns that both her LA teacher and TVI had about Zoe not using her tools in her classes. Contrary to Zoe being visually exhausted from completing her research project with her group members, she used appropriate magnification tools when she was presenting in front of a younger audience. Zoe loved presenting with her group members. Zoe, being a social butterfly, truly enjoyed group activities and did not seem to mind the visual fatigue that she encountered while accessing the various tasks involved in such activities.

Although the activities of essay writing and online reading assessment were supposed to be independent, Zoe was dependent on her braillist and LA teacher while doing them. Zoe was frustrated with both of these activities. Her computer froze when she was trying to write her essay, and the online reading assessment logged her out multiple times. Zoe could not hear the contents of the whole passage in the test from McGraw-Hill. She had to highlight one paragraph at a time to hear the passage. As long as tests such as the one created by McGraw-Hill are not screen-reader friendly, students like Zoe would not be fully independent in online activities in general education classrooms. In the future, Zoe’s strength as a social being and her grit would determine how far she would go to advocate to get her needs met in all her learning environments.

Reflection on Ella's Access in General Education Classrooms

Ella received vision services from her TVI only for the last 2 years. She was very new to the low-vision world which may have influenced her acceptance of using VI-specific devices in her classes. According to Ella's IEP, she lost engagement when she could not access distant targets. Ella was the least engaged in Social Studies class when the teacher was giving whole-group instruction on the smartboard. Based on her visual diagnosis, Ella could not see the smartboard without her device. Any of the following IEP accommodations would have improved Ella's access and engagement: (a) reminding Ella to use the CloverBook to follow along; (b) giving Ella access to the digital copy of the slides projected on the screen; (c) providing Ella with magnified prints of the slides; (d) verbal descriptions of instructions; or (e) verbal checks for understanding. None of the above accommodations were followed through in Ella's Social Studies class. On the other hand, Ella seemed to be the most engaged in the same Social Studies class when she was working on her presentation independently. She asked questions and was not bothered by distractions around her. This tells me that because of her visual impairment, Ella's attention and engagement to near tasks were better as compared to distance tasks. There were opportunities for educators to make things more accessible, but more often than not, they did not know how to or they chose to use activities that worked for the majority. During assembly, Ella was very aware of her surroundings. Being a shy person who did not want to stand out, Ella faked what she could see which was inadvertently affecting her access and learning.

Ella's access to digital activities was better than her access to paper-based activities. It was ironic that all the paper copies presented in Ella's classes were printed off from digital copies. The Science teacher created the unit assessments in Google Docs. For Ella, he magnified and printed them out. If only he had given the digital copy to Ella as a Google Doc, she could have magnified the digital print and accessed them better. She could have voice-typed her answers into the Google Doc instead of writing with pencil and paper. Similarly, the Reading teacher could have shared the slide that had higher contrast color pictures digitally with Ella instead of printing them out as black and white pictures. Ella could have magnified into her digital copy to look at the pictures and words. Using the digital copies with Ella could have also saved teachers time in enlarging and printing them out. It was very interesting to note that Ella did not feel conscious about sticking her nose to the paper. However, she resisted using VI-specific devices due to fear of looking different from her peers.

While we cannot change the teaching styles of general education teachers, it is important to emphasize the advantages of using digital content in classrooms. All students should be comfortable in using and accessing their environments with tools like spell check, emails, Word documents, and voice-typing. Schools should not resist using digital media for fear of it being misused by students. If using digital tools was a priority in schools, there would have been a chance that students like Ella were less resistant to using VI-specific accessibility tools that met their needs. Before I discuss the findings in relation to the research questions and literature, Table 12 is a reference for the themes and sub-themes that emerged from this study.

Table 12

Themes and Sub-Themes Discussed in the Literature

Research questions and findings	Sub-Themes discussed in the literature
Q1: How do middle school students with VI describe their experiences in accessing the various technologies used in general education classrooms? Theme 1: Technology is imperative in general education classrooms. Theme 2: Frustrations with accessibility issues.	• Piaget's cognitive development theory and experiences. • The explosion of technology in classrooms. • Inaccessible classroom activities. • Student choice and advocacy.
Q2: How do general education teachers support the technology accessibility needs of middle school students with VI in their classrooms? Theme 3: For general education teachers, it is a learning curve.	• General education teachers are open to training. • More differentiation than UDL in general education classes. • No knowledge of accessibility laws.
Q3: How do teachers of students with VI support the technology accessibility needs of middle school students with VI educated in general education classrooms? Theme 4: The buck stops with TVIs when it comes to access technologies.	• TVIs have minimal training in access technology. • TVIs need support to problem-solve access issues.

Research Question 1 Findings

Piaget's Cognitive Development Theory and Experiences of Luke, Zoe, and Ella

The theoretical framework that guided my research inquiry was Piaget's cognitive development theory. Several factors related to the theoretical framework influenced the experiences of Luke, Zoe, and Ella in general education classrooms. Educators were considered facilitators of learning according to Piaget's cognitive development theory. Luke who had the least vision, used braille and auditory means to access his environment. Educators in his school facilitated his learning by providing the appropriate accommodations in his classrooms. In all of his classes, Luke used the Google platform instead of Schoology which was not accessible in his BNT. So, all his teachers converted their slides and visual content into text as Google Docs. Zoe and Ella accessed their print with magnification. However, both of them preferred using mainstream tools such as computers or an iPad to magnify their print rather than using VI-specific devices. Both Zoe and Ella did not want to feel different from their sighted peers. Ella lost her engagement when she could not access her classroom content visually. General education teachers in their schools often did not understand the extent of Zoe's and Ella's visual impairments. Ella zoned out during her Social Studies presentation, and Zoe wanted to throw her computer out the window as it froze multiple times when she was completing an online assessment. Hence, successful implementation of accessible technologies by educators greatly influenced the experiences of students with VI in general education classes.

As emphasized by Piaget's cognitive development theory, observations in general education classes identified the divergent access needs of students with VI. All three students in the study saw their world differently. Zoe's ability to copy things from the board was challenging even with the IEP accommodations she had in place. Luke could not access visuals without descriptions, and Ella needed support to access the print projected on the smartboard. However, if classroom activities were available to students in multiple modalities, students would equitably access them based on their needs and learning media preferences. If the smartboard presentations were available as digital texts for students or if images were described on the slides, students would not access content in only one way. The seamless access to content irrespective of the preferred mode (visual, tactile, or auditory) greatly influenced the experiences of students in general education classes.

In this study, task analysis as called for by Piaget's cognitive development theory greatly influenced the engagement level of students with VI. Ella was highly motivated to make her presentation using Google Slides. She was engaged as she knew what she needed to do and she had access to it. However, making a picture dictionary in Spanish class was not engaging for Luke. Even though Luke understood the task, pictures did not have any meaning to him if they were not described. Conversely, in Science, Luke participated equitably in completing a tactile puzzle when his sighted peers completed a visual puzzle. Hence, when educators were creating tasks that were engaging and accessible, they were positively influencing the experiences of students with VI in their classes.

