Observations and Perspectives of Technology Use Among Students with Visual Impairments

By

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In dedication to my former students with visual impairments, who reshaped the way I viewed the world as a journey of understanding the different ways in which all people experience the world and creating ways to share those experiences with one another. To my former colleagues, who's passion in the field of visual impairment was contagious and pushed me to pursue creating invitations for others to join the field. To my family, who encouraged and supported me throughout this long endeavour.

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CHAPTER I

Introduction

The field of visual impairment (VI) has a long tradition of including students in general education classrooms (Duquette, 2008). Assistive technology (AT) has been an important tool in facilitating student access to information and instruction (Smith & Kelly, 2014). AT provides students with VI an efficient means of acquiring, sharing, and producing information (Kapperman & Sticken, 2003). However, there is limited empirical evidence supporting the use of AT (Ferrel et al., 2014; Tuttle & Carter, 2022). Yet, a small body of quantitative and qualitative research demonstrates the promise of AT for increasing students' access to information and instruction (e.g., Beal & Shaw, 2009; Bouck et al., 2016; Hahn et al., 2019). For example, Beal and Rosenblum (2018) reported that students with VI required less direct help from a special educator while using AT to solve math problems. Likewise, Farnsworth and Luckner (2008) found that a student could interact directly with educators with the aid of technology, as well as access and produce printed materials. In addition to learning, AT is a tool for communication, social interaction, and physical access to resources (Pal et al., 2017). Students' ability to interact, communicate, and organize information using technology can promote independence. Thus, consideration of AT is imperative when providing students with VI access to information.

Definition of Assistive Technology

Defining AT has become an increasingly challenging task, especially in the field of visual impairment. The Individuals with Disabilities Education Act ([IDEA], 2004) defines AT broadly 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 a disability" (IDEA, 2004, § 602 (1) (A)). However, with the rise of computerized technology in the 1970s and 1980s, reference to AT in the literature now differentiates between simpler technology and newer, complex electronics (Smith et al., 2009). The term "low-tech" describes traditional forms of AT, such as braillerwriters, domes, and telescopes. In contrast, the term "high-tech" refers to technologies such as braille notetakers, video magnifiers, and optical character recognition. Although teachers are required to support the full range of AT, this dissertation study focused on the latter form of AT. Therefore, all future references to AT in this dissertation refer to "high-tech" AT. There is precedence in the VI literature for using a narrower definition of AT, focusing solely on electronic devices (e.g., Kelly, 2009; Kelly, 2011; Wong & Cohen, 2011). One reason for a narrowed focus on AT among VI researchers may be due to literature that documents educators' need for continued education related to complex AT (e.g., Abner & Lahm, 2002; Ajuwon et al., 2016; Zhou et al., 2011; Zhou et al., 2012). In Zhou et al. (2011) and Zhou et al. (2012), teachers of students with VI (TVIs) self-reported low levels of expertise for competencies, such as: troubleshooting devices, teaching students to use the internet, using braille translation software, supporting refreshable braille displays, and teaching file transferring. In Ajuwon et al. (2016), TVIs consistently expressed their desire for more access to professional development opportunities related to new AT devices. Thus, there seems to be a call in the field of VI to focus on newer electronic technology.

Moreover, technology continues to be integrated into the general curriculum (Kamei-Hannan et al., 2017). Universal design has pushed classroom technology and curricula to become more accessible for all students (Rose, 2000). Thus, a conceptual overlap has formed between AT and instructional technologies (Ok & Roa, 2019). For example, a student may use an application such as Google Classroom (i.e., instructional technology), but also need to download extensions in Google Chrome or learn screen reading commands (i.e., AT) to access the information presented in the application. Therefore, this dissertation considered any form of electronic technology listed in a student's Individualized Education Plan (IEP) or technology supported by a special educator as AT.

Assistive Technology Use and Services Among Students with Visual Impairments

Despite the importance placed on promoting AT use as a key element of access and participation in classrooms, direct examination of AT usage in classrooms is quite limited. The small body of existing literature examining AT use primarily derives findings from teacher responses to surveys (i.e., Abner & Lahm, 2002; Edwards & Lewis, 1998; Kapperman et al., 2002; Tuttle & Carter, in press) and secondary analyses of national data sets (i.e., Kelly, 2009; Kelly, 2011). These studies provide several critical conclusions about AT use.

First, students' use of technology is related to their TVI's service delivery model (i.e., itinerant, resource, resource/itinerant, or self-contained; Kapperman et al., 2002; Kelly, 2011). Moreover, these factors are stronger predictors of AT use than student factors. Students' AT use being tied to anything other than their educational needs suggests that some students who might benefit from AT may not be receiving these services. Moreover, educators in itinerant service models may not be considering AT for all their students. The potential neglect of AT consideration is further suggested by variations in AT use among students who have very similar learning profiles (Kelly, 2009; Kelly, 2011).

Second, the scope of AT use seems limited in terms of the basic functions students can perform. For example, Tuttle and Carter (in press) found that less than half (47%) of 51 students with VI in the state of Tennessee used AT for word processing and 51% use the internet. This is a much higher reported level of AT use compared to the 3% of students using word processors reported in Edwards and Lewis (1998) and the 17% reported in Abner and Lahm (2002). Likewise, internet use increased from 8% to 51% (Abner & Lahm, 2002). Improvement in the accessibility of technology, increased access and reliance on technology, and skills resulting from personal technology use over the last 20 years likely plays a major role in the differences in technology use across these studies. However, the persisting modest proportion of students using AT in these areas is concerning, given the role these skills play in general education curricula and post-secondary success.

Third, the range and types of technology used across students suggest that AT needs are highly individualized (Abner & Lahm, 2002; Edwards & Lewis, 1998; Tuttle & Carter, in press). Studies have found that students often use multiple devices that perform an array of functions. Moreover, given the current body of knowledge regarding access to AT, limited AT services may be correlated to limited AT use in classrooms. Moreover, relatively little is known about the nature of these students' device use within inclusive classrooms due to a lack of observational studies.

Although this body of literature provides valuable insights into the field, an incomplete picture of technology use remains. Currently, implications for AT use are quite broad and focus on expanding AT consideration to a broader population of students and across a wider set of applications. However, researchers have not examined the types of instruction and support needed to promote AT use. The need for a greater understanding of students' AT use within core content classrooms is driven by at least two concurrent trends. First, legislative and policy initiatives continue to emphasize the importance of AT in instructional programming. Educators are legally required to consider AT for any student with an IEP (IDEA, 2004). Moreover, educators are required to provide students with VI AT services to support their use in these classrooms. Documenting current practices seems critical given the lack of empirical research available on AT (Ferrell et al., 2014; Smith & Kelly, 2014). It is instructive to consider more closely the landscape of AT use in classrooms to ensure that devices are having the intended impact laid out in the policy. Direct observation can also help identify barriers to opportunity, attitudes, and support that may limit the extent to which devices are used. When addressing AT use, researchers and practitioners should consider multiple factors: the environment, competing supports, and the individual needs of students with VI.

Factors Associated with Assistive Technology Implementation

Several studies have examined barriers to AT among students with VI to explain their underwhelming AT use. Identifying barriers to AT use and services have primarily been examined through teacher-reported data. These studies focus on factors related to educators, such as inadequate AT knowledge and skills (e.g., Ajuwon et al., 2016; Wong & Cohen, 2011; Zhou et al., 2012). Other external factors such as barriers to funding and cost for AT (Kaye, 2009; Senjam et al., 2020), constraints on instructional time (Lohmeier et al., 2009; Wolffe et al., 2002), lack of instructional curricula (Trotter et al., 2018), and lack of parental support (Trotter et al., 2018; Wong & Cohen, 2011). However, these studies identified a narrow scope of barriers to AT use. For example, these studies lack students' perspectives on the benefits and challenges of using AT in classrooms and direct observation of AT use. One study (D'Andrea, 2012) examined students' perspectives regarding AT use for literacy. Students reported using a wide variety of devices used for reading and writing, which were utilized by students based on the tasks they were participating in and personal preferences. However, these perspectives were limited to literacy experiences rather than offering a broad perspective on technology use throughout instructional routines.

The Need for Direct Observation

Direct observation of AT use and services could inform the field of VI in several important ways. First, direct observation provides a more precise measure of AT use. Surveys of AT are often limited to identifying who uses technology rather than how often, when, and where technology is used (e.g., Kapperman et al., 2002; Kelly, 2009; Kelly, 2011). Direct observation can depict AT use with more precise measures to quantify the length and frequency of AT use in classrooms. Second, direct observation can help illustrate the contexts and experiences of students who use AT. For example, observations could document the types of classes in which students use AT, the instructional expectations placed on them, and the social participation of AT users. Understanding the landscape of and classroom experiences of AT users can help prioritize AT needs identified through observations. Educators may be providing students instruction based on curricula unaligned with students' classroom experiences. For example, students may receive disproportionate instruction on skills rarely used to participate in classroom activities (e.g., using presentation applications such as PowerPoint or Keynote).

Third, direct observations allow for the exploration of factors related to AT use beyond the perceptions of educators. Most surveys have been limited in identifying factors related to AT use beyond instructor-reported factors. However, there may be a myriad of contextual variables that influence AT beyond what is reported by teachers. For example, instructional format or proximity to other students and teachers may impact whether students utilize their technology.

The Need for Student Perspectives

Evaluating student perspectives could make several important contributions to research. First, student perspectives may provide much-needed insights on barriers to AT use. Some factors may not be easily observed and would be best explored through students' descriptions of AT experiences. For example, students with VI may choose not to use AT because of the stigma associated with a device (Murchland & Parkyn, 2010; Parette & Scherer, 2004; Shinohara & Wobbrock, 2016) or they may feel that their technology preferences are not considered (Martin et al., 2011; Philips & Zhao, 1993). Students might also identify ways device performance impacts AT use (Gajos et al., 2010; Murchland & Parkyn, 2010; Philips & Zhao, 1993). Exploring the experiences of students is vital for directly identifying why students are or not using their devices.

Second, students could address how AT devices or services can be extended to meet their needs better. For example, students may indicate they have needs unmet by the device(s) they use or that they have not learned to use various features of devices. Thus, student perspectives might identify a need for expanding the technology or services available to students.

Third, students may identify important benefits of technology that lead to increased AT use. Conceptual models of AT suggest that perceived benefits of technology reinforce and promote future technology use (Lenker & Paquet, 2003). Thus, research gathering students' perceptions on the benefits of AT could provide practitioners with important information on promoting student "buy-in" regarding technology to improve AT use, especially for new AT users.

Purpose

Current examinations of AT use speak broadly to the types of students with VI receiving AT devices, services, and the types of tasks conducted with AT. However, little is known about the specific AT supports students receive and how AT is used to engage in access to information and instruction. Moreover, few studies have examined the perceived benefits and challenges of AT use through student perspectives. This study was designed to address these issues through the following research questions:

1. What are the characteristics of AT use among students with VI in core-content classes?
2. What are the academic and social experiences of students with VI who use AT?
3. Is individual AT use associated with contextual variables or student behaviors?
4. What benefits of AT do students report?
5. What factors influence AT use?

CHAPTER II

Method

I used a multiple-method, explanatory design consisting of two distinct phases: classroom observations of middle and high school students with VI (quantitative) followed by semi-structured interviews with participants (qualitative; Morse, 2003). The first phase examined assistive technology (AT) use by students with VI in core-content classes and explored related factors. The second phase expanded on the observational findings by exploring students' perspectives on influential factors and benefits of AT use. I connected the first and second phases by using patterns in the quantitative data to inform the subsequent interviews with students.

Participants

Ten students participated in this study. To be included in this study, participants had to meet the following six criteria: (a) identified as having a visual impairment in their IEP, (b) enrolled in a middle or high school in grade level 6 or above in a local district public school or state school for the blind; (c) attended a core-content class (i.e., math, science, language arts, social studies) with peers; (d) had a "high-tech" AT device (i.e., an electronic form of AT) assigned to them; (e) spoke English as a primary language; and (f) provided student assent after I obtained parental consent.

Recruitment and Selection

After receiving approval from the Vanderbilt Institutional Review Board, I reached out to 18 districts and two state schools for the blind seeking approval for my study. I first sought districts in the Middle Tennessee area. Recruitment began in August 2021 in the midst of the COVID-19 pandemic. In particular, Delta and Omicron surges shaped the participation and research policies of several school districts that did not allow visitors in classrooms. Therefore, I expanded my recruitment to districts surrounding large cities in Tennessee and at the Kentucky School for the Blind to achieve my recruitment goals. Three school districts and the Kentucky School for the Blind provided approval. Five districts declined participation due to their COVID visitor policies. One district approved the student interviews but did not allow classroom observations. Another school district declined participation due to requests for IEP information. Eight districts did not respond to multiple invitations for participation. Administrators at the Tennessee School for the Blind expressed a willingness to participate in the study. However, the state research review committee did not review the study before data collection concluded.