The Explosion of Technology in Classrooms

Luke, Zoe, and Ella were exposed to digital tools and programs in all of their general education classes. According to Edyburn (2013), innovations and constant changes in education technology programs would only increase the inaccessibility of such programs for students with VI. Programs such as "Flocabulary" used by Luke's LA teacher or "Wonder by McGraw-Hill" used by Zoe's LA teacher helped in meeting the needs of more students. These programs were interactive and customizable. However, such programs were not completely accessible for students with VI. Luke could not access the videos and interactive elements of Flocabulary with his BNT. Zoe could not independently complete an assessment from Wonder because she could not use the "text-to-speech" feature of the program. While general education teachers used programs such as Flocabulary and Wonder, they were not aware of issues that affected access to these programs for students with VI in their classes. This finding was similar to the results of the survey of companies that produced pre-college instructional software, which found that only 2 of the 19 companies were even aware of accessibility issues (Access Computing, 2023). The explosion of educational technology and programs in schools has led to decreased time in the vetting process of such technologies regarding accessibility.

Inaccessible Classroom Activities

Park et al. (2019), in their study to identify the needs and barriers that students with VI face in Massive Open Online Course (MOOC) platforms, found that the lack of alternate texts in non-texts or images led to students with VI not fully participating in the platform. Although the participants in this study were much younger, Luke's experience with online platforms such as Schoology or websites with non-described images was the same. The quantitative conclusions of the study conducted by Carver et al. (2012) revealed similar findings that braille readers were more likely to respond accurately when image descriptions were provided during test administration. Ella and Zoe did not have the same issue with non-texts or images because their vision allowed them to see magnified images. While Ella and Zoe were able to magnify digital text the majority of times, they still could not access online assessments such as iReady. This was because the maximum magnification allowed in such programs was not sufficient for these students to see without visual fatigue and frustration. According to Barclay and Chu (2022), when the magnification was not enough or if the distance at which the print was accessed was very close to the eyes, visual fatigue and related headaches led students to be frustrated with the print activity. Similar to the findings by Bohnsack and Puhl (2014) and Muwanguzi and Lin (2010), poor accessibility of classroom activities led to frustration and disengagement of students with VI. Moreover, activities that involved inaccessible visuals led to the dependency of students with VI on peers and teachers. Filler activities in classrooms involving pop-ups, games, and quizzes could not be accessed by students in this study without the help of adults or peers. Such activities were also time-consuming for students with VI. Correa-Torres and Muthukumaran

(2021) found that many TVIs in their study reported that the mainstream platforms used by school districts during the pandemic were not accessible to students who were blind. Two years after the study by Correa-Torres and Muthukumaran (2021), TVIs in this study also expressed their frustration around inaccessible mainstream platforms.

Apart from school-adopted assessments and instructional programs, general education teachers used free technological programs that had no research evidence on effectiveness or accessibility. Ella’s Math teacher used lessons from DESMOS, a program-sharing curriculum created by other math teachers. Using programs that have interactive visual components made it very challenging for TVIs to adapt them, especially in secondary schools where there were multiple general education teachers. Before this study, I assumed that the inaccessible programs were the ones adopted by the school or the district that teachers integrated within their curricula. However, I did not think of the accessibility of programs that were created and shared by other teachers. Ella’s Math teacher loved DESMOS because she could save time by using highly interactive and engaging lessons created by other teachers. Another example of such a program is “TPT” (Teachers pay Teachers) where lessons created by other educators could be purchased. Students with VI who experienced many such inaccessible digital programs created and shared by educators were often excluded from their learning environments. According to Siu and Presley (2019), the use of inaccessible mainstream technology by general education teachers made it difficult for TVIs to adapt such materials to meet the access needs of their students.

Student Choice and Advocacy

Student choice and advocacy played a role in the experiences of technologies by students with VI in general education classrooms. Zoe and Ella preferred to use mainstream tools built-in with accessibility features rather than VI-specific magnification devices. These students did not want to look different or stand out from their peers. In their pursuit of wanting to be the same as their peers, these students lost on being equitable with their peers. They would rather not access a classroom board than look different using a magnification device. They would rather look at regular-size print at 2-3 in from the paper than use magnified print that would cause them less visual fatigue. They would rather disengage from a group activity than use a braille device to be on par with their peers. Among all three students in this study, Luke was the only one who embraced his ability to access the content at the same time as his peers. He took ownership of his learning and advocated for meeting his access needs in most of his classes. All three students in this study were not accessing distant targets such as the smartboard or the whiteboard either because the visual components were not adapted or because they were not using their VI-specific devices. Luke said that his teachers were good at explaining what they did on the board, and he felt included in his classes. However, Ella played with her fidgets in Social Studies class as she chose not to use her device to access the presentation projected on the board. Students' choice in using appropriate devices played a role in how they accessed their classroom activities. When videos were used in classrooms, student choice and advocacy played a role in accessing the videos. According to Ferrell et al. (2017), elementary students who were braille readers were likely to perform better when audible image descriptions were used in standardized assessments. In this study, when videos or presentations were not described, or when students did not access them visually using their devices, they became passive learners. In none of the general education classes were audio descriptions of videos consistently used. However, in almost all of the general education classes that the students in this study went to, educators used videos as part of their learning content.

One of the findings of this study suggested that students' choice in using accessibility tools and features played a role in how they experienced their learning content. While Luke had his BNT to access digital content, Ella and Zoe used mainstream touch-screen devices to access digital content. The VI-specific devices such as CloverBook and Jupiter and mainstream devices such as an iPad helped Zoe and Ella access distant targets. While there were several choices of both mainstream accessibility tools and VI-specific devices, the ones that were consistently used by all students were the ones that the students preferred. Student choice of devices played a big role in the use of such devices in general education classes. In her study, Hamlin (2021) explored strategies that were successful to increase the use of assistive technologies in classrooms. One of the successful strategies found by the study was the self-advocacy of students with VI. When students with VI advocated their needs, there was a successful use of assistive technologies in general education classrooms (Hamlin, 2021). In this study, tools preferred by students were the only ones advocated by them. Luke loved using his BNT in all his classes because it gave him equitable access to learning content as his peers. The more Luke used his BNT, the more he advocated for it. Zoe loved using her iPad to access the smartboard instructions in her classes. Ella preferred to listen to instructions on the smartboard than use her CloverBook. The more practice students get in their preferred method of access, the more efficient they become in using such technologies in environments beyond their schools.

Research Question 2 Findings

For General Education Teachers, it is a Learning Curve

One of the significant barriers to including students with VI in general education settings was related to the proficiency of educators in using accessible technology in classrooms. A recent study conducted by Fernández-Batanero et al. (2022) found that university teachers had a significantly low level of technological competencies in using access technologies for students with disabilities including those with VI. University educators seemed to have a very low degree of knowledge on creating accessible materials for individuals with disabilities (Fernández-Batanero et al., 2022). Although the students in this study were much younger, the findings of this case study were similar to the findings of the study conducted by Fernández-Batanero et al. (2022). The findings of this study emphasized the need for educators to be trained in providing technologies that can be seamlessly accessed by students with disabilities. For all three general education teachers in this study, it was a learning curve in understanding the accessibility needs of their students with VI in their classes.

There is limited research on the use of accessible technologies in general education classes by students with VI. One of the barriers including students with disabilities in technology-rich classrooms as identified by Okolo and Diedrich (2014) was the lack of teacher knowledge about technologies that were accessible and meaningful for these students. General education teachers in this study depended on their TVIs to help their students with VI access their curricula. While general education teachers were keen on learning about new technologies, they were not using technologies that were seamlessly accessible for students with VI in their classes. They implemented technologies that were highly interactive and visual, thereby engaging the majority of the students in their classes. Findings of the study by Losinski et al. (2016) found that video modeling served as an accessible tool for students with learning disabilities. While general education teachers were motivated to learn and implement evidence-based technology tools such as video modeling that worked for students with high-incidence disabilities, they were not aware of how meaningful and equitable such interactive tools would be for students with VI.

The findings of this study related to the use of accessible and assistive technologies by students with VI in general education classes were similar to the findings of the dissertation study completed by Johnson-Jones (2017). Observation of the three students with VI in a rural district in the U.S.A. revealed that none of them were using assistive technology devices during classroom instructions even though such devices were part of their accommodation stated in their IEP (Johnson-Jones, 2017). Moreover, similar to the general education teachers in this study, not all teachers consistently provided access to their instructions through assistive technology devices in their daily classroom routines (Johnson-Jones, 2017).

More Differentiation than Universal Design for Learning

According to Griful-Freixenet et al. (2020), both UDL and differentiation of curriculum share the same goal of helping children to have successful learning outcomes by meeting their needs. While differentiation was a constant adaptation of learning content to meet the needs of all students, UDL was anticipating the needs of students from the outset (Griful-Freixenet et al., 2020). In this study, one of the themes that emerged was that general education teachers were willing to differentiate their curricula and were flexible in accommodating the needs of students with VI in their classes. However, they did not always choose a curriculum that accounted for learner variability at the outset. For example, all students in Zoe’s class were expected to write an essay as part of their exhibition project research. All students were expected to prepare a presentation on the Caribbean islands using Google Slides in Ella’s Social Studies class. The TVIs and general education teachers retrofitted the activities to meet the needs of their students with VI. Zoe needed the support of her TVI to use accessibility tools such as speech-to-text and text-to-speech to write her essay. When working on her presentation, Ella was visually exhausted because of the proximity of her eyes to the computer screen. Instead of differentiating the curriculum to a more accessible format for students with VI, the UDL framework challenges educators to implement a curriculum that was accessible to everyone from the very start (Hartmann, n.d.). For example, instead of students expressing their knowledge through just essays or presentations, UDL would ensure multiple ways by which students could express their learning. According to the study by Taylor (2016), to ensure equitable access for all students with and without disabilities, educators must provide lesson materials in multiple formats, allow students to express their learning in multiple ways, and use tools that engage students in multiple ways. In this study, across all three schools, more differentiation of curricula was observed than UDL.

No Knowledge of Accessibility Laws

All participants in this study reported that they understood the legal basis of IDEA and how their schools should implement the accommodations listed in their students' IEPs. However, none of the participants expressed their knowledge of other accessibility laws that K-12 schools should abide by. According to Crossland et al. (2016), legal mandates provided motivation for improvements around accessibility for individuals with disabilities. Participants were not aware of other laws and regulations concerning assistive technology including the Assistive Technology (AT) Act, Americans with Disabilities Act (ADA), Every Student Succeeds Act (ESSA), and Section 508 of the Rehabilitation Act. In this study, the limited knowledge of accessibility laws in K-12 schools of both general education teachers and TVIs was a surprising theme. Even with implementing the IEP accommodations, educators did so because of their own intent to meet the needs of all their students and not because of the legal mandates. The participants in this study understood that IEP accommodations should be in place to make the educational environment a level-playing field for their students with disabilities. However, they were unaware of case laws related to substantive violations of the IEP such as the *D.S. v. Bayonne Board of Education* (2010) where the courts found the IEP inappropriate as the school district failed to provide proper modifications and accommodations. It is not my intention or purpose of my study to create fear in educators by citing case laws. However, knowing accessibility case laws and their relevance to their teaching will ensure equitable access using technologies for students with VI.

Research Question 3 Findings

Minimal Training in Access Technology

In researching the assistive technology competencies of TVIs in the nation, Ajuwon et al. (2016) found a lack of confidence in instructing students with VI using assistive technology. Contrary to the findings of Ajuwon et al. (2016), the three TVIs in this study were confident in instructing students with technologies. However, they reported that they had minimal training in access technology despite their desire to make learning content accessible for their students. While Ella's and Luke's TVI had training with VI-specific devices in their universities, they expressed that they had to learn a lot on their own when they started their job as a TVI. All three TVIs reported their concerns about seeking on-demand support for accessibility issues that their students faced in general education classes. This finding further called attention to the support received by new TVIs who were beginning their careers or were in rural districts. New TVIs may not be confident or have the support they needed to try new technologies for their students.

Need for Support in Access Technology

All three TVIs in this study expressed that they were left alone to explore technology-related solutions for their students. Results of the two surveys completed in 2020 and 2021 suggested that 85% of TVIs reported having at least one student with an online accessibility issue (Rosenblum et al., 2020; Rosenblum et al., 2021). Similarly, in the study conducted by Correa-Torres and Muthukumaran (2021), TVIs expressed their frustrations with solving accessibility issues that their students faced in online learning environments during the first 10 months of the pandemic. The study by Zhou et al. (2012) found that TVIs were more confident and more likely to teach technology to their students when their knowledge of assistive technology skills was reviewed periodically through professional development (Ferrell et al., 2014). Similarly, Siu (2015) found that a virtual community of practice helped in providing ongoing and on-demand professional development for TVIs and influenced their teaching practices. The TVIs in this study reported that they had to seek out virtual learning communities to help them solve accessibility issues for their students with VI.

One of the related themes found in this study was that general education teachers were dependent on the expertise of TVIs to make their content accessible. The three general education teachers in this study expressed the importance of collaborative relationships with TVIs to make their learning curricula accessible. Collaboration between Luke’s general education teachers and his TVI helped him to access his classroom materials in a timely and equitable manner with his sighted peers. This finding corroborated the results of a recent study conducted by Koehler and Wild (2019) on access to a science curriculum by students with VI. The study found that collaboration between general education teachers and TVIs was critical in ensuring the accessibility of the science curriculum for students with VI (Koehler & Wild, 2019). However, some general educators in this study implemented IEP accommodations without collaborating with the TVIs. Ella’s Science teacher magnified print materials for her without understanding that Ella’s access to digital text was better than print. As there is limited empirical research on the competencies of general education teachers in using accessible technologies, collaborating with competent TVIs will facilitate more inclusive practices in schools.

Implications for Practice

As a practitioner in this field, one of the biggest takeaways for me from completing this study was that observing students in classrooms helped in understanding accessibility concerns and successes. While several access solutions seemed to meet the needs of students with VI, not one solution worked the same way for the three students in this study. Hence spending a day observing students in their classes could help create efficient ways for students to access their learning content. The findings of this study on the experiences of middle school students with VI accessing and using technologies in inclusive classrooms were: (a) technology is imperative in general education classrooms; (b) frustrations with accessibility issues in general education classrooms; (c) for general education teachers, it is a learning curve; and finally (b) the buck stops with TVIs when it comes to access technology. The findings highlighted several important implications for practice in schools. In Chapter II, I discussed universally accessible technologies that allowed students with VI to have improved experiences in accessing information using UDL principles. Based on the book published by Siu and Presley (2019), I discussed four categories in which technology could provide meaningful and equitable access for students with VI in general education classes. In the next section, I discuss the implications of this study based on the four categories and the experiences of Luke, Zoe, and Ella in their general education classrooms.