My goal was to recruit at least 10 secondary students (i.e., grades 6 to 12) based on several observational studies using similar observational measures (e.g., 13 students in D'Allura (2002), 16 students in Carter et al. (2005), 16 students in Chung et al. (2012), 10 students in Chung et al. (2019), 11 students in Rehm and Bradley (2006). To recruit participants, I obtained contact information for TVIs from special education directors, personnel identified by a district's research review committee, and district websites. I emailed TVIs to request assistance in recruiting students to participate. In the email, I explained the purpose of the study, briefly described the data collection procedures, listed the inclusion criteria for participants, and described the involvement of TVIs (see Appendix A). Based on teacher requests, I provided TVIs with hard or electronic copies of consent forms.

Across the four districts and one state school for the blind that participated, I reached out to 14 TVIs. Ten teachers sent home consent forms to 21 students; ten consent forms were returned by parents . After receiving consent forms, I met with TVIs to obtain student assent and a copy of the student's IEP. Of note, three potential participants were mentioned by TVIs who were enrolled in virtual learning formats due to personal concerns related to COVID. The three students were described as being proficient AT users, but were excluded from the study because their instructional format prevented classroom observations.

Demographics

I primarily gathered student demographic information from students' IEPs. At the beginning of their interviews, I also asked students to provide information regarding the number and types of assistive technology devices they used. A total of 10 students participated in the study. The majority (80.0%) was female and white, non-Hispanic (80%). Two students were Asian American. All students had light perception and were legally blind (i.e., 20/200 acuity or worse with best correction). Four of the students (40%) used braille as a primary learning medium and six students (60%) used large print. None of the students used audio or adapted/alternative communication methods (including augmented communication devices) as their primary learning media. One of the students had an additional intellectual disability, and one had a specific learning disability. Most students (n = 9; 90%) reported having multiple devices assigned by schools (M = 2.9 devices per student). One student reported using a personally owned device for schoolwork. All other devices were provided by the state or local school district. One factor that arose during interviews was the length of time students had been assigned their technology. One student mentioned that they had only been using their device for a year (See Owen in *Technology Skills*). However, this data was not readily available in IEPs and data were not gathered for all students but would be important demographic data for future research in this area.

Table 1

Participant Information

	Demographics						
Student	Sex	Race/ ethnicity	Primary learning medium	School level	Additional disabilities	Devices	Class subject[b]
Emma	Female	White	Large print	High school	-	tablet	Social studies
Haley	Female	White	Large print	High school	-	laptop, tablet, portable video magnifier	Chemistry
Hana	Female	Asian American	Braille	Middle school	-	tablet, braille notetaker, book player, adapted desktopa	English and language arts
Henry	Male	White	Large print	High school	Intellectual disability	laptop, talking calculator	Math
Kelsey	Female	White	Braille	High school	Specific learning disability	braille notetaker, laptop, phone	Physics
Laura	Female	White	Braille	Middle school	-	tablet, braille notetaker, book player, talking calculator	English and language arts
Melanie	Female	White	Large print	High school	-	laptop, tablet, phone	English and language arts
Olivia	Female	Asian American	Braille	High school	-	laptop, talking calculator	Social studies
Owen	Male	White	Large print	Middle school	-	tablet, book player, adapted desktopa	Social studies
Turner	Female	White	Braille	High school	-	tablet, phone, braille notetaker, laptop	Math

Note. [a]Desktop was located in a room for students with VI and was used when students were unable to complete their work in class on other forms of AT. The device had a keyboard with enlarged symbols on keys and high contrast. The device also had multiple assistive applications installed on the computer (e.g., screen enlargement and screen reading software).
[b]The subject of the core-content class that students were observed during the study.

Schools and Classrooms

Students attended seven different schools in four different districts and one state school school for the blind. Eight students (80%) attended schools in their local public school district. Two students (20%) attended the Kentucky State School for the Blind. Three students (30%) attended a middle school (i.e., grades 6-8) and seven students (70%) attended a high school (i.e., grades 9-12). Student enrollment averaged 1,034 (*SD* = 572) across schools.

Table 2
School Demographics

		Demographics								
School	Population	Female[a]	Black	Asian	Hawaiian[b]	Hispanic	Native American	White	Multi-Racial	Disability[d]
Eastview HS	1739	51.6%	2.8%	9.9%	0.1%	3.6%	0.2%	79.4%	4,1%	6.2%
Greenland HS	830	47.6%	6.1%	0.5%	0.0%	4.6%	0.2%	86.3%	2.3%	19.3%
Greenwood[c]	63	31.7%	7.9%	11.1%	0.0%	9.5%	0.0%	68.3%	3.2%	100%
Lone Oak HS	1759	50.9%	1.6%	4.4%	0.1%	6.4%	0.1%	83.2%	4.2%	8.6%
Mountainview MS	399	45.4%	5.3%	1.5%	0.0%	11.0%	0.3%	79.4%	2.5%	13.8%
Pine Hills HS	1043	46.6%	13.7%	0.4%	0.1%	6.3%	0.3%	76.2%	3.0%	21.4%
Woodcreek MS	946	47.5%	7.9%	3.7%	0.1%	6.0%	0.1%	78.9%	9.4%	9.4%
West HS	1487	51.2%	18.1%	2.3%	0.0%	11.0%	0.0%	62.8%	5.9%	10.8%

Note. HS = high school; MS = middle school. The graph breaks down the demographics of each participating schools using the National Center for Education Statistic's Common Core of Data for the 2020-2021 school year. Pseudonyms of school names have been generated for each school.
[a]Sex reports the percentage of females.
[b]Full description is Hawaiian and Pacific Islanders.
[c]State school for the blind.
[d]Data are pulled from the state department of education demographic reports, which represent enrollment in special education services (i.e., assigned a 504 or Individualized Education Plan).

The average percentage of female students across schools was 46.6% (range, 31.7% to 51.6%). Students identified with a disability averaged 23.7% (range, 6.2% to 100%) across schools. The race/ethnicity of each school's students was often reflective of local demographics, with the largest demographic being white (*M* = 76.8%; range, 62.8% to 86.3%).

Observations occurred during one core-content class (i.e., math, science, English and language arts, social studies). I observed three students (30%) in English and language arts classes, three students (30%) in social studies classes, two students (20%) in math classes, one student (10%) in a physics class, and one student (10%) in a chemistry class. Across these subjects, seven students (70%) attended inclusive classes, two students (20%) attended classes in the academic wing at the state school for the blind, and one student (10%) attended a remedial math class with additional special education service providers and supports. I selected classes for observations based on recommendations from the TVIs and students (in cases where TVIs referred to multiple options). I asked TVIs to base recommendations for classes on where the student was most likely to use their devices. According to TVIs, students were enrolled in an average of 4.7 inclusive classes (range, 2 to 7) at the time of the study. Six students (60%) attended classes on a period schedule (i.e., classes lasted from 40 to 70 min), and four students (40%) attended classes on a block schedule (i.e., classes lasted longer than 90 min). Class sizes consisted of an average of 15.4 students (range, 2 to 29) and 1.7 adults (range, 1 to 5). While COVID restrictions resulted in restricted visitor policies for some school districts, COVID restrictions were not observed in any of the participating classes. I and my secondary observers wore masks during all of our observations to comply with CDC recommendations and University policy. However, only a small minority of students chose to wear masks in their class and none of the classroom teachers wore them while providing instruction. Moreover, none of the participating students sat next to students with masks. Thus, COVID likely had little impact on the classroom experiences of participants.

Classroom Observations

I used observational measurement to examine students' AT use in core-content classes. Data collection occurred in person using paper-and-pencil data collection forms (see Appendix A). I used in-person data collection to capture contextual variables within the classroom. I conducted three direct observations for each participating student. Observers positioned themselves where the focus student could be seen and heard clearly while avoiding being intrusive. Observers avoided interactions with students, peers, or adults during the observations. If students or staff asked what the observer was doing, the observer responded with the following statement: "Our focus is on how students complete classroom activities." After the observations concluded, observers filled in secondary measures on the observation form and completed the support behavior checklist and technology use checklist (see Appendices D and E).

Each observation lasted the entire class period (i.e., from bell to bell). Observations averaged 61.7 min (range, 41 to 87 min). I did not conduct observations on days when tests/assessments were taking place, when students watched a video for the entirety of the class period, when the classroom teacher was absent, when a field trip was scheduled, or when the class was held outside of the classroom. I collected data using 30-second intervals and an intermittent coding procedure (i.e., 15s observe, 15s record). I measured social interaction and technology support variables using partial interval sampling. I coded whether these behaviors occurred at any point during the 15s observe period. For all other variables (i.e., AT use, work tasks, peer and adult proximity, instructional grouping, and academic engagement), I used momentary time sampling and coded behaviors occurring at the end of the 15s observe period. In addition, the observers took notes on the types of instructional activities that occurred and the technology students used during observations. When teachers sent students work on the devices, the observers asked the classroom teacher about the instructional expectations and for copies of assigned work.

Observational Measures

I collected observational data for nine variables. My primary measure was AT use, which I contextualized with two additional observational measures: malfunction and device proximity. I used these three variables to address my first research question (What are the characteristics of AT use among students with VI in core-content classes?). For my second research question (What are the academic and social experiences of students with VI who use AT?), I also collected data on four contextual classroom measures (i.e., technology supports, work tasks, peer and adult proximity, instructional grouping) and two measures of student behavior (i.e., academic engagement, social interaction) to explore factors related to AT use. My third research question (Is individual AT use associated with contextual or student behaviors?) was addressed by exploring nested AT use data in relation to the other observational measures. For a summary of observational codes, see Appendix B.

Additionally, I collected two secondary measures to provide further descriptive information about AT use: (a) a checklist of different functions students performed on the devices, and (b) a checklist of the different types of technology support students received (see Secondary Measures and Appendices D and E).

AT Use. I coded the extent to which students used their AT during class. A student's use of AT often manifested differently based on their primary learning medium. I defined *AT use* as the occurrence of any of the following behaviors: (a) students operating buttons or keys on their device to navigate or produce information, (b) students visually fixating on the text on a device's screen, (c) students listening to text-to-speech generated by their device, or (d) students moving their fingers across a refreshable braille display (Tuttle & Carter, 2020). For example, AT use could involve a student typing up answers to a worksheet on a braille notetaker, listening to an audiobook, playing a game, or proofreading an assignment. Actions coded as AT use did not have to relate to activities assigned by an adult. I did not consider a student to be using a device when they were resting hands on the device while listening to their classroom teacher or when students indicated their device was not working (see malfunction).

I coded two additional variables to contextualize students' opportunities to use devices: malfunctioning and device proximity. I coded when students reported that their device was not working or unusable. I defined *malfunction* as the focus student verbally indicating to an adult that they could not use their device (Tuttle & Carter, 2020). For example, one student told their paraprofessional their device was not usable because the battery died. Once I began to code malfunctioning, I continued to code the subsequent intervals as malfunctioned until the device was fixed or replaced. Malfunctioning did not include the student communicating that they did not know how to perform a task on the device or indicating that information on the device was inaccessible. Malfunctioning and AT use were mutually exclusive. Thus, both could not be coded at the same time.

I also coded whether students were in proximity to their AT devices. For *proximity to AT devices*, devices had to be clearly visible within their workspace (i.e., out on their desk or a table) and within arm's length (Tuttle & Carter, 2020). Devices in a backpack or stowed away in a student's desk were not considered to be in proximity.

Contextual Classroom Measures. I collected observational data on four contextual measures—technology supports, work tasks, peer and adult proximity, and instructional groupings. These data were used to explore contextual associations with AT use. Definitions for each measure are provided below.

Technology Supports. I defined *technology support* as an interaction (see Social Interaction) with a peer or an adult that encouraged students to use their devices or explicitly helped them operate or repair their devices. When an interval was coded with a technology support, I also indicated whether a peer or an adult provided the support.

Work Tasks. I defined a *work task* as the instructional activity presented by a general or special educator in which the student is expected to engage (Kuntz & Carter, 2021). Expectations were often communicated verbally by the teacher, but at times expectations were communicated in writing (e.g., on the board or instructions posted on a learning platform) or embedded in classroom routines (e.g., bellwork). I measured seven different types of work tasks: listening, discussion, reading, written work, hands-on activity, other task, or no task. For *listening* to be coded, there had to be an expectation that the student should be oriented to a speaker (i.e., adult or peer) or their device to receive information (including information presented in videos or audiobooks). Students were not expected to respond during a listening task. For a *discussion* task to be coded, students had to be oriented to a speaker or partner with an expectation to also respond to their speaker or partner. For *reading* to be coded, students had to be expected to tactilely or visually read a handout, textbook, or material but not expected to write. For *written work* to be coded, students had to be expected to read and write on a worksheet, workbook, notebook/journal, or write down responses to verbally/visually presented questions. For *hands-on activities* to be coded, the student had to be expected to manipulate physical materials other than paper and AT devices (e.g., 3-dimensional geometric shapes, bingo board, lab equipment) in an instructional activity. If a task did not meet the previous codes' definition, I coded it as *other*. I coded *no task* when students were not presented with a task, were transitioning, or had downtime. If the no task condition was coded, the interval also had to be coded as *no instruction* (see *Instructional Grouping*). Because no task and no instruction had to be coded simultaneously and shared operational definitions, only no instruction is reported to reduce repetition of data.