Technologies for Accessing Print

Using Digital Versions for Visual Access to Print

Ella and Zoe accessed most of their print visually with magnification. Luke accessed most of his print using braille and some visually with magnification. To maintain a healthy distance between the eyes and print, Ella needed a magnification of 36-point font size, Luke needed a 72-point font size, and Zoe needed 90-point font size print. Instead of enlarging large volumes of text presented to students in classes, a universal way of accessing print was using the digital format. According to Harman (2018), the digital version of enlarged print creates a non-isolating experience for students with VI instead of using huge font sizes of text or magnification devices. As digital versions can be magnified to any font size, students with VI can access print without having to lean in very close and get visually exhausted.

Using Text-to-Speech for Auditory Access to Print

All three students in this study used text-to-speech accessibility features that were built into their devices and computers in their classes. Listening to text was another universal way to access print. According to general education teachers in this study, audiobooks and text-to-speech features allowed their students to access grade-level content. Although Luke was observed using his auditory skills to listen to books and passages in his classes, Ella and Zoe did not use them as often. To succeed in a digital world, Summers (2018) emphasized the importance of mastering text-to-speech programs for students with VI. Hence, more practice using text-to-speech programs in general education classes would allow students with VI to be successful in a technology-rich low-vision world.

Using Braille Displays for Tactile Access to Print

Luke was the only student in this case study who used his braille note taker, BNT, in his general education classes. Luke was a fluent braille reader. Instead of his TVI adapting all his classroom content in braille, Luke accessed all of the print from his BNT. Luke’s access to classroom notes and tests was successful because his general education teachers were using digital versions of print for all their students. Instead of accessing the digital text using a computer, Luke accessed the same text with his BNT. However, in classes like Math and Science, Luke needed the help of his TVI to adapt print materials into braille and tactile graphics. This was because haptic technology has not yet become mainstream in K-12 classrooms because of the cost of the devices and the specialized programming skills required to use such devices (Darrah et al., 2014). With the explosion of educational technology programs in K-12 schools, TVIs should be willing to learn and teach braille displays to their tactile learners as it would eventually save them time from constantly adapting classroom materials to braille.

Using Universally Accessible Digital Content Versus Digital Content

Based on observation of general education classes across three schools, there was a lot of digital content that students were exposed to. However, not all digital content was universally accessible. Many of the programs used in classes could not be accessed by students with disabilities because they did not follow the four principles, Perceivable, Operable, Understandable, and Robust (POUR) discussed in Chapter II. Two of the guide-lining aspects of POUR mandates were audio descriptions in videos and alternative descriptions of images (Web Accessibility, 2022). In this case study, general education teachers used videos and images regularly in their lessons with the intention of engaging more students. However, the majority of the videos and images did not have audio or text descriptions. An empirical study by Ferrell et al. (2017) found that braille readers performed better with audible image descriptions in standardized assessments. Similarly, a study by Taylor (2016) found that digital versions of annotated images and texts allowed students with VI to participate in university lectures at the same time as their peers. Hence using audio-described images and videos is one of the ways to make digital content universally accessible for all students with varying abilities.

One of the findings of this study suggested that educators often did not know how to make images accessible or where to find audio-described videos. One of the evidence-based practices related to technology for students with VI as discussed in a U. S. Department of Education report by Ferrell et al. (2014) was training pre-service TVIs in specific technologies including screen reading software, magnification devices, and braille displays. Contrary to the findings of Ferrell et al. (2014), this study suggested that instead of training pre-service teachers on specific devices and programs, teaching access skills would be more beneficial. Similarly, accessibility training should not be limited to pre-service training of TVIs. Pre-service general education teachers should also learn how to develop universally accessible lessons. All teacher education programs should teach skills that involve adding a description to images and videos, creating accessible slides and documents that can be read using a screen reader, and creating UDL lessons that provide multiple ways by which students can learn, engage and express themselves.

Using Braille Displays and Speech-To-Text for Authoring and Producing Alternate Media

All three students in this study used voice typing in a few of their general education classes. They expressed that the speech-to-text features available on their computers and phones were very helpful to them. Although Luke used voice-typing at times, he used his BNT to write text in most of his classes. Using speech-to-text programs allowed students to create digital content that could be instantly shared with their peers and teachers. Although multi-modal notetaking was not observed in any of the general education classrooms in this study, according to Coles (2018), notetaking apps allowed users to gather information in many different ways including writing, typing, audio recording, or video. Consistent use of such technology-based authoring tools in general education classrooms would not only allow students with VI equitable access to their learning content but would also create a non-isolating experience for them.

Limitations

This was a qualitative case study involving three students with VI, their TVIs, and three of their general education teachers. Observation time was one of the limitations of this study. I completed this study as part of my dissertation in the spring semester by observing the students, each for 2 school days, and interviewing three general education teachers and three TVIs. If I had more than a semester to conduct this study, I would have probably observed each student for at least a week. Observing students for more than 2 days would have given more information on other experiences of technology-based activities that may have occurred in general education classrooms. Moreover, my findings from Zoe’s observation may have been slightly compromised as I observed her for 2 hr less than I observed Ella and Luke due to snow-related delays. Another limitation of this study was that all three students who participated were from the state of Colorado. Hence my interview with the TVIs in this study may have been biased considering they were my colleagues in the state and that we had met before and became acquainted at state conferences. As two of the three students attended middle schools having several general education teachers, interviewing just one general education teacher for each student may have limited the findings of this study. Even though the students were observed in all general education classes, only one general education teacher for each student was interviewed. Hence information of support that other general education teachers teaching subjects such as Spanish, Social Studies, or choir provided to students with VI could not be obtained in this study.

Another limitation of this study was related to any bias I may have had due to the familiarity with Zoe's district and her TVI. Due to a lack of participants who fit the inclusion and exclusion criteria for this study, I had to include one student (Zoe) who attended a school in the same district I worked. Even though I did not know Zoe before the study, her TVI was my colleague for the past six years in the district. Understanding the struggles of the TVI in providing access support for Zoe could have influenced my findings related to Zoe. Finally, as with any other study, using observation as a data collection method was a limitation. Even though I was a "complete" observer and did not interfere with the student during my observation in classrooms, knowledge of my observation could have caused changes in the behavior of the students. Students could have used their access devices or pretended to successfully experience classroom activities because of my presence in the classrooms.

Future Research Directions

This study provided a glimpse of the low-vision technology-rich world that middle school students with VI experienced in general education classrooms. For future research directions, I will recommend three main areas that will help improve inclusive practices for students with VI. Firstly, qualitative research on the experiences of other student populations in general education classrooms should be conducted. This study focused on middle-school students. Future research should understand the experiences of students with VI in high schools and elementary schools. Findings in other school settings would give more insight and meaning into the findings obtained in this study.

Secondly, future research should be conducted to understand the competence of access technology skills in general education teacher programs. The findings of this study suggested the dependence of general education teachers on TVIs to make content accessible for their students with VI. Instead, if universities prepare general education teachers in creating universally accessible materials, it would empower educators to meet the needs of students of different abilities.

Finally, another recommendation for future research is to identify successful strategies that help support TVIs with access technologies. The findings of this study suggested that TVIs had to figure out the best access tools and methods on their own to support their students. Some of the research areas that would help TVIs are mentorship, virtual professional development, virtual learning community groups, and access to digital literacy personnel for on-demand professional support.

Conclusion

In this chapter, I discussed the interpretation of my findings on the experiences of three middle school students with VI in general education classrooms. I first discussed my reflection on Luke’s, Zoe’s, and Ella’s access in general education classrooms. I then discussed the themes found in the study from the cross-case analysis in relation to the research questions. My first research question was on the experiences of students with VI in technology-rich general education classrooms. The two themes that emerged for the first research question were: (a) technology is imperative in general education classrooms, and (b) frustrations with accessibility issues in general education classrooms. Based on the theoretical framework that guided my research, Piaget’s cognitive development theory, I discussed the experiences of Luke, Zoe, and Ella in their general education classes. Educators as facilitators, the divergent access needs of students with VI, and the use of technologies for meeting the needs of students with VI were observed in all three schools. The sub-themes in relation to the first research question were: (a) the explosion of technology in K-12 schools, (b) inaccessible online activities used in general education classes, (c) inaccessible technologies used in classrooms were not only the ones adopted by the school or district but included the programs created and shared by other teachers, (d) students with VI preferred using mainstream technologies with built-in accessibility features rather than VI-specific devices to meet their needs in general education classes, and (e) student choice and advocacy played a role in the experiences of students with VI in technology-rich classrooms.

My second research question was on the support that general education teachers provided students with VI in their classes. The overarching theme that emerged for the second research question was that for general education teachers, it is a learning curve. The sub-themes in relation to current literature discussed were: (a) general education teachers used technologies that were more engaging than accessible; (b) all educators were differentiating the curricula to meet the needs of students through constant adaptation as opposed to using tools that accounted for learner variability at the outset; and (c) while the students, general education teachers, and TVIs in this study understood the legal mandates of IDEA and an IEP, they did not know any other accessibility laws related to technologies that K-12 schools should abide by. My final research question was on the support that TVIs provided their students with VI in general education classes. The theme that emerged from this study for the third research question was that the buck stops with TVIs when it comes to access technology. The sub-themes discussed for the final research question were: (a) TVIs had minimal training in access technology, and (b) minimal support existed for TVIs to solve accessibility issues involving technologies. I also discussed implications for practice, limitations to this study, and future research directions in this chapter.

This multi-case qualitative study stressed the importance of accessible learning materials to create equity in schools. As a researcher striving for equity, I hope to continue understanding the experiences of students with VI in general education classrooms in K-12 schools. As a practitioner, I hope to empower my students with many digital skills that will help them access their technology-rich world. And finally, as a lifelong student and community member, I hope that the readers of this dissertation can empathize with the narrated stories and help create a more equitable inclusive world for students with VI like Luke, Zoe, and Ella!

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APPENDIX A

UNIVERSITY OF NORTHERN COLORADO
INSTITUTIONAL REVIEW BOARD
APPROVAL

UNIVERSITY OF NORTHERN COLORADO

Institutional Review Board

Date:	11/11/2022
Principal Investigator:	Anitha Muthukumaran
Committee Action:	**IRB EXEMPT DETERMINATION – New Protocol**
Action Date:	11/11/2022
Protocol Number:	2211045726
Protocol Title:	Experiences of Middle School Students with Visual Impairments Accessing Technologies in Inclusive Classrooms
Expiration Date:	

The University of Northern Colorado Institutional Review Board has reviewed your protocol and determined your project to be exempt under 45 CFR 46.104(d)(701) (702) for research involving

Category 1 (2018): RESEARCH CONDUCTED IN EDUCATIONAL SETTINGS. Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Category 2 (2018): EDUCATIONAL TESTS, SURVEYS, INTERVIEWS, OR OBSERVATIONS OF PUBLIC BEHAVIOR. Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or (iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 45 CFR 46.111(a)(7).

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

You may begin conducting your research as outlined in your protocol. Your study does not require further review from the IRB, unless changes need to be made to your approved protocol.

As the Principal Investigator (PI), you are still responsible for contacting the UNC IRB office if and when:

- You wish to deviate from the described protocol and would like to formally submit a modification request. Prior IRB approval must be obtained before any changes can be implemented (except to eliminate an immediate hazard to research participants).
- You make changes to the research personnel working on this study (add or drop research staff on this protocol).
- At the end of the study or before you leave The University of Northern Colorado and are no longer a student or employee, to request your protocol be closed. *You cannot continue to reference UNC on any documents (including the informed consent form) or conduct the study under the auspices of UNC if you are no longer a student/employee of this university.
- You have received or have been made aware of any complaints, problems, or adverse events that are related or possibly related to participation in the research.

If you have any questions, please contact the Research Compliance Manager, Nicole Morse, at 970-351-1910 or via e-mail at nicole.morse@unco.edu. Additional information concerning the requirements for the protection of human subjects may be found at the Office of Human Research Protection website - http://hhs.gov/ohrp/ and https://www.unco.edu/research/research-integrity-and-compliance/institutional-review-board/.

Sincerely,

Nicole Morse

Nicole Morse
Research Compliance Manager

University of Northern Colorado: FWA00000784

Carter Hall 2008 | Campus Box 143 | Greeley, CO 80639 | Office 970-351-1910

APPENDIX B

RECRUITMENT EMAIL

Date

Dear (Teacher of Students with Visual Impairments),

Hello! Hope you are doing well, and that your school year is going well too! I would like to share an opportunity that may contribute to a better understanding of the experiences of students with visual impairments (VI) in accessing technologies in general education classrooms. I am conducting a study on the experiences of middle school students with VI accessing technologies in inclusive classrooms.

I am seeking three students with the following criteria: (a) has a visual impairment with a distance acuity of 20/100 or worse as determined by a medical authority and is not completely blind; (b) has an Individualized Education Program (IEP) qualified under the category of "Visual Impairment and/or blindness" and does not have any other identified disability; (c) chronicle age ranging from 11 and 14 years enrolled in a public middle school; and (d) placed in inclusive setting spending 80% or more of their instructional time in general education classrooms in a public school and (e) reading level is not more than 2 years behind their grade level. Students will be observed on at least two occasions in their school. Students, their general education teachers, and TVIs will be asked to participate in an interview.

A study packet containing consent forms and demographic forms is attached to this email which can be forwarded to interested families of students who appear to fit the above criteria for this study. I have also given my phone number in the study packet that families may call to obtain further information about the study. Your assistance in recruiting students will help me in collecting accurate information. Please call or email me if you work with a student who meets these criteria and who may be interested in participating. Thank you so much for considering this request and I greatly appreciate your assistance!

Looking forward to hearing from you!

Sincerely,

Anitha Muthukumaran
Teacher of Students with Visual Impairments
Doctoral Student at the University of Northern Colorado, Greeley
anitha.muthukumaran@unco.edu

APPENDIX C

STUDENT PARTICIPANT CONSENT FORM
FOR PARENTS/GUARDIANS

UNIVERSITY OF NORTHERN COLORADO

CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH

Study Title: Experiences of Middle School Students with Visual Impairments Accessing Technologies in Inclusive Classrooms

Principal Investigator: Anitha Muthukumaran, Doctoral Student at the School of Special Education; Email: anitha.muthukumaran@unco.edu

Research Advisor: Dr. Correa-Torres, Professor of Special Education at the School of Special Education; Email: silvia.correa-torres@unco.edu

Purpose and Background: The purpose of the study is to understand the experiences of students with visual impairments (VI) when they are presented with technologies in general education classrooms. This study could benefit the participants by allowing them to self-reflect on activities that work or not work for them with technologies in classrooms. The findings of the study can be applied to the future inclusion of students with VI in general education classrooms.