Peer and Adult Proximity. I coded the presence of peers and adults near the participants. I defined *peer and adult proximity* as the student with VI being within three feet of another person (adapted from Carter et al., 2011; Carter et al., 2016; Tuttle & Carter, 2020). I coded the role of the people in proximity to the student with VI using the five different classifications (i.e., classmates with disabilities, classmates without disabilities, special educators, paraprofessionals, and general educators). Classmates had to have a visible disability or visual impairment to be coded as a classmate with a disability.

Instructional Groupings. I coded the groupings in which the focus student received instruction. This measure had five codes: large group, small group, adult one-on-one, independent work, or gone (adapted from Carter et al., 2016). I coded *large group* when the student received instruction in a group of eight or more. I coded *small group* when the student received instruction in a group of two to seven students. I coded *adult one-on-one* when the student was the only one who received instruction from an adult. For example, I coded as adult one-on-one when a paraprofessional was working with just the participating student on an assignment. I coded *independent work* when the student received an assignment or activity to complete on their own. If students finished their work, or were not provided instruction, I coded *no instruction*. When an interval was coded as no instruction, the interval also had to code *no task* (see *Work Task*) and *not engaged* (see *Academic Engagement*) had to be coded. For purposes of repetition, no I coded *gone* when the student was not present in the classroom.

Behavioral Measures. I collected data on each student's academic engagement and social interaction. The purpose of collecting this data was to address my second and third research questions: What are the academic and social experiences of students with VI who use AT? Is individual AT use associated with contextual or student behavior?

Academic Engagement. I coded whether students were academically engaged at the end of each observation interval using momentary time sampling. I categorized engagement as actively engaged, passively engaged, and not engaged (adapted from Carter et al., 2011; Carter et al., 2016; Tuttle & Carter, 2020). These codes were exhaustive and mutually exclusive. I defined *actively engaged* as the student physically interacting with materials or engaging in activities assigned by an instructor. For example, I considered students writing down answers to an assigned activity or participating in a small-group discussion activity to be actively engaged.

Students had to perform verbal or physical actions to be actively engaged. I coded students as *passively engaged* when they listened to a class lecture or videos. Students were assumed to be engaged unless they were actively exhibiting behaviors that indicated they were unengaged. I considered students as *unengaged* if they were clearly disengaged with an instructional activity (e.g., not completing an activity that is assigned by a teacher) or actively involved in a non-instructional activity (e.g., sifting through their backpack, participating in social-related interactions during a lecture, working on activities from another class, or putting their head down). Academic engagement was not mutually exclusive with AT use. Thus, students could be using their devices to participate in off-task behaviors, such as games, social media, or completing assignments from other classes.

***Social Interaction*.** I defined *social interactions* as verbal behavior with clear communicative intent between the student with VI and another person (adapted from Carter et al., 2011; Carter et al., 2016). This definition did not include non-verbal behaviors because students' VI complicate their ability to identify physical or non-verbal communication attempts. Social interactions reflected the different social partners the students interacted with (i.e., classmates with or without disabilities, special educators, paraprofessionals, and general educators). I did not code verbal behaviors that were not directed toward another individual (e.g., self-talk, echolalia). I also coded the number of unique peers contacted (i.e., peers with whom students had at least one interaction) and the number of students and adults in the classroom to document the classroom context and the social opportunities available to students. I coded these once, immediately after the observation had concluded.

Secondary Measures. I recorded two secondary descriptive measures related to the technology supports students received and the different ways technology was used throughout the observations (see Appendices D and E). These measures were collected through checklists completed immediately after the observation had been completed. The purpose of the checklists was to capture the range of technology supports and types of use. Each checklist item was a brief description of a different type of technology use students engaged in or technology support students received (adapted from Carter et al., 2016). An example of a type of technology use was a student using their device to submit their work via email. An example of a technology support was a paraprofessional telling a student to open the start menu (i.e., verbally reorients the student to their digital location). See Appendices D and E for a complete list of checklist items.

Each support or type of use was coded only once per observation. Most technology support items were adapted from Abner and Lahm (2002). Items on the Function of Technology summary sheet are adapted from earlier studies (i.e., Abner & Lahm, 2002; Bausch et al., 2015; Tuttle & Carter, in press).

Observer Training

The primary observer across all observations was the first author. Additionally, I prepared three secondary observers during two training sessions. The secondary observers all had or were obtaining special education degrees. One was a master's graduate student, one was a doctoral candidate, and one was a post-doctoral researcher. First, observers participated in an initial meeting where I reviewed the observational data collection sheet (see Appendix C), the technology support checklist (see Appendix D), the technology use checklist (see Appendix E), and the corresponding behavioral coding manual, including operational definitions, examples, and non-examples for each variable. I coded 10 sample intervals from video examples developed as a criterion-code measure. Second, observers completed four practice coding videos on their own. I created three video examples and non-examples of sample classroom observations. I acted out the scripts with an assistant who did not participate as a coder in the study. The video allowed trainees to engage in multiple coding opportunities of prototypical examples, marginal examples, and marginal non-examples of each observational measure. I used one additional publicly available video clip to practice coding different instructional groupings. Then, I held a follow-up meeting where I discussed any disagreements between trainees' codes and the coding criterion and trainees completed a written quiz on definitions of codes and coded vignettes describing classroom situations. The second meeting lasted approximately 40 min. Observers were required to achieve at least 80% agreement on all variables when coding four short video segments and 90% accuracy on a written test of coding definitions. One observer failed to meet a 90% criterion on the written quiz. The observer watched two additional videos to practice coding on their own before completing and passing a different second quiz.

Interobserver Agreement (IOA)

I collected IOA data for one third of observations for each focus student. IOA observations were scheduled based on the availability of second observers. During IOA observations, coders began coding simultaneously at the class bell or the posted class start time when a bell was not used to signal the start of class (i.e., following the starting criteria outlined in the coding manual). After the observations, observers identified disagreements and held formative agreement discussions to review coding definitions and prevent observer drift.

I calculated IOA for each variable through point-by-point agreement by dividing the total agreements by the total agreements and disagreements and multiplying by 100. Overall agreement for each behavior was as follows: AT use (M = 94.2%, range 90.0% -100.0%), device proximity (*M* = 98.4%, range 91.9% -100.0%), device malfunction (*M* = 100.0%), technology support (*M* = 99.5%, range 97.8% -100.0%), work tasks (*M* = 88.1%, range 67.6% - 97.2%), peer proximity (*M* = 98.6%, range 80.8% -100.0%), adult proximity (*M* = 98.9%, range 91.9% - 100.0%), peer social interactions (*M* = 97.7%, range 88.9% -100.0%), adult social interaction, (*M* = 98.1%, range 90.9% -100.0%), instructional grouping, (*M* = 94.0%, range 95.0% -100.0%), academic engagement (*M* = 92.0%, range 81.7% -98.8%). Some variables (i.e., device malfunction, technology support, and social interactions) occurred infrequently. Table 3 provides a more detailed breakdown of IOA measures to provide more conservative estimates (i.e., occurrence and non-occurrence agreement) of agreement and account for chance agreement. Occurrence agreement was calculated by the number of intervals both coders coded a behavior divided by the number of intervals both coders coded a behavior plus the number of times only one coder coded a behavior. Non-occurrence agreement was calculated by the number of intervals neither coder coded a behavior divided by the number of intervals neither coder coded a behavior plus the number of times only one coder coded a behavior.

Agreements on AT use were very high overall. Disagreements occurred due to the context of the usage and differences in visibility across observers. For example, one student primarily used a talking calculator during class, exhibiting only brief usage while completing problems on his worksheet. Coding was also influenced by the ability to see or hear students operating their devices. These disagreements were infrequent, as observers adjusted positioning when these issues arose. Similar high agreement and disagreement issues were present for technology supports, various proximities (i.e., device, peer, and adult), social interactions, and engagement. The agreement was also high for instructional grouping. Infrequent classification disagreements occurred when students finished tasks or brief breaks occurred during instruction.

Work task agreement was high but presented the most disagreements. Disagreements most often occurred when expectations for students fluctuated between solely listening to lectures to class-wide discussions or guided notes.

Table 3

Interobserver Agreement for Observational Measures

Item	Overall	Occurrence	Non-occurrence
Assistive technology use	94.4% (90-100)	86.7% (75-100)	90.4% (79-100)
Device proximity	98.4% (92-100)	98.1% (93-100)	91.8% (75-100)
Malfunctioning[a]	100%	100%	100%
Peer technology support	100%	-	100%
Adult technology support	98.9% (96-100)	58.0% (0-100)	98.3% (93-100)
Work tasks[b]	88.3% (68-98)	-	-
Peer proximity			
Classmate	97.2% (81-100)	94.6% (81-100)	89.9% (0-100)
Classmate with disabilities[a]	100%	100%	100%
Adult proximity			
Teacher	97.7% (92-100)	70.2% (0-100)	97.6% (91-100)
Special educator	99.8% (99-100)	98.5% (98-99)	90.8% (0-100)
Paraprofessional	99.2% (91-100)	94.3% (89-100)	97.2% (69-100)
Instructional grouping[b]	94.1% (85-100)	-	-
Engagement[b]	92.0% (79-99)	-	-
Peer social interaction			
Classmate	95.6% (87-100)	71.1% (59-100)	94.3% (93-100)
Classmate with disabilities[a]	99.8% (98-100)	80.0%[c]	99.4% (98-100)
Adult social interaction			
Teacher	96.6% (89-100)	77.8% (50-100)	96.3% (88-100)
Special educator	99.3% (96-100)	94.2% (92-100)	99.6% (96-100)
Paraprofessional	98.6% (91-100)	88.6% (77-100)	97.6% (86-100)

Note. Values are mean averages across student and ranges are provided in parentheses. See *Interobserver Agreement* for a description on how agreement was calculated for each estimate of agreement.
[a]Behavior occurred during a single agreement observation. Thus, a range cannot be provided.
[b]Occurence and non-occurrence agreement is not provided for exhaustive measures because they are coded during every interval.
[c]Social interactions with a classmate with disabilities only occurred in one agreement observation.

Chance agreement was below thresholds (i.e., 80%) for adult technology supports. This agreement level was heavily impacted by the low frequency of data. Adult technology supports only occurred in four IOA observations and was influenced by an observation where there was only one opportunity for occurrence agreement. Observer drift by one of the observers likely impacted agreement for this observation. If this one missed opportunity was removed, occurrence agreement for adult technology support would have been 72.5%.

Interviews

After the classroom observations were completed, I conducted semi-structured interviews to gather further information about students' AT use and associated factors. Interviews consisted of several open-ended questions in which students could respond with as much or as little detail as they decided (see Appendix E). These interviews averaged 30 min (range, 16 to 36 min). The interviews were guided by the following four overarching questions/prompts:

1. Describe how you currently use AT.
2. Describe the types of AT instruction and supports you currently receive.
3. How have you benefited from using AT?
4. How do you determine when you do or don't use your technology? What are the challenges you experience while using your technology?

First, I identified the different types of AT students used and clarified the contexts in which students used their devices. Second, I asked students to report the kind of AT instruction and supports they received to explore their perspectives on their preparedness to use AT. Third, I asked students what they viewed as the benefits of AT use to explore the positive impacts AT has. Fourth, I asked the students to identify classroom factors that influenced their decision on whether or not to use AT devices. I further explored these factors by asking students to share the challenges they experience when using AT to identify variables beyond their choices that impact AT use.

My primary reason for using semi-structured interviews was to capture a range of perceived benefits and factors associated with AT use. I recorded field notes throughout each interview to note follow-up questions for comments students made that needed additional clarification. I took considerable efforts to make participants feel comfortable by assuring them of the confidentiality and privacy of our conversation, using understandable language, and reviewing the purpose of my study. I conducted interviews in a private location (away from other students) identified by each student's TVI to protect the student's confidentiality and privacy (e.g., a pullout room, library, empty teacher lounge). Three interviews occurred in the TVI's office and the TVI was present and sometimes interjected during the interview. I also adopted each participant's communication preferences and terminology. Finally, I emphasized that (a) the purpose of data was to understand how to better support AT use in classrooms, (b) they could choose not to answer any questions, and (c) there were no "correct" answers. I audio-recorded, transcribed, and de-identified all interviews and field notes. I reaffirmed student assent at the start of the interviews.

After the interviews were completed, I used a third-party transcription service to transcribe interviews. I checked the transcripts to verify that participants' words were scripted verbatim. I also de-identified participants using pseudonyms. I used Microsoft Word and qualitative coding software, NVivo, to analyze and code transcripts.

Data Analysis

I have broken down descriptions of my data analyses by the type of analyses I used to address the research questions. I used quantitative analyses to address my first three questions and qualitative analysis to address my last two research questions.