We will collect data using demographic questionnaires, two observations in general education classrooms, and interviews. You will be asked to sign this consent form to help ensure you understand the purpose of the study and that your child's identity will remain confidential. Pseudonyms or fake names will be chosen before collecting data and only pseudonyms will be used throughout the study.

Your child will be asked questions regarding their experiences with accessing technologies in general education classrooms, how they are receiving support, challenges that they might be experiencing, and success stories among others. As a parent/guardian, you will also be asked demographic questions prior to the interview of your child. I will interview the student in-person at a time that does not interfere with any of his/her class instructions. The interview is expected to last no longer than 60 minutes. When you give this consent, you also consent for audio recording the interview with your child. In addition, your child will be observed during two school days. Your child will not be disturbed while he or she is being observed.

If you agree for your child to participate in this research study, the following will occur:

- Your child will be observed during two school days in their classroom without any interruption to the activities they are pursuing in their classes.

- After observation, your child will be asked questions about their experiences in accessing technologies in general education classrooms during a scheduled interview.
- Your child's teacher of students with visual impairments (TVI) will share your child's Individualized Education Plan (IEP) and past academic progress data with me.
- You will be asked for demographic information, such as your child's medical and visual condition, age, and skill level in technology access.

_________ (Participant's Initials)

Confidentiality: Your child's responses will only be shared with my research advisor and a peer researcher who will assist me with the research data analysis. By allowing your child to participate in this study, you have given us permission to release information to these persons. Although confidentiality cannot be guaranteed, every effort will be made to maintain your confidentiality. The confidentiality of participants will be ensured through the use of pseudonyms or fake names. Even during communication between the researcher and the research advisor or the peer researcher, real names will not be used. Audio recordings will be uploaded and stored in the UNC One Drive folder with access given only to me, my advisor, and a peer researcher to maintain security. They will be immediately transferred from the recording device to the One Drive folder after which they will be deleted from the recording device. Your signed consent will be kept locked in the office of my advisor, Dr. Correa-Torres, for three years.

Risks: Foreseeable risks are no greater than those that might be encountered in conversations with fellow teachers or colleagues. If emotional distress occurs, the UNC Counseling Center may be contacted for free counseling services. Contact information is listed as UNC Counseling Center 1901 10th Ave., Greeley, CO 80639, 970-351-2496

Benefits: The proposed research could benefit the participants by allowing them to self-reflect on activities that work or not work for them with technologies in classrooms. The findings of the study can be applied to the future inclusion of students with VI in general education classrooms.

Costs: The cost of participating in this study is the time invested to participate in the interview. No compensation will be provided to your child for participating in this study.

Questions: If you have any questions about the study, you may contact the investigators by phone or email.

Participation is voluntary. You may decide for your child not to participate in this study and if your child begins participation, you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in a loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any questions, please sign below if you would like for your child to participate in this research. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact Nicole Morse, IRB Administrator, Office of Sponsored Programs, 25 Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910.

Participant's Signature ____Date___________

Researcher's Signature _______________________________________Date___________

APPENDIX D

EDUCATOR PARTICIPANT CONSENT FORM

CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH

Study Title: Experiences of Middle School Students with Visual Impairments Accessing Technologies in Inclusive Classrooms

Principal Investigator: Anitha Muthukumaran, Doctoral Student at the School of Special Education; Email: anitha.muthukumaran@unco.edu

Research Advisor: Dr. Correa-Torres, Professor of Special Education at the School of Special Education; Email: silvia.correa-torres@unco.edu

Purpose and Background: The purpose of the study is to understand the experiences of students with visual impairments (VI) when they are presented with technologies in general education classrooms. This study could benefit the participants by allowing them to self-reflect on activities that work or not work for them with technologies in classrooms. The findings of the study can be applied to the future inclusion of students with VI in general education classrooms.

We will collect data using demographic questionnaires and one interview. You will be asked to sign this consent form to help ensure you understand the purpose of the study and that your identity will remain confidential. Pseudonyms or fake names will be chosen before the interview and will be used throughout the study.

You will be asked questions regarding the support you provide to students with VI in accessing technologies in general education classrooms, how you are providing support, challenges you might be experiencing, and positive outcomes among others. You will also be asked demographic questions before the interview. I will utilize semi-structured (questions are open-ended and I will not use a strict list of questions) in-person, video conference, or phone interviews as the research instrument. The interview is expected to last no longer than 60 minutes. When you give this consent, you also consent for audio recording of the interview.

If you agree to participate in this research study, the following will occur:

- You will be asked questions about your experiences of supporting students with VI in accessing technologies in general education classrooms.
- You will be asked for demographic information, such as experience with students with VI, the number of years of teaching, and your age.

_________ (Participant's Initials)

Confidentiality: Your responses will only be shared with my research advisor and a peer researcher who will assist me with the research data analysis. By participating in this study, you have given us permission to release information to these persons. Although confidentiality cannot be guaranteed, every effort will be made to maintain your confidentiality. The confidentiality of participants will be ensured through the use of pseudonyms or fake names. Even during communication between the researcher and the research advisor or the peer researcher, real names will not be used. Audio recordings will be uploaded and stored in the UNC One Drive folder with access given only to me and my advisor, and a peer researcher to maintain security. They will be immediately transferred from the recording device to the One Drive folder after which they will be deleted from the recording device. Your signed consent will be kept locked in the office of my advisor, Dr. Correa-Torres, for three years.

Risks: Foreseeable risks are no greater than those that might be encountered in conversations with fellow teachers or colleagues. If emotional distress occurs, the UNC Counseling Center may be contacted for free counseling services. Contact information is listed as UNC Counseling Center 1901 10th Ave., Greeley, CO 80639, 970-351-2496

Benefits: The proposed research could benefit the participants by allowing them to self-reflect on activities that work or not work for them with technologies in classrooms. The findings of the study can be applied to the future inclusion of students with VI in general education classrooms.

Costs: The cost of participating in this study is the time invested to participate in the interview. No compensation will be provided to you for participating in this study.

Questions: If you have any questions about the study, you may contact the investigators by phone or email.

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in a loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any questions, please sign below if you would like to participate in this research. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or treatment as a research participant, please contact Nicole Morse, IRB Administrator, Office of Sponsored Programs, 25 Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910.

Participant’s Signature ____Date___________

Researcher’s Signature ____Date___________

APPENDIX E

PRINCIPAL PERMISSION FORM

Study Title: Experiences of Middle School Students with Visual Impairments Accessing Technologies in Inclusive Classrooms

Principal Investigator: Anitha Muthukumaran, Doctoral Student at the School of Special Education; Email: anitha.muthukumaran@unco.edu

Research Advisor: Dr. Correa-Torres, Professor of Special Education at the School of Special Education; Email: silvia.correa-torres@unco.edu

{School Name}

{School Contact Information}

{Date}

Dear School Name,

The purpose of the research is to understand the experiences of students with VI when they are presented with technologies in K-12 general education classrooms. This study is not testing the accessibility of technologies used in classrooms. Instead, the study is about understanding the experiences of students with VI in K-12 general education classrooms and how they are accessing and learning from technologies used in their classrooms. The proposed research could benefit the participants by allowing them to self-reflect on their practices that involve accessible technology for their students. The perspectives of participants will increase researchers' understanding of how best students with visual impairments are included in technology-rich classrooms. The findings of the study can be applied to the future inclusion of students with visual impairments in general education classrooms.

Benefits: The proposed research could benefit the participants by allowing them to self-reflect on their practices that involve accessible technology for their students. The perspectives of participants will increase researchers' understanding of how best students with visual impairments are included in technology-rich classrooms. The findings of the study can be applied to the future inclusion of students with visual impairments in general education classrooms.

As part of this study, I authorize the researcher to observe the students for two school days and to interview (face-face/virtual) student participants, their general education teachers, and teachers of students with visual impairments (TVI) and audio record the interview. Individuals' participation will be voluntary and at their own discretion. We understand that our organization's responsibilities include: participants' time and observation rooms. We reserve the right to withdraw from the study at any time if our circumstances change. We understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the research team at the University of Northern Colorado (UNCO) without permission from the {school name}. Details of the research team at UNCO along with their phone numbers and email IDs are as above. This authorization covers the time period of Spring Semester 2023. I confirm that I am authorized to approve research in this setting.

Sincerely,

{Authorization Official signature}

{Contact Information}

APPENDIX F

MINOR PARTICIPANT ASSENT FORM

ASSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH
UNIVERSITY OF NORTHERN COLORADO

Hi!

My name is Ms. Anitha Muthukumaran and I am a teacher of students with visual impairments in another school district in Colorado. I am doing a project to understand how you are accessing or using technologies in general education classrooms. If you want, you can be one of the students I work with. If you want to work with me, I will observe you for two days while you are in school, and I will interview you with some questions about your experience using some of the technologies presented to you in class. The interview is not a test, there are no right or wrong answers, and there won't be any score or grade for your answers. I will write down what you say, but I won't even write down your name. I will record the interview to listen later for my project and I will not use the recording for any other purpose. I will ask your teacher for the best time to work with you so that you don't miss anything too important. Talking with me probably won't help you or hurt you. Your parents have said it's okay for you to talk with me, but you don't have to. It's up to you. Also, if you say "yes" but then change your mind, you can stop any time you want to. Do you have any questions for me about my project?
If you want to be in my project, then you can write your name as your signature below and write today's date.

Date ________

Signature ________________

Researcher__________________

APPENDIX G

DEMOGRAPHIC DATA FORM FOR STUDENTS FILLED BY PARENTS/GUARDIANS

Please provide the following background information about your child:

1. Age:
2. Gender:
3. What grade level is your child currently?
4. What is child's eye condition?
5. Age when he/she/they obtained eye diagnosis?
6. How many years has your child received special education services under Visual Impairments (VI)?
7. Is your child currently receiving direct or consultative services from a certified teacher of the visually impaired?
8. Is your child currently receiving direct or consultative services from a certified orientation and mobility specialist?
9. Does your child have any other medical conditions? Yes___ No ___
10. If yes, please list the conditions:

    ____

    ____

    ____

11. How many years have your child attended public school?
12. On a scale of 1 to 5 (1 being low confidence to 5 being high confidence), how independent do you think your child is in using technologies that help them access mainstream and social media platforms?

Information about you:

13. Gender: ________

14. Age (years)
    18-25
    26-35
    36-45
    46-55
    56-65
    66 or older
    Prefer not to answer

15. Ethnicity
    African American
    Caucasian
    Latino/a
    Native American/Asian
    More than one
    Other
    Prefer not to answer

16. Highest Education Level
    High school/Associate's
    Bachelor's
    Master's
    Master's +
    Doctorate
    Alternative Certification
    Prefer not to answer

17. Geographic Area
    Urban
    Rural
    Suburban
    Prefer not to answer

APPENDIX H

DEMOGRAPHIC DATA FORM FOR TEACHERS OF STUDENTS WITH VISUAL IMPAIRMENTS

Please provide the following background information.

Pseudo Name/ID#: ____________

1. Gender: ______

2. Age:
   18-25
   26-35
   36-45
   46-55
   56-65
   66 or older

3. Ethnicity:
   African American
   Caucasian
   Latino/a
   Native American/Asian
   More than one
   Other
   Prefer not to answer

4. Highest Education Level: ___________

5. Years of teaching students with visual impairments including this year: _____

6. Please describe your current job responsibilities: _____

7. Please select which one best describes your community?

___Urban
___Suburban
___Rural

8. Check the category that best describes the type of program you work for:

___District Program
___Regional Program

___Special School or Center
___Other (please indicate) ___________

7. What year did you get your TVI degree? _______

8. Please list your teacher certifications if any: ____________

9. What is the number of students in your caseload? ______

10. On a scale of 1 to 5 (1 being low confidence to 5 being high confidence), how comfortable are you in using technologies that support students with visual impairments access their general education learning environment?

APPENDIX I

DEMOGRAPHIC DATA FORM FOR GENERAL EDUCATION TEACHERS

Please provide the following background information.

Pseudo Name/ID#: ____________

1. Gender: ______

2. Age:
   18-25
   26-35
   36-45
   46-55
   56-65
   66 or older

3. Ethnicity:
   African American
   Caucasian
   Latino/a
   Native American/Asian
   More than one
   Other
   Prefer not to answer

4. Highest Education Level: ___________

5. Years of teaching experience in middle school including this year: _____

6. Please describe your current job responsibilities: _____

7. What grade and subject are you teaching this year?

8. What year did you get your teacher’s degree? _______

11. Please list your teacher certifications if any: ____________

12. How many students with visual impairments you have taught in the past? ______

13. On a scale of 1 to 5 (1 being low confidence to 5 being high confidence), how comfortable are you in using technologies that support students with visual impairments access their general education learning environment?

APPENDIX J

OBSERVATION OF STUDENTS PROTOCOL

Case Pseudonym:

Date:

Place:

Observation Day:

- Observation Day 1
- Observation Day 2

Classroom	Period/Time	Activity/Event Observed	Reflexive Notes

APPENDIX K

INTERVIEW QUESTIONS FOR STUDENTS

Interview Questions for Students

1. Please describe your experience with technologies in your classrooms/classes?
2. Describe a time that technology helped you?
    a. What are your favorite programs and applications used in the classroom and why?
    b. What do you do when you are not able to use the technology presented to you in class?
3. How do you feel included when you use technology in your classes?
4. How do you keep up with the technology skills you need to access your classes?
    a. How does your teacher support you in using technology?
    b. How should your teachers use technology in classrooms?
5. How do you complete your work with technology when compared to your sighted peers?
6. How will your technology skills transition into the workplace?
7. What else do you like to share with me?
8. Do you have any questions for me?

[Added more specific questions after the first day of observation, reading the Individualized Education Plan (IEP) and academic records of specific students and their activities in classrooms]

APPENDIX L

INTERVIEW QUESTIONS FOR GENERAL EDUCATION TEACHERS

Interview Questions for General Education Teachers

1. Tell me about your experience working with students with visual impairments?
2. What part does technology play in your classroom?
    a. How do you see different types of technology/programs playing a part in an inclusive classroom?
    b. What type of technology do you use in your classrooms?
    c. How do you use technology?
    d. When do you use technology?
3. Please describe a time that technology helped your student with visual impairments?
    a. What are the students' favorite programs and applications used in the classroom and why?
    b. How do you change which technology you are using based on student engagement?
4. How do you see technology increasing isolation or facilitating the inclusion of students with visual impairments in your classroom?
5. How do you keep up with available technology for your students?
    a. How much support is there for teachers learning and using new technology in your job/district? What types of support?
    b. How should classroom technology be included in teacher training?
6. How do students with visual impairments access the technologies you use in your classroom?
7. How do you see that the technology you are using will transition into the workplace for your students?
8. What else do you like to share with me?
9. Do you have any questions for me?