Quantitative Analysis

I used descriptive statistics to summarize the contextual variables and student behaviors recorded during observations (i.e., technology use, academic engagement, peer and adult proximity, social interactions, technology support, work task, and instructional groupings for each student with VI; see Tables 4, 5, and 6). I calculated these descriptive statistics by identifying the number of intervals coded for a specific category (e.g., actively engaged, large group instruction) by the total number of intervals students were observed across all three observations. When calculating descriptive statistics, I removed the intervals in which students were gone from the classroom. I reported the percent each category was coded across all three observations. I aggregated observations of students (i.e., the three observations of students) by adding the total number of intervals a behavior or contextual variable was coded by the total time the student was observed across all three classes. I used aggregated observational data to ensure that data represented a stable sample of student behavior (Bottema-Beutel et al., 2014; Yoder et al., 2018). For clarity in reporting and due to a lack of clear patterns in data, peer and adult data were aggregated into peer groupings (i.e., classmates with disabilities, classmates without disabilities) and adult groupings (i.e., classmates with disabilities, classmates without disabilities, special educators, paraprofessionals, and general educators) when nested statistics were used.

What Are the Characteristics of AT Use Among Students with VI in Core-content Classes? Descriptive statistics for AT use was the primary variable I used to address my first research question (see Table 4). I analyzed each student's aggregated AT use (see *Quantitative Analyses*) and disaggregated AT use (see Figure 1). Aggregated AT use allowed for analysis of patterns of AT use across students, while disaggregated AT use revealed variations in AT use across observations for each student.

I also reported descriptive statistics for the different functions of technology collected through secondary descriptive checklists (see Table 7). Individual descriptions of each student's functions of technology were calculated by dividing the number of observations where a technology function occurred by three (i.e., the total number of observations). Table 7 reports an aggregated descriptive statistic for how often each function of technology occurred across all students. I calculated the aggregated statistics for functions of technology by dividing the number of observations any student performed the function of technology (e.g., access to assignments, calculation, recreation) by the total number of observations conducted (i.e., 30). Aggregated statistics are reported in Table 8 due to the low number of data collection opportunities.

What Are the Academic and Social Experiences of Students with VI Who Use AT? I used descriptive statistics for the remaining observational variables (i.e., technology supports, work tasks, peer and adult proximity, instructional grouping, academic engagement, and social interactions) to address my second research question (see Tables 4, 5, and 6). I aggregated variables for each student (see *Quantitative Analyses*) to summarize each of their classroom experiences.

I also reported descriptive statistics for the technology supports students received (see Table 8). I aggregated technology supports across students due to the low number of data collection points. I calculated these statistics by dividing the number of observations where a technology function occurred during any observation with any student by the total number of observations (i.e., 30).

Is Individual AT Use Associated with Contextual or Student Behaviors? I explored the nested frequency of device use during different contextual variables and student behaviors (see Tables 9 and 10). I reported the average percentage of intervals devices were used within each context across all three observations for each student. For example, I calculated the percentage of intervals devices were used during large-group instructional groupings by identifying the number of intervals device use and large group were coded in the same interval across all three observations divided by the total number of intervals (across all three observations) in which large group was coded.

Qualitative Analysis

To answer my fourth and fifth questions (i.e., What benefits of AT do students report? What factors influence AT use?), I utilized a general inductive approach of analysis to synthesize my qualitative data and describe students' perspectives of AT use (Thomas, 2006). I chose a general inductive approach because I sought to identify a full range of perceived benefits of AT and factors perceived to influence AT use. This analytic approach was well suited for this study for three reasons: (a) it helped me reduce raw text data into summaries of experiences that describe AT use, (b) it identified themes related to AT use, and (c) it allowed analysis to be guided by pre-determined research objectives.

I conducted my analysis with my advising professor, who has qualitative research experience and did not participate in the study as an interviewer. The focus of my analysis was descriptive in nature. The purpose of my qualitative data was to paint a picture of students AT experiences related to perceived benefits and factors related to decision-making rather than develop theories around these areas. First, all interviews were transcribed. Next, my partner and I independently read and identified response passages (i.e., a phrase, sentence, or group of sentences) in which participants discussed the ways technology provided a benefit (i.e., descriptions of how technology has created a positive change in their lives) or factors that influenced the technology use (i.e., descriptions of the way the environment, social behaviors or expectations, or personal priorities influenced their decisions to use a device). Then, I assigned open codes (i.e., descriptive codes that labeled passages of participant experiences that met definitions above). During this phase we created codes with terms used by the participant (e.g., "personal preference," "what is most helpful," "can work without it"). We discussed discrepancies in our coding to form a unified codebook. Second, I reviewed transcripts and held discussions with my partner to ensure codes were applied consistently across interviews. Last, I analyzed my compiled codebook and interviews for broader categories and themes that emerged from patterns in the application of codes. During this phase, coding occurred on a categorical level to label groups of open codes. For example, several codes (e.g., access to reading materials, assignments, distance information, tests, and homework) described accessing different types of content within classrooms. These were collapsed into a single theme (i.e., access) where the thematic relationships (e.g., common benefits of AT for participating in each activity) could be highlighted and contrasted with the unique qualities of codes (e.g., limitations of AT for accessing distance information) within each theme. My analysis was descriptive (i.e., to identify a full range of benefits and factors related to AT use) rather than theoretical or structural.

Credibility. I purposefully recruited participants with a range of severity of visual impairment and modes of access to devices. Additionally, I limited recruitment to participants with experience with technology to ensure participants' reflections yielded rich and relevant information about AT use. Semi-structured interviews provided space to clarify each student's responses and provided a rudimentary level of member checking to ensure clear participant responses.

Transferability. I used participant quotes in my results to allow readers to interpret the different perspectives of each participant. Moreover, I purposefully sampled participants to focus on the specific characteristics of AT use and the needs of students with visual impairment. I used negative case analysis to generate descriptions of a variety of experiences. As mentioned previously, participants represented various severities of visual impairment.

Dependability and Confirmability. I used intermediate member checking during interviews to clarify responses and ensure accurate interpretations of responses. I was transparent with my coding procedures in the description of my data analysis procedures. Additionally, my codes were developed through joint analysis with a partner to increase the dependability of codes. I reported my codebook and examples to communicate the process of my analysis and allow consumers of my research to evaluate its dependability. My partner served as a peer debriefer and provided me feedback on the transparency of my reporting and the rigor of my analysis (especially related to negative case analysis). In regard to my positionality, I approached this work with the belief that AT is important for students with VI to access information and participate in classroom instruction. Experiences and knowledge of prior research and working as a TVI also led me to anticipate that students likely receive little technology instruction/supports and underutilize technology despite the potential benefits.

CHAPTER III

Results

Quantitative Findings

The primary variable of interest was AT use. Other coded behaviors were malfunction and device proximity, technology supports, work tasks, peer and adult proximity, instructional grouping, academic engagement, and social interaction. Tables 3, 4, and 5 display descriptive information for all variables across participants.

Table 4
Descriptive Statistics of Student Behaviors

		Academic engagement			Tech support		Social interaction				
Student	AT use	AE	PE	NE	P	A	C	D	T	S	Pp
Emma	87.0%	76.4%	0.6%	23.0%	0.6%	0.0%	18.6%	0.0%	0.6%	0.0%	0.0%
Haley	22.8%	55.3%	5.7%	39.0%	0.0%	0.0%	8.1%	0.0%	4.1%	0.0%	0.0%
Hana	51.4%	18.9%	38.2%	42.9%	0.5%	0.9%	25.0%	0.0%	9.0%	0.0%	0.0%
Henry	30.5%	55.7%	13.0%	31.3%	0.0%	4.6%	0.0%	0.0%	51.9%	0.0%	1.5%
Kelsey	49.7%	66.2%	8.6%	25.2%	0.0%	4.6%	0.0%	3.3%	45.7%	0.0%	0.0%
Laura	87.6%	68.4%	8.0%	23.6%	0.4%	4.0%	10.8%	0.0%	15.6%	0.4%	0.0%
Melanie	52.7%	56.9%	0.0%	43.1%	0.0%	9.0%	4.8%	3.6%	55.7%	0.0%	0.0%
Olivia	60.1%	39.9%	27.0%	33.1%	0.7%	29.1%	1.4%	0.0%	37.2%	0.0%	19.6%
Owen	10.4%	74.1%	3.7%	22.2%	0.0%	0.7%	31.9%	0.0%	12.6%	11.9%	0.7%
Turner	26.4%	60.6%	15.9%	23.6%	0.0%	3.4%	0.0%	0.0%	4.3%	60.6%	0.0%
Average	**47.9%**	**57.2%**	**12.1%**	**30.7%**	**0.2%**	**5.6%**	**10.1%**	**0.7%**	**23.7%**	**7.3%**	**2.2%**

Note. AT = assistive technology; AE = actively engaged; PE = passively engaged; NE = not engaged; P = peer; A = adult; C = classmates without disabilities; D = classmates with disabilities; T = teachers/general educators; S = special educators; Pp = paraprofessionals. Percentages represent the number of observation intervals an item was coded over the total observation intervals a student was present in a class (i.e., total observation intervals minus the number of intervals the student was gone).

Table 5
Descriptive Statistics of Instructional Variables

	Instructional grouping						Work task					
Student	LG	SG	IN	A1	NI	G	L	D	R	W	H	O
Emma	1.2%	0.0%	83.9%	0.0%	14.9%	0.6%	0.6%	0.6%	3.7%	86.3%	0.0%	0.0%
Haley	11.4%	4.9%	58.5%	0.0%	25.2%	0.0%	5.7%	0.0%	0.0%	63.4%	6.5%	0.0%
Hana	25.5%	5.7%	35.4%	0.0%	33.5%	1.4%	43.4%	7.5%	0.0%	15.6%	0.0%	0.0%
Henry	30.5%	0.0%	42.7%	0.0%	26.7%	0.8%	13.7%	16.8%	0.0%	42.7%	0.0%	0.0%
Kelsey	0.0%	34.4%	49.7%	0.7%	15.2%	0.0%	9.3%	6.6%	0.0%	55.6%	13.2%	0.0%
Laura	18.4%	9.6%	57.2%	1.2%	13.6%	2.8%	8.8%	13.2%	11.6%	52.8%	0.0%	0.0%
Melanie	0.0%	32.9%	25.7%	9.0%	32.3%	1.2%	0.6%	26.9%	5.4%	34.1%	0.6%	0.0%
Olivia	44.6%	0.0%	35.8%	1.4%	18.2%	30.4%	27.7%	0.0%	0.0%	54.1%	0.0%	0.0%
Owen	79.3%	0.0%	8.1%	0.0%	12.6%	0.0%	3.7%	0.7%	3.7%	80.0%	2.2%	2.2%
Turner	16.3%	0.0%	5.3%	59.1%	19.2%	16.3%	16.3%	1.4%	0.0%	63.5%	0.0%	0.0%
Average	**22.7%**	**8.8%**	**40.2%**	**7.1%**	**21.2%**	**5.4%**	**13.0%**	**7.4%**	**2.4%**	**54.8%**	**2.3%**	**0.2%**

Note. LG = large group; SG = small group; IN = independent work; A1 = adult one-on-one; NI = no instruction; G = gone; L = listening; D = discussion; R = reading; W = writing task; H = hands-on activity; O = other. Percentages represent the number of observation intervals an item was coded over the total observation intervals a student was present in a class (i.e., total observation intervals minus the number of intervals the student was gone).

Table 6
Descriptive Statistics of Support and Adult and Peer Proximity Variables

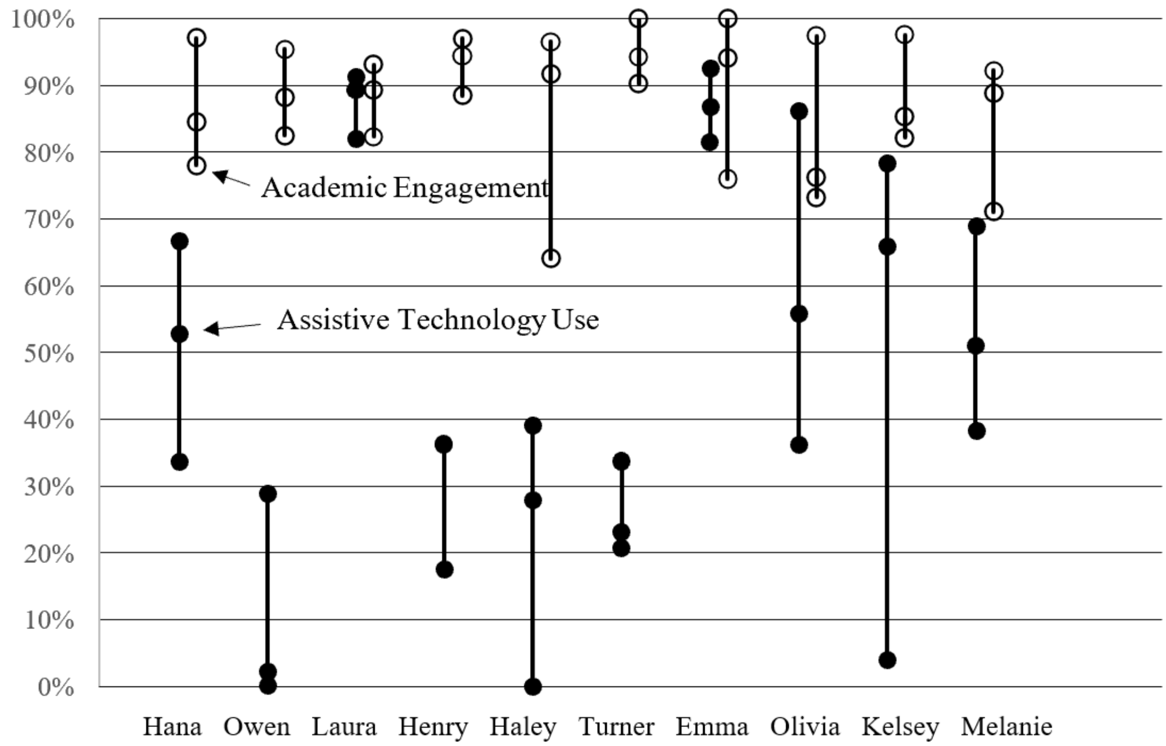
	Proximity					Technology supports		
Student	C	D	T	S	P	Peer	Adult	Device Proximity
Emma	100%	0.0%	27.3%	0.0%	0.0%	0.6%	0.0%	100%
Haley	95.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	63.4%
Hana	93.4%	0.0%	3.8%	0.0%	0.0%	0.5%	0.9%	92.9%
Henry	0.0%	31.3%	37.4%	0.0%	0.0%	0.0%	4.6%	83.2%
Kelsey	0.0%	11.9%	17.2%	0.0%	0.0%	0.0%	4.6%	82.1%
Laura	43.2%	0.0%	8.0%	0.0%	0.0%	0.4%	4.0%	98.4%
Melanie	0.6%	1.2%	18.0%	0.0%	0.0%	0.0%	9.0%	88.0%
Olivia	1.4%	0.0%	13.5%	0.0%	31.1%	0.7%	29.1%	97.3%
Owen	97.8%	0.0%	5.9%	0.0%	12.7%	0.0%	0.7%	58.2%
Turner	0.0%	0.0%	1.9%	97.1%	0.0%	0.0%	3.4%	84.6%
Average	**43.2%**	**4.4%**	**13.3%**	**6.1%**	**3.1%**	**0.2%**	**5.6%**	**84.8%**

Note. C = classmates without disabilities; D = classmates with disabilities; T = teachers/general educators; S = special educators; P = paraprofessional. Percentages represent the number of observation intervals an item was coded over the total observation intervals a student was present in a class (i.e., total observation intervals minus the number of intervals the student was gone). Peer data aggregate supports provided by classmates without disabilities and classmates with. Disabilities. Adult data aggregate supports provided by teachers, special educators, and paraprofessionals.

What Are the Characteristics of AT Use Among Students with VI in Core-content Classes?

Devices were used an average of 47.9% (range, 10.4% to 87.6%) of intervals in which students were present (i.e., not coded as gone) in classes during observations. There was a wide range of variability in AT across students and their class periods. Figure 1 displays the percentage of intervals students were using their AT devices and academically engaged with classroom instruction for each observation of each student. Three patterns of AT users emerged from this observational measure. First, frequent users (i.e., Laura and Emma) used devices consistently and for most of the class. Second, moderate users (i.e., Hana, Olivia, Kelsey, and Melanie) used devices often (more than 33.3% of observations), but that use varied widely across observations. Third, sporadic users (i.e., Owen, Henry, Haley, and Turner) used devices infrequently (average of less than 33.3% across their observations) with considerable variation.

Figure 1
Assistive Technology Use and Academic Engagement by Student



Note. Image shows the percent of observation intervals involving assistive technology use (closed circles with solid black lines) or academic engagement (open circles with solid black lines) over the total observation intervals a student was present in a class (i.e., total observation intervals minus the number of intervals the student was gone) for each of the students' three observations.

Table 7 lists the different ways technology was used (i.e., functions of technology) across observations. The features within this list are based on surveys in Abner and Lahm (2002) that explored the ways students with use AT. These functions of technology often overlapped with one another. For example, Laura had a language arts vocabulary worksheet emailed to her to complete an assignment. To complete this activity, Laura had to use *email* to *access an assignment* (i.e., documents provided to the students), and use a *word processor* and *refreshable braille display* to complete the worksheet. In a less complex example, Laura was provided a writing prompt (verbally) that only required her to generate written responses in a *word process* while using her *refreshable braille display*. Moreover, the list includes both the tasks students performed (e.g., access to assignments, texts, email, internet use) and the media students used to participate in tasks (e.g., screen enlargement, refreshable braille, audio). The most common tasks students used their technology was to access assignments (50.0% of observations; *n* = 14) and access to texts (30.0% of observations; *n* = 9), which were closely followed by using the internet, email, learning platforms, and recreation all used 23.3% of observations (*n* = 7). The most common media by which students engaged with devices was through screen enlargement, which occurred at least once during 43.3% (*n* = 13) of observations. Students used screen readers in 23.3% (*n* = 7) of observations and refreshable braille in 20.0% (*n* = 6) of observations.

Table 6 depicts that students' devices were usually in proximity to students (*M* = 84.8%; range, 58.2% to 100%). Only one device malfunctioned for a single student (Kelsey) and was quickly resolved by the student restarting their device, impacting 0.7% of their observation time.

Table 7
Functions of Technology Performed across Observations

Function	Percent
Media functions	
Screen enlargement	43.3%
Screen reader	23.3%
Refreshable braille	16.7%
Task functions	
Access to assignments	50.0%
Access to digital text	30.0%
Internet use	26.7%
Email	26.7%
Word processing	23.3%
Recreation	23.3%
Educational platforms	23.3%
Document scanning	20.0%
Calculation	16.7%
Note taking	13.3%
Adult collaboration	6.7%
Peer collaboration	3.3%
Spreadsheet/database	0.0%
Calendar/planning application	0.0%
Augmented Communication	0.0%
Switch use	0.0%
Dictionaries or thesaurus	0.0%
Printing or embossing	0.0%
Other:	10.0%

Note. Represents the percentage of the 30 observations across all students that a device or application was used to perform a certain function was provided. Data are summarized across students due to the low number of data points. For descriptions of individual types of technology use, see section *What Are the Characteristics of AT Use Among Students with VI in Core-content Classes?*

Frequent Users. Laura and Emma used technology for the vast majority of their observations (87.6% and 87.0% of the total intervals they were observed, respectively; see Table 4). Laura was observed in a middle school English class and Emma was observed in a high school social studies class (see Table 1). Both students used primarily iPads. Laura also used a braille notetaker and book player at times. The AT use by frequent users was diverse. Laura and

Emma used devices for similar functions regarding screen enlargement (2 and 3 observations, respectively; see Table 7), assignments (3 observations), internet access (2 observations), educational platforms (2 observations), email (1 observation), and recreation (1 observation). Laura also used a device for refreshable braille (3 observations).

Frequent users often received few technology supports (see Table 7) and worked primarily independently (see Table 5). Laura received occasional technology supports from her classroom teacher (4.0% of intervals), and both rarely received technology supports from peers (0.4% and 0.6% of intervals, respectively). However, a breadth of supports was provided despite a small number of supports provided. Laura's supports from adults included prompting to use her device (2 observations), setting up equipment (2 observation), orienting to digital locations (2 observations), retrieving work (2 observations), and redirection (1 observation). Most supports were small forms of guidance to get students set up with an activity, rather than teaching students how to use devices in classrooms. This is further reflected by the low number of support intervals (see Table 6). Laura's range of AT supports suggest she needed some support in getting started on her work when using AT. In short, if Laura was not prompted, helped setting up, or provided guidance on her location/the location of her work than her AT use may have been lower.

Moderate Users. Moderate AT usage ranged from an average use of 49.7% of intervals to 60.1% of intervals (see Table 4). Hana used her iPad primarily for screen enlargement (2 observations; see Table 7), access to texts (3 observations), and assignments (2 observations). Turner used her iPad and iPhone to perform calculations (3 observations) and take notes (2 observations). Olivia used her iPad for screen reading software (3 observations), educational platforms (2 observations), and an assignment (1 observation). Kelsey used her braille notetaker for the refreshable braille display (3 observations), email (2 observations), a word processor (1 observation), and an assignment (1 observation). Melanie used her laptop for screen reading software (3 observations), email (2 observations), and assignments (2 observations). Although moderate users had some diversity of AT use, the range of diversity was narrower than frequent users' types of use. Users used devices for three to four different types of use, compared to six different types of use of frequent users. A narrower range of use may be related to the lower levels of AT use during observations.

Moderate users also had a bit more variation in the type of technology support they received (see Table 8). For Hana, her adult technology support involved monitoring of her use (1 observation) and prompting use of her device (1 observation by an adult and 1 observation by a peer). Turner's adult technology supports included monitoring of device use (2 observations), receiving feedback on work (2 observations), and prompting use of her device (1 observation). Olivia's adult technology supports included, setting up equipment (3 observations), monitoring use and reorienting the student to their digital location (2 observations), and receiving feedback on work, describing digital content, prompting device use, and retrieving work (1 observation). Kelsey received adult technology support monitoring her use (2 observations), prompting device use, troubleshooting, and reorienting her to her digital location (1 observation). Melanie received adult technology support monitoring her use (3 observations), feedback on work (2 observations), and reviewing commands, explicit instruction on how to use her device, prompting her to use her device, and redirecting her to use her device (1 observation). The wide range of supports provided to moderate users suggests that differences in AT use between frequent and moderate users might not be due to a lack of supports. However, the more intense supports provided to moderate users (e.g., reviewing commands, explicit instruction) suggest they may not have an equal level of mastery of technology skills possessed by frequent AT users. Differences in levels of AT use might be related the intensity of AT support required by students.

Table 8

Percentage of Observations Technology Supports were Provided

Technology supports	Adult delivered	Peer delivered
Monitoring AT use	40.0%	0.0%
Verbally reorients the student to their digital location	30.0%	3.3%
Prompting to use an AT device	26.7%	0.0%
Setting up AT equipment	23.3%	6.7%
Prompting the use of a feature of a device/application	16.7%	3.3%
Providing feedback on students work located on AT device	16.7%	0.0%
Retrieving the students' work from the device	13.3%	0.0%
Redirecting the students' use of the device	13.3%	0.0%
Explicitly teaching a specific technology-related skill	6.7%	0.0%
Writing down a student's answers on a device	6.7%	0.0%
Troubleshooting an issue on a device	6.7%	0.0%
Modifying an assignment so that it can be completed on a device	6.7%	0.0%
Describing or explaining inaccessible content	6.7%	0.0%
Reviewing a device or application command	3.3%	0.0%
Assisting in notetaking on a device	0.0%	0.0%
Initiating use of an AT device for games	0.0%	0.0%
Encouraging collaboration with other students using the AT device	0.0%	0.0%
Reminding students of proper device care	0.0%	0.0%
Other:	6.7%	0.0%

Note. Represents the percentage of all 30 observations across students in which a support was provided. Data are summarized across students due to the low frequency of data collection. For descriptions of individual technology supports received by students, see section *What Are the Characteristics of AT Use Among Students with VI in Core-content Classes?*

Sporadic Users. Sporadic AT usage ranged from an average use of 10.4% of intervals to 30.5% of intervals (see Table 4). Owen used his iPad for screen enlargement (2 observations; see Table 7) and to view information off the board (i.e., distance viewing, 1 observation). Henry used his talking calculator exclusively for calculation (3 observations). Haley used her Chromebook for screen enlargement (2 observations), access to an educational platform (1 observation), internet use (1 observation), and calculation (1 observation). Range on the types of use was extremely narrow for Owen and Henry, who only used devices for very specific tasks. The pattern between the level and range of AT use is reinforced across all three types of AT users (i.e., frequent, moderate, and sporadic). The different ranges in AT usage across students indicates that students with VI have highly individualized AT needs. Some students may require less support from AT to access and participate in instruction. For example, Owen may use his iPad for enlarging pictures of visual because his visual impairment is less severe than Laura who cannot access print information at all.

Sporadic AT users also rarely received technology supports (0.7%, 4.6%, and 0.0% of intervals, respectively; see Table 6). Owen received adult technology support prompting him to use his device (2 observations; see Table 8). Henry received adult technology support including feedback on his work (2 observations), prompting him to use his device (1 observation), and monitoring his AT use (1 observation). Supports for sporadic users were less intense (i.e., prompting and feedback vs. explicit instruction) than moderate users and occurred at lower levels. Clear patterns in the differences in the level and type of supports students receive were hard to identify. One reason may be that other factors have a more direct relationship with AT use (e.g., individualized AT need, instructional experiences). However, more direct investigations of AT supports are needed to fully gauge the impact supports have on AT use. Moreover, the impact of AT supports may be predicated on planned and structured delivery of supports. Similar findings have been identified in other support interventions, such as peer support arrangements (Brock et al., 2017).