[Added more specific questions after the first day of observation, reading the Individualized Education Plan (IEP) and academic records of specific students and their activities in classrooms]

APPENDIX M

INTERVIEW QUESTIONS FOR TEACHERS OF STUDENTS WITH VISUAL IMPAIRMENTS

Interview Questions for Teachers of Students with Visual Impairments

1. Tell me about your experience with technologies for your students in general education classrooms?
    a. Can you please describe the training you had with technologies?
2. What part does technology play in your job?
    a. How do you see different types of technology/programs playing a part in an inclusive classroom?
3. Describe a time that technology helped your student with visual impairments?
    a. What are the students' favorite programs and applications used in the classroom and why?
    b. How do you change which technology you are using based on student engagement?
4. How do you see technology increasing isolation or facilitating the inclusion of students with visual impairments in general education classrooms?
5. How are you able to keep up with available technology for your students?
    a. How much support is there for teachers learning and using new technology in your job/district?
    b. How should classroom technology be included in TVI training?
6. How do your students access the technologies used in classrooms?
7. How do you see that the technology students are using will transition into the workplace for your students?
8. What else do you like to share with me?
9. Do you have any questions for me?

[Added more specific questions after the first day of observation, reading the Individualized Education Plan (IEP) and academic records of specific students and their activities in classrooms]

APPENDIX N

INTERVIEW PROTOCOL

Interview Protocol

Date:
Time:
Interviewee Pseudonym:
Interviewer:
Interview Length:
File Name of the Audio Recording:
File Name of the Transcribed Recording:

Introduction for Educators: [Remember to ask for verbal consent at the beginning of the audio recordings). The purpose of the study is to understand the experiences of middle school students with visual impairments (VI) using and accessing technologies in general education classrooms. The interview will be open-ended questions and you may choose to elaborate on any particular questions or talk about related content even if it is not part of the questions. I have observed the student with VI in your class for one whole school day prior to this interview and I have reviewed the student's Individualized Education Plan (IEP) and the academic progress reports. So, some of the questions I may have for you will be based on my observation and education documents of the students. The interview should not take more than 60 minutes. Let me know if you have any questions about the study before I begin.
Introduction for Students: I am doing a project to understand how you are accessing or using technologies in general education classrooms. I will interview you with some questions about your experience using some of the technologies presented to you in class. The interview is not a test, there are no right or wrong answers, and there won't be any score or grade for your answers.

Opening questions for educators: What do you like most about your job?
Opening question for students: What do you like most about school?

Content questions: Use the interview questions according to the type of participants.

If answers seem of less content, use the following probes:

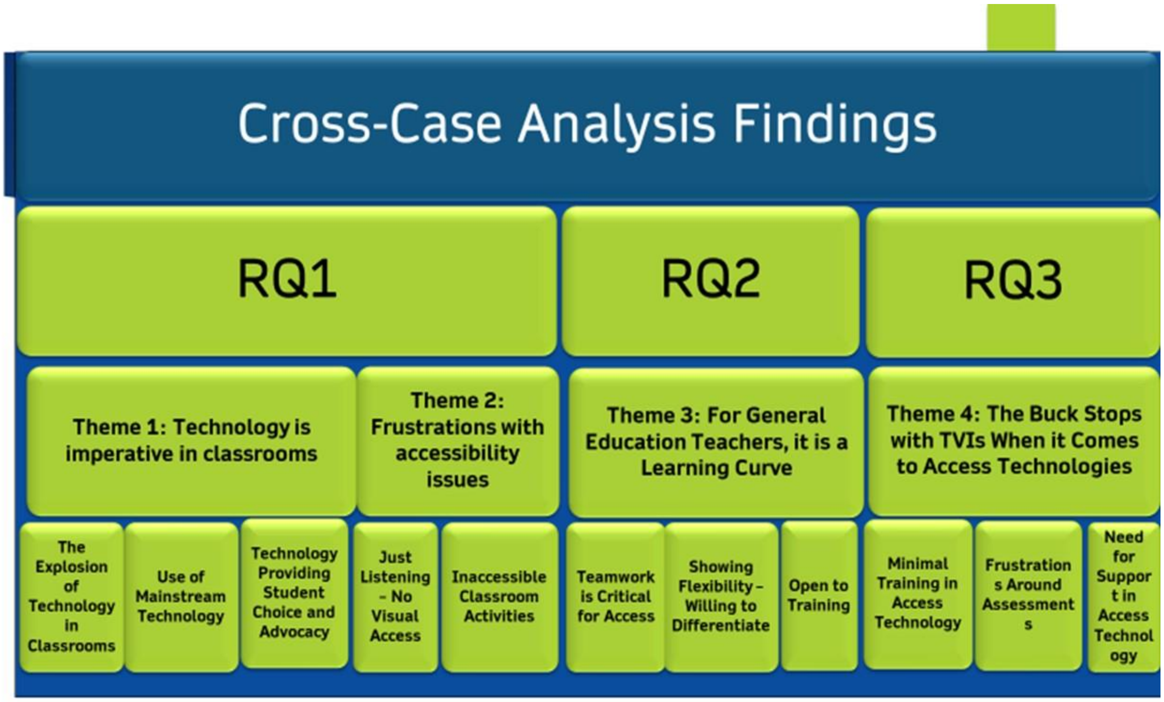
- Tell me more
- I need more details; can you give me examples?
- Could you explain your response more?

Closing comment for educators: Thank you for your time. Feel free to contact me via email if you have any other comments/feedback after this interview. After this interview, I will observe the student participants one more time, then transcribe all the interview data, and analyze all my data. I will send you the transcripts of our interview and some major findings/themes that I have interpreted from our conversation and observation of the student participants. I would appreciate it if you could get back to me if my findings seemed accurate to you and if you have any other thoughts about my initial analysis. After my study is completed, I will send you an abstract of my final study.

Closing comment for students: Thank you so much for answering my questions. After this, I will observe you one more time during your classes. At the end of my project, I will send you a small paragraph of my major findings of my final study. If you have any comments about my findings or have any questions for me after this interview, you can let your TVI know, and I will contact you.

APPENDIX O

CROSS-CASE ANALYSIS--THEMES


Cross-Case Analysis Findings
RQ1
RQ2
RQ3
Theme 1: Technology is imperative in classrooms
Theme 2: Frustrations with accessibility issues
Theme 3: For General Education Teachers, it is a Learning Curve
Theme 4: The Buck Stops with TVIs When it Comes to Access Technologies
The Explosion of Technology in Classrooms
Use of Mainstream Technology
Technology Providing Student Choice and Advocacy
Just Listening – No Visual Access
Inaccessible Classroom Activities
Teamwork is Critical for Access
Showing Flexibility – Willing to Differentiate
Open to Training
Minimal Training in Access Technology
Frustrations Around Assessments
Need for Support in Access Technology