What Are the Academic and Social Experiences of Students with VI Who Use AT?

Students had a wide range of classroom experiences (see Tables 4, 5, and 6). On average, students were gone for 5.4% of observations (range, 0.0% to 30.4%). When students were present in classes, they were in proximity to an adult for almost a quarter of the class (M =

26.9%; range, 0.0% to 97.1%) and peers for over half the class on average (*M* = 47.5%; range, 0.0% to 100%). Table 6 provides a detailed breakdown of peer proximity (i.e., classmates with and without disabilities) and adult proximity (i.e., teachers, special educators, and paraprofessionals). Adult proximity varied widely for most students (i.e., intermittent and usually low levels of proximity). For most students, variability in peer proximity occurred primarily across students (i.e., students had consistent seating arrangements). Thus, whether or not a student sat next to a peer did not frequently change within or across observations for each student.

For work tasks, students were most often assigned written work (*M* = 54.8; range, 15.6% to 86.3%; see Table 5). Instructors sometimes expected students to attend to listening tasks (*M* = 13.0%; range, 0.6% to 43.4%) and participate in discussions (*M* = 7.4%; range, 0.0% to 26.9%). Students were rarely given reading tasks (*M* = 2.4%; range, 0.0% to 11.6%) where reading was the sole expectation, hands-on tasks (*M* = 2.3%; range, 0.0% to 13.2%), or other tasks (*M* = 0.2%; range, 0.0% to 2.2%). Work tasks coded as other were both short presentations students gave to their peers. Students were assigned no task for 21.2% of observations on average (range, 12.6% to 33.5%). For instructional grouping, students most often worked independently (*M* = 40.2%; range, 5.3% to 83.9%; see Table 5) followed by large group (*M* = 22.7%; range, 0.0% to 79.3%), small group (*M* = 8.8%; range, 0.0% to 34.4%), and adult one-on-one (*M* = 7.1%; range, 0.0% to 59.1%) formats. The instructional experiences of students with visual impairment were wide ranging and consisted of both within and across student variability. This suggests that there is variability in instructional strategies across lessons. However, some forms of instructions (e.g., written work and independent groupings) were more commonly relied upon than other forms of instruction (e.g., hands-on activities, small groups).

Social Experiences. Students had a wide range of social experiences. Students interacted with a peer for an average of 10.6% of intervals (range, 0.0% to 31.9%; see Table 4) and with an adult for 32.6% of intervals (range, 4.1% to 55.7%). Frequent users had few social interactions in general, where they interacted with peers an average of 15.2% of intervals (range, 10.8% to 18.6%) and teachers for 8.4% of intervals (range, 0.6% to 15.8%). Moderate AT users had higher levels of interaction than frequent users, though the types of interaction varied across moderate AT users. Hana interacted more with peers (25.0% of intervals), while Turner, Olivia, Kelsey, and Melanie interacted more with adults (63.1%, 37.2%, 45.7%, and 55.7% of intervals, respectively). Sporadic users had a wide variation in social interaction patterns. Owen interacted frequently with peers (31.9% of intervals) and his teacher or paraprofessional (23.7% of intervals), while Henry primarily interacted with his teacher or a paraprofessional frequently (52.6% of intervals) and Haley rarely interacted with a peer (8.1% of intervals) or an adult (4.1% of intervals). The variation in interactions within and across groups of AT users suggests that there may not be a strong relationship between the social patterns of students and AT use. This relationship is further explored below (see *Social Interactions.*)

Is Individual AT Use Associated with Contextual or Student Behaviors?

There was a wide variety of AT use across participants. Tables 9 and 10 display AT use nested by contextual and student variables. Findings for each nested variable are described below. Nested AT use is described by student behaviors first, followed by contextual variables.

Device Proximity. Devices were near students most of the observations (*M* = 85.6%; range, 57.8% to 100%; see Table 6). Students used AT for 53.0% of the intervals their device was near them (see Table 9). Device proximity was generally not a limiting factor for students.

Students often had access to devices throughout observations and device use closely mirrored device use of overall observations.

Technology Supports. Students rarely received technology supports throughout observations and were most commonly provided by adults (see Table 10). For the few technology supports students received, high levels AT use were recorded for both peer technology supports (*M* = 75.0%; range, 0.0% to 100%) and adult technology supports (*M* = 77.2%; range, 50.0% to 100%). Strong conclusions are hard draw on technology supports due to the infrequent occurrence of these supports.

Work Task. Device use was common during written tasks, where students used the devices 60.4% of intervals coded as a written task (see Table 9). Higher device use during written tasks as compared to other types of tasks was evident for all students, excluding Owen, who rarely used his technology. High usage during written tasks was likely driven by clear expectations for students to produce text. Typing and word processing goals in IEPs indicate students are taught to rely upon devices for producing written text. Moreover, written work was one of the most common forms of instruction students experienced during observations. Thus, the primary mode of instruction seems conducive to creating opportunities for AT use.
Devices use was also high during reading tasks (*M* = 47.4%; range, 0.0% to 89.7%) for several students. Similar to written tasks, there were clear behavioral expectations to interact with text during reading tasks. However, reading work tasks were assigned infrequently across students (*n* = 4 students). In contrast, device use was much less frequent during listening, discussion tasks, and hands-on tasks (see Table 9). These tasks often have less clear expectations on producing or engaging with text. For example, listening tasks focus on gathering information through a source other than text and often do not set clear expectations for note taking. Likewise, discussions

focus on producing interaction with peers or adults and hands-on activities focus on interaction rather than text. Thus, there seems to be a high reliance on AT devices for text access and production.

Table 9

Nested Statistics of Contextual Variables

		Instructional grouping					Work task						Proximity	
Student	Device proximity	LG	SG	IN	A1	NI	L	D	R	W	H	O	P	A
Emma	87.0%	50.0%	-	89.6%	-	75.0%	0.0%	0.0%	33.3%	92.1%	-	-	87.0%	100%
Haley	35.9%	21.4%	0.0%	31.9%	-	6.5%	14.3%	-	-	32.1%	0.0%	-	22.9%	-
Hana	55.3%	25.9%	8.3%	97.3%	-	29.6%	63.0%	75.0%	-	54.5%	-	-	54.5%	12.5%
Henry	36.4%	17.5%	-	41.1%	-	28.6%	11.1%	22.7%	-	41.1%	-	-	26.8%	30.6%
Kelsey	60.0%	-	11.5%	85.3%	0.0%	21.7%	7.1%	0.0%	-	82.1%	0.0%	-	0.00%	19.2%
Laura	89.0%	82.6%	100%	97.2%	0.0%	52.9%	81.8%	87.9%	89.7%	97.0%	-	-	92.6%	50.0%
Melanie	55.3%	-	43.6%	81.4%	86.7%	29.6%	0.0%	35.6%	66.7%	87.7%	0.0%	-	33.3%	70.0%
Olivia	61.8%	45.5%	-	86.8%	50.0%	44.4%	48.8%	-	-	71.3%	-	-	0.00%	50.0%
Owen	17.9%	9.3%	-	18.2%	-	11.8%	0.0%	0.0%	0.0%	11.1%	0.0%	33.3%	10.6%	2.4%
Turner	31.3%	8.8%	-	72.7%	30.9%	15.0%	8.8%	0.0%	-	34.8%	-	-	-	25.6%
Average[a]	**53.0% (10)**	**32.6% (8)**	**32.7% (5)**	**70.2% (10)**	**33.5% (5)**	**31.5% (10)**	**23.5% (10)**	**27.6% (8)**	**47.4% (4)**	**60.4% (10)**	**0% (4)**	**33.3% (1)**	**36.4% (9)**	**40.0% (9)**

Note. LG = large group; SG = small group; IN = independent work; A1 = adult one-on-one; NI = no instruction; A = adult; P = peer; L = listening; D = discussion; R = reading; W = writing task; H = hands-on activity; O = other. Percentages represent the number of observation intervals assistive technology use and an item was coded simultaneously over the total observation intervals an item was coded.

[a]Percentages are averaged across students followed by the number of students with qualifying data in parentheses.

Instructional Grouping. Devices were most commonly used in independent instructional groupings (*M* =70.2%; range, 18.2% to 97.3%; see Table 9), which was associated with the highest proportion of AT use during a work task across most students (*n* = 8 students). This suggests AT helped facilitate independence among students with VI. This finding is consistent with the theoretical benefits of AT and descriptive benefits of AT described in the literature (e.g., Farnsworth & Luckner, 2008; Lancioni et al., 2007; McCarthy et al., 2016). AT use was lower when grouped with others during instruction. Overall, students' frequency of AT use was comparable in a large group, small group, and adult one-on-one instructional groupings (averages were 32.6%, 32.7%, and 33.5%, respectively). Wide variations in AT use in these formats have several possible explanations. First, there are variations in the types of activities students completed across formats. For example, large-group instruction sometimes consisted of listening tasks such as lectures and at other times written tasks such as guided notes. Differences in activities may explain some of the individual variation in AT use. This would suggest that (outside of independent work) work tasks may impact AT use more than the number of peers or adults students work with. Second, working with peers and adults may provide competing supports. Students may not need to solely rely on AT in other instructional groupings. AT use could vary (and be lower than independent work) due to peers and adults supporting students in ways that do not require technology. Third, AT use may vary because students are not using devices to collaborate with peers or adult. For example, a student might not use their device to complete an assignment with a peer or adult because they cannot share their text (e.g., the text is only depicted in braille). There are other possible reasons students may choose or be unable to use their device to collaborate. For example, students may not be able to use collaborative applications such as Google Docs, the teacher may not normally integrate technology into grouped formats, or students feel stigma about using their device when they work with others. Finally, students used their devices for almost a third of the intervals no instruction was coded (M = 31.5%; range, 6.5% to 75.0%; see Table 9). Students sometimes used devices to complete work from another class or recreationally (e.g., listening to a book, social messaging, browsing the internet) when teachers did not assign work. The vast majority of AT use was related to assigned tasks, although an average of 11.7% (range, 5.1% to 18.3%) of students AT use's occurred during non-instructional time (i.e., number of intervals AT use and no instruction were both coded divided by the total number of intervals AT use was coded). These data suggests that AT is a way to keep students occupied during down time in addition to being a tool for engaging to classroom instruction, not a distraction that keeps students from engaging in academic participation.

Peer and Adult Proximity. Although AT use varied widely across students based on proximity to a peer or an adult, the average percentage of intervals devices were used was comparable in proximity to a peer (*M* = 36.4%; range, 0.0% to 92.6%; see Table 9) and an adult (*M* = 40.0%; range, 2.4% to 100%) were quite comparable. Students who were seated next to peers and adults (see Table 6) tended to have higher AT use than students who sat alone. This finding suggests device engagement may benefit from access to peers and adults. This is consistent with the high levels of AT use during peer and adult technology supports, albeit supports were provided infrequently. However, infrequent provision of supports still likely benefits from students being seated amongst classroom peers or adults.

Academic Engagement. AT use was high when students were actively engaged with a task (*M* = 58.9%; range, 12.0% to 94.7%; see Table 10). This finding suggests a large portion of activities that require student responses can incorporate or require AT use among students. Thus, AT is indeed an essential tool for the participation of students with VI in classrooms. AT use when passively engaging with a listening task averaged 24.9% of listening task intervals (range, 0.0% to 80.0%). Lower AT usage during passive engagement reinforces that the type of work tasks may impact AT usage. Thus, students use AT more when there are clear expectations to interact with or produce information.

Devices were only used 32.2% of intervals where students were coded as unengaged (range, 6.3% to 69.5%). This is primarily due to device use during periods of no instruction. Students rarely used devices for distractions (i.e., functions unrelated to assigned tasks) during classroom instruction.

Social Interaction. Devices were used more when students interacted with adults (*M* = 38.5%; range, 0.0% to 100%; see Table 10) than peers (*M* =27.5%; range, 0.0 to 100%). This may be due to the fact that adults provided technology supports more than peers. Thus, AT use may be influenced by the type of interactions students are having. However, students usually used devices less when participating in social interactions (n = 8 students) than their average device use overall. This finding reinforces that working with peers and adults may provide competing supports.

Table 10
Nested Statistics of Assistive Technology Use by Student and Technology Support Behaviors

	Academic engagement			Social interaction		Technology Supports	
Student	AE	PE	NE	P	A		
Emma	100%	0.0%	45.9%	70.0%	100%	100%	-
Haley	35.3%	14.3%	6.3%	0.0%	0.0%	-	-
Hana	67.5%	60.5%	36.3%	17.0%	10.5%	100%	50.0%
Henry	38.4%	5.9%	26.8%	-	30.4%	-	100%
Kelsey	62.0%	7.7%	31.6%	0.0%	52.2%	-	71.4%
Laura	94.7%	80.0%	69.5%	100%	59.0%	100%	80.0%
Melanie	68.4%	-	31.9%	21.4%	43.0%	-	86.7%
Olivia	74.6%	50.0%	51.0%	0.0%	57.5%	0.0%	72.1%
Owen	12.0%	0.0%	6.7%	11.6%	11.8%	-	100%
Turner	35.7%	6.1%	16.3%	-	20.6%	-	57.1%
Average[a]	58.9% (10)	24.9% (9)	32.2% (10)	27.5% (8)	38.5% (10)	75% (4)	77.2% (8)

Note. AE = actively engaged; PE = passively engaged; NE = not engaged; A = adult; P = peer. Percentages represent the number of observation intervals assistive technology use and an item was coded simultaneously over the total observation intervals a an item was coded.
[a]Percentages are averaged across students followed by the number of students with qualifying data in parentheses.

Qualitative Findings

The primary goal of the qualitative analysis was to identify a range of perceived benefits and factors associated with AT use. Figures 2 and 3 list the different perceived benefits and factors associated with AT use along with descriptions of each.

What Benefits of AT do Students Report?

Three overarching themes emerged in the benefits students attributed to AT use. First, AT provided basic *access* within the classroom that allowed students to glean information from instructional content. Second, students' *participation* was enabled or enhanced by using AT. Third, students described *skill development* as a peripheral benefit of using AT. Each of these themes are described below.

Figure 2
Qualitative Themes and Definitions for Perceive Benefits of Assistive Technology

Theme	Definition
• Access	-the ability to receive glean information provided by teachers
• Assignments	-teacher-assigned information requiring verbal/written responses
• Reading materials	-books, handouts, or other information not requiring direct responses
• Distance information	-information written on the board or a screen at the front of the class
• Tests	-a particular assignment focused on students' quality/performance
• Homework	-a particular assignment expected to be completed outside of school
• Participation	- the ability to respond/generate information to complete assignment
• Improved efficiency	- the ability to complete work faster, easier, and better
• Improved communication	- sending and receiving information to/from educators
• Peer collaboration	- working with classmates
• Skill development	- different abilities students gain as a result of using technology
• Technology skills	- the ability to use high-tech devices and applications
• Problem-solving skills	- the ability to find solutions in the midst of adversity
• Time-management skills	- the ability to keep track and utilize time productively

Note. Definitions are provided for codes that expand upon the definition of the root theme.

Access. Some of the foremost benefits outlined by students were access to various forms of information. Students identified five different types of access provided by their devices: *assignments*, *reading materials*, *distance information*, *tests*, and *homework*. Access to content is fundamental to engaging with instruction. For most students (n = 9 students), AT was their primary tool for accessing this classroom content. For example, Melanie described the essential access her laptop provides her:

> I get a lot of accessible things out of it. If I didn't have the technology that I did, it would be really hard to get my work done in school.

Students described an array of *assignments* (i.e., teacher-assigned information requiring a verbal or written response) they received from teachers, such as "questions" about content, "research" activities, "math problems," "Spanish worksheets," and "fill-in-the-blanks." Even when assignments didn't require electronic responses from students, having access to the assignment was important. For example, Kelsey described how having access to her assignments also enables her to review instructional materials later:

> It helps me to understand the lesson, especially visual concepts… it's really good for me to have notes or an email to go back and reference, to remember some of the stuff and to get what I may have missed before in the class.

Similar benefits were described for *reading texts* (i.e., books, handouts, or other information not requiring a direct response). For example, Melanie described how her computer help with reading texts: "I use [my computer] for when I'm reading because it helps with reading. It makes it bigger." This was true of taking *tests* ("I only really need [my laptop for a state test that I have to take," Hana), which were particular assignments focused on students' quality of performance, and completing *homework* ("I've tried using reminders to have for homework and stuff," Turner), which were particular assignments students were expected to complete outside of school. Students also used AT to access distance information ("I just take a picture, zoom in, and then I continue while the teacher's talking," Emma). Access to *distance information* was usually characterized by devices helping students see information that had been presented by teachers on the whiteboard or via projectors. For example, Owen was able to "take pictures off the board" and "zoom in" so that he could read the information presented by his teacher. In general, AT provided a wide range of access benefits for students.

Participation. Students described several ways in which their devices allowed them to generate and produce written work to complete assignments. Participation benefits were characterized as improved efficiency, improved communication with educators, and peer collaboration.

Students frequently brought up comparisons between completing their work on devices to traditional paper-based methods. Students often described the use of devices as being favorable to paper-based methods. These comparisons highlighted *improved efficiency*, or the ability to complete work "faster," "easier," and "better" using technology in contrast to other methods. For example, Melanie indicated that her phone was a preferable tool for completing most of her assignments:

> If you give me a Word document with multiple choice, I could do that on my phone. It's just a lot easier. I get it done a lot faster.

Emma said she was able to participate more because she no longer has to "do everything in Braille," making her work "a little bit complicated." Most students indicated that they had access to their work sooner because it did not need to be converted to large print or transcribed in braille. Even though a preference for using technology was often expressed by students, they also described situations in which paper-based methods were more beneficial than technological solutions. For example, Owen indicated that despite the benefit of using his tablet to "to enlarge where [he] can't see" (e.g., information on from the projector or whiteboard), paper-based methods were easier for written tasks for him because he "can write faster than [he] can type."

Another of the participation benefits described by students was *improved communication*. This was defined as the ability to share/send their work and receive feedback from teachers. Students could send emails to receive or turn in assignments. Most students (n = 9) also had a device in their classes with a visual display that teachers could use to view students' work. Some students indicated that these modes of communication and teachers' access to their work allowed teachers to provide students with timely feedback. For example, Turner indicated that she "get[s] email feedback sometimes" and that her teacher helps her when she is roaming the room to check on student work. Moreover, Turner speculated that this would not be possible without her technology because her teachers could not read her work:

People would be able to, on the computers and stuff, people [are] able to read things. In

> braille, I'd be the only one able to read it, and then somebody would have to interline it and all that stuff.

When asked, two students indicated that technology was helpful for *peer collaboration* (i.e., working with their peers). Students primarily described working with their peers through online web applications, such as Google Docs or Office365. The web applications provided classmates with a shared workspace to complete assignments together while allowing students with VI still to use accessibility tools such as screen readers or magnifiers. Emma described how technology helped her collaborate:

> So, it's like a document that you both can work on at the same time… and you can see who's on which slide, and what they're typing to.

However, the majority of students (n = 8) indicated that they did not use their devices to work with classmates. In general, students did not indicate why they did not use their devices with peers. Owen indicated that his peers in his social studies class were not using technology. The fact that peers did not have regular access to technology could be a large factor in why students did not use technology as a collaborative tool more frequently. Most students (n = 7) were the only students in their class using a device to complete assigned work.

Skill Development. In addition to access and participation, students indicated that they gained some distal skills as a result of using technology. These skills included the ability to use technology itself, problem-solving skills, and time-management skills. Many students described that using technology was a benefit unto itself. *Technology skills*, or the ability to use high-tech devices or applications, included typing, editing, navigating the internet, and coding. As Olivia put it, "Well, I mean, I've learned how to use the technology, which is useful for after school as well." She added that her use of her tablet made her feel like "most teenagers":

Well, I think that had I not been using technology as much, I don't think I would be able to relate as much with my peer, who are constantly on their technology and doing things like that.

Some students suggested that technology increased their *problem-solving skills* or the ability to generate solutions when experiencing adversity. Only one instance of such a device malfunctioning was observed during the observational portion of the study. However, all students described in interviews running into issues as they used their technology at other times. Many students still indicated that they were able to overcome the issues they experienced with technology. For example, Melanie described some of her initial steps for handling her issues with her technology:

> [My computer] has also helped me with problem-solving. There has been tons of times when my computer has just shut down and said, "I give up, I'm done." So I have to figure out, what are my options? What can I do next?

Finally, some students suggested that features on their device improved their *time-management skills* or the ability to track and manage time effectively. Students attributed their improvement to features such as access to a clock, "alarms," calendar/planner application, and virtual assistants (e.g., Siri, Alexa, "OK Google"). When probing students about how technology improved their time management skills, some students listed access to clocks. Students indicated that they would not have an awareness of the time without their devices. However, students did not articulate how this helped them with managing their time. In contrast, students could describe how they used alarms and calendars to complete homework assignments or plan extracurricular activities. Students expressed that digital schedules/reminders mostly helped outside of school-day schedules. As Kelsey put it, alarms and calendar events were "a really big thing that helps at home." One of the ways students commonly described creating alarms and reminders was through virtual assistants (an application that complete a simple voice commands such as Siri or Cortana). In fact, only one student (Laura) described using alarms or planners without a virtual assistant. The convenience of dictating alarms and reminders may be important for getting students to engage with time management applications.

Figure 3

Qualitative Themes and Definitions for Factors Influencing Assistive Technology Use

Theme	Definition
• Technology factors	-factors related to the device or technology itself
• Functionality	-the capability of AT to perform a task
• Usability	-influence of the technology's design
• Portability	-the impact of the size or weight of technology
• Technical issues	-the technology becomes partially or completely unusable
• Accessibility issues	-the technology cannot interact with content provided to the student
• Environmental factors	- factors related to the context the technology is used
• Task type	- instructional expectations
• Wi-Fi access	- availability of wireless internet access
• Visibility	- the ability to locate or see distance information
• Personal factors	- factors related to the students' desires, abilities, and experience
• Personal preference	- unspecified opinions held about AT
• Learning style	- alignment between technology and mode of instruction
• Technology skills	- the ability to use technology
• Familiarity with technology	-comfort and length of experience
• Self-sufficiency	-a lack of need for technology
• Social factors	-students' perceptions about the classroom norms and milieu
• Disrupting others	-devices negatively impacting peer class participation
• Peer questions	-undesirable verbal attention
• Perceived stigma	-undesirable non-verbal attention
• Technology supports	-verbal or non-verbal behaviors from peers or adults that enable students' technology use
• Adult influence	-technology use based on instructions or recommendations from an adult

Note. Definitions are provided for codes that expand upon the definition of the root theme.

What Factors Influence AT Use?

Several overarching themes emerged as factors that influenced AT use, which included technological factors, environmental factors, personal factors, social factors, support needs, and adult influences. Some factors influenced *whether* AT was used, while other factors influenced *which* type of AT was used. Each theme is described below.

Technological Factors. Technological factors were factors described by students that influenced AT use related to devices or the technology itself. Students described five different types of technological factors: functionality, usability, portability, technical issues, and accessibility issues. *Functionality* was defined as the capability of AT to perform a desired effect, such as magnification or speech-to-text. Students highlighted distinct aspects of functionality, including AT's ability to "enlarge," take "pictures," "multi-task," produce technical braille "symbols" (e.g., Nemeth code), "format," and perform speech-to-text. There were mixed experiences regarding the functionality of AT that contributed to positively or negatively to usage. For example, Emma described using her iPad because it can "actually take pictures." She contrasted this to being unable to use her Chromebook to access distance information. Thus, functionality impacted whether she used technology in a situation where she needed to access distance information. In contrast, Kelsey described how her device's limitations in functionality prevented her from using it in certain classes:

> [I don't use AT in] math and science because science is a lot of symbols and numbers and things like that. And symbols format wrong on the BrailleNote a lot, like if it's one-third, it would pronounce it 13 because it would leave the fraction symbol out.

Both Emma and Kelsey described situations of absolute functionality (i.e., a device completely could or could not perform a task). However, some students described degrees of functionality (i.e., a device could not perform a task completely satisfactorily). For example, Hana described the limitation of her technology to enlarge her work:

> Sometimes on the iPad. Actually, today I was taking an English test and I was blowing it up as much as I could, but it was still kind of small. It wouldn't let me make it any bigger. And I just ended up putting my face really close to it.

Kelsey and Olivia described similar issues with screen readers that could not read some information, such as images. Students indicated functionality sometimes impacted *which* technology they used, such as the example above where Emma depended on her iPad for distance tasks instead of her Chromebook. In Olivia's case, her screen reader doesn't work with images or websites:

> JAWS sometimes won't read stuff… There have been like sometimes I would ask for help. If VoiceOver wouldn't read, somebody would come help me fix it.

However, functionality also influenced *whether* AT was used as it did in Kelsey's situation. Kelsey could not use AT in whole class periods due to limitations in functionality.

Usability was defined as the design of a device or application influencing the students' ability or desire to use the device. Students highlighted technology designs that positively impacted their AT use and made completing work more convenient. Usability factors often referenced a comparison between two technologies, in which students expressed how device designs influenced decisions on *which* devices to use. For example, Emma described how on her Chromebook, "The keys are more spread out, and it's more suitable for your hands and stuff," indicating the ergonomics of made the Chromebook made it preferable over her iPad for presentations.

A closely related factor to usability was portability. *Portability* was defined as the size or weight of a device influencing its usage. In contrast to usability, students often described portability qualities that impacted *whether* they used AT and primarily focused on negative qualities (e.g., "too big," "heavy"). For example, Haley described how the lack of portability kept her from utilizing her video magnifier unless she absolutely needed it:

> I don't use [my video magnifier] as much because it's really big and heavy, hard, well, it's not hard to set up, but I'm just too lazy most of the time. But when I really can't see something, I'll pull that out.

Usability and portability features of devices were fixed qualities that students and educators could not address after the selection and procurement of devices.

Technical issues were defined as intermittent situations where technology becomes partially or completely unusable. Students often described technical issues as “glitches” where technology is not operating within its normal capacity. For example, Turner described how she experiences technical issues on her iPad: “Sometimes I’ll have the dreaded glitch where things don’t save, and I’ll have to do things all over again.” Most technical issues were similar to Turner’s, where the cause seemed likely to be attributed to device error. Situations, such as Turner’s, were often attributed to “outdated” technology provided by schools. However, students also described a preventable technical issue of battery management. Students indicated that battery issues were rare and that they took steps toward preventing them (i.e., bringing their charger to school). However, battery issues still occurred and had a big impact on classroom experiences when they did, as Haley illustrated:

> I bring my charger to school now every day. So I always have my laptop and my charger if I ever need it, but normally if I don’t have my charger, I panic in math class, and... I think I really only panic during math class. Oh, and not Spanish... I think English and math are very stressful for me without my laptop.

Technical issues described by students had a temporary impact on students’ AT use. Students did not indicate AT use was impacted beyond the periods where technical issues limited usage.

Accessibility issues were defined as situations where AT did not interact with digital content or other forms of technology. Accessibility issues were similar to limited functionality in impact but differed in that the digital content or certain applications were deemed at fault rather than the student’s AT. Limitations in accessibility described by students also identified formats, website accessibility, and document types. One of the most common forms of digital content identified as inaccessible were PDFs. Turner, Olivia, Kelsey, and Melanie all identified PDFs as an issue because their screen reading software could not access the text on the documents.

Students also frequently listed websites and web applications (such as GoogleDocs) as inaccessible. For example, Turner described how the layout of websites cause access issues.

> I would not do research on it because just accessing a webpage with a braille display isn't very easy because most webpages are visually laid out. And so they don't really translate well on like a little 18-cell [display].

Like functionality, accessibility issues impacted device use for certain tasks. However, accessibility issues cannot be solved with device selection procedures or trial periods (in contrast to functionality). Instead, accessibility issues arise in the curation of classroom content and technology. Educators must consider whether the content they select will interact with students' AT. Advocating to content creators may also address accessibility issues. However, advocacy sometimes yields limited results, as was the case for Kelsey:

> I just wish that companies and apps were more accommodating and open-minded to blindness and any type of disabilities because we've reached out to a few companies over the years and they've either not responded or said there was nothing they could do.
> As mentioned previously, formats were also an issue for students.

Turner found columned texts "annoying" because it created an additional spatial component that caused her to lose her place at times. Students also frequently described issues when navigating the internet that made independently retrieving information difficult. For example, Olivia indicated that she is not able to access internet information needed to complete her assignments:

> When I'm trying to research things, not all the websites that they want us to go to research are accessible or when they want us to do activities on the web. Not all of those are accessible.

Students' descriptions of AT as beneficial for providing access to classroom content also made clear that access was not universal across activities. Access also required consideration from educators of the types of materials and activities they asked students to engage in.

Environmental Factors. Environmental factors were factors that influenced AT use related to instruction, seating, or equipment available in the contexts they used their technology.

Students described three different types of environmental factors: task type, Wi-Fi access, and visibility. *Task type* was defined as the instructional expectations impacting AT use. As Laura put it, "The first question that comes to mind is, how would I be able to do my work on this?" Several students described how unique features of different tasks influenced the type of technology they used ("If it's a presentation, something like that, then I'd use the Chromebook. But if it's just notes on the PowerPoint, I'd use the iPad," Emma) or whether they used technology at all ("I prefer [writing on] paper, but only I'm having trouble with is science… I can write faster than I can type." Owen). The influence of task type was closely related to the functionality of devices. For example, Kelsey described preferring a braille writer to a braille notetaker for science work because the notetaker does not display math symbols correctly (see *Functionality*). However, Owen's experience of differences in writing and typing skills suggests other factors may relate to task types' influence on AT use.

Wi-Fi access was defined as the availability of wireless internet access in an environment. Wi-Fi access was rarely mentioned by students (Hana and Owen). Hana and Owen indicated that Wi-Fi access primarily impacted their ability to complete homework. For Owen, this was a minor impact on his desire to complete homework on his way home ("I can't use it on the bus, but I can use it wherever I have Wi-Fi"). However, Hana "experienced problems" doing her work at home due to Wi-Fi.

One student (Owen) also mentioned visibility as an environmental factor that influenced his AT use. *Visibility* was defined as the ability to locate or see distance information to use AT. Owen rarely used his AT in his social studies class. When he did, he primarily used it to take pictures on the board to zoom in and read the information. One factor that influenced whether Owen utilized his AT or sought other supports was his ability to take clear pictures of the board:

"I was at a weird angle in Ms. [teacher]'s class. So the point where the words are kind of sideways. So I couldn't really see it, even on the iPad, so I kept asking for help." Owen's situation highlights the importance of seating arrangements on technology use for low vision students. Emma and Haley used their device in similar ways as Owen but did not identify visibility as an issue. Both Emma and Haley were seated near the front of the classroom.

Personal Factors. Personal factors were factors that influenced AT use related to students' desires, abilities, and experiences. Students described five different types of personal factors: personal preference, learning style, technology skills, familiarity with technology, and self-sufficiency. *Personal preferences* were defined as unspecified opinions held (e.g., picking a device just because the student liked it) that influenced whether students utilized AT. Some students did not or were not able to articulate their motivation for utilizing AT other than an intrinsic desire to do so. This was evident in Melanie's experience in selecting different technologies:

> I think it's a preference thing. I think you get taught how to use each different device and then it's a preference on what you think is best to use for different assignments.

Some students may not have developed, or could not articulate, strategies for selecting technology, such as Melanie. These strategies should be addressed with formal AT instruction (Smith et al., 2009). Likewise, students had undefined reasons for not using technology ("I don't use [my video magnifier] at school because I don't want to," Haley). The presence of personal preferences documents the complexity of students' AT usage. If students lack the vocabulary to attribute preferences about devices, they may also be limited in expressing AT needs. For Haley, further probing revealed that portability and perceived stigma also played a role in her decision to use AT. Although these identified factors may help elucidate her decision not to use a video magnifier, unarticulated and internalized factors may remain, such as the usability of a device or more experience and knowledge of devices. AT instruction is important for providing students with language to articulate their preferences in relation to other factors that educators can address (e.g., technological, environmental, and social factors). Exploration of other AT devices may also help students identify preferable technology when they cannot articulate preferences beyond abstract desires.

Some students indicated that they chose to use technology because it aligned with a preferred *learning style* or a mode of instruction (e.g., visual, auditory, tactile, kinesthetic) students identified as learning best. Learning styles were almost exclusively used to describe a preference for a type of technology. For example, Melanie and Owen preferred to use an iPhone or iPad, which they attributed to being "visual learners." Additionally, Kelsey preferred her braille notetaker because she appreciated access to the refreshable braille display. Devices appealing to learning styles could improve AT use based on students' responses. However, no students identified themselves as auditory learners, even though text-to-speech was identified as a benefit of AT by three students (Laura, Emma, and Olivia). The contrast between preferred learning styles and access benefits suggests that devices with multiple media out-puts are preferable to devices that appeal to a single learning style.

Technology skills were defined as a student's ability to use technology influencing their AT usage. Limiting technology skills identified by students included "typing," "screen-reader" knowledge, "keyboard commands," and how to use a "word processor" or the "internet." Limited technology skills were often attributed to the introduction of new technology. As Owen describes, he was relatively new to the technology he was using:

> I've been doing [my work] for seven years then, because I got held back. Yeah, I've been doing everything the normal way for seven years, and then out of nowhere, my vision gets decreased by a lot. Like it rapid fired on me.

Owen had been learning how to use his technology for a year prior to participating in the study. Owen's limited ability to touch type limited the range of activities he could complete on his iPad. He completed his writing manually with pencil and paper instead of on his iPad. Other students indicated that limited technology skills impacted the type of technology they used. For example, Melanie indicated she uses her phone instead of a computer due to her computer skills.

> You've probably seen, since you've seen me, is I mostly use my phone for some things. Sometimes I get frustrated with [my computer] because I'm still working on learning how to use it.

Melanie's decision to use her phone sometimes occurred even in situations where she acknowledged the computer was "better for typing."

Students also highlighted comfort and length of experience as a factor that influenced AT use, which I labeled *familiarity with technology.* Familiarity with technology was closely tied to technology skills. However, students emphasized that comfort with technology, not just knowledge, impacted the likelihood they chose to use a technology. For example, Melanie described a desire to have more experience in using a laptop:

> But I think that having [a laptop], even after I graduate would give me some experience with a laptop and working with it… I'm saying like more experience with accessing different websites, different typing websites… It's going to feel different, it's going to look different.

The influence of familiarity on AT use suggests students need technology supports beyond explicit instruction. Intentional supports would help prompt students to use devices in natural settings to gain experience while also addressing issues that arise as students develop "comfort" with technology. As highlighted with technology skills, observational data identified that technology supports are currently limited.

A lack of requirement for AT was also mentioned by students. I defined lack of AT use due to a lack of need as *self-sufficiency.* Haley and Owen both indicated that for some of their work they “did not need” their technology. For Haley, worksheets in large print mitigated a need for technology. She also indicated that technology was not needed during labs in her chemistry class. For Owen, he expressed he did not need AT for most of his note-taking. He felt that most of the benefit of his notes was writing them down rather than reviewing them. These descriptive experiences contrast the context students who had the highest level of AT use: written tasks. This highlights the importance of identifying individualized needs across a wide variety of tasks for each student. Identifying these needs (or lack thereof) in written implementation is important for educational teams to support AT use across academic routines.

Social Factors. Social factors were factors that influenced AT use related to students' perceptions of the classroom norms and behavioral expectations. Students described three distinct types of personal factors: disrupting others, peer questions, and perceived stigma. *Disrupting others* was defined as a student indicating their device negatively impacted a peer's ability to participate or pay attention in class. Disruption to others was only mentioned by three students (Hana, Owen, and Olivia). Students described their voice-to-text “distracting [for] other people” (Owen). However, disrupting others could often be mitigated with accessories. As Hana described:

> There's online textbooks and text to speech options for when… I have to read a bunch. So, I just put my headphones in like in English

Headphones were a simple solution for most students. However, headphones weren't a universal fix for all students. Owen described feeling uncomfortable using headphones in front of his peers:

> In class, I think it's really distracting other people. So I can't really use text to speech because if I use headphones, everybody's wondering, why do I have headphones in? Everybody's going to keep constantly looking over at me and I'm going to be the distraction of the class again.

Owen's discomfort with using headphones was driven by non-verbal attention to differences in how he participated in classwork. I defined this as *a perceived stigma.* Social issues often cascaded together, which is further illustrated in Owen's experience. Owen also experiences *peer questions*, which I defined as verbal attention to differences in how students participated or completed classwork. Owen described how his AT use drew unwanted verbal attention:

When I don't use it, I don't have people asking me, "Why do you have an iPad?" But say if I pull it out, then people are wondering, "Why does he have an iPad?" And then I get asked questions after class, and I'm saying, "I have to use it because I can't see much things."

In Owen's example, his primary objection was doing his work using tools that his peers were not also using. When asked, Owen said he would feel less stigma, or receive fewer questions about AT, if his peers used the same technology:

> Most definitely, because then [using a laptop] won't feel weird. I won't feel like I'm in the class. Because I don't feel a big part in the class, because if anybody does something normal, it just feels normal… I know in high school [using laptops] can be normal, because high school people, they use laptops.

Students in Owen's class did not use technology to complete their work. Owen's reflection suggests that stigma may be felt due to differences in work style rather than the technology itself. Both Haley and Emma's schools had one-to-one devices and suggested that this may alleviate social stigma. For example, Haley described how her reliance on her Chromebook over other AT tools was related to assimilating to her peers: "It makes you feel like you're not the only ones sticking out…" The contrast in experience highlights an interesting aspect of universal design for learning. Universal design focuses on making the core curriculum and instruction more accessible rather than relying on adaptations. Technology has been identified as a critical feature of universal design in providing flexibility in accessing information, generating student responses, and giving feedback to students (Rose et al., 2005). However, technology also has the potential to enable the universal delivery of content to students. The experiences described by students in this study suggest this may impact the social milieu of classrooms. One-to-one devices and higher reliance on technology in general education classrooms may create a more inclusive environment for students with VI by making the delivery of content more universal.

Support Needs. When probed about how to address issues that negatively impacted AT use, students affirmed technology supports. I defined *technology supports* as verbal or non-verbal behaviors from peers or adults that enable students to use their technology when unable to do so independently. The preference and knowledge between peer and adult providers of technology supports varied across responses. For example, Olivia received supports from a paraprofessional on her technology for making stuff accessible. She did not think students could help with the same issues. In contrast, Hana described the opposite experience: "The teacher doesn't help me so much because she doesn't know. [The classmate] I sit next to helps sometimes." Differences in support experiences indicate that supporters require technical knowledge to support students' AT needs. Providing peers and adults supports with technology training could strengthen the technology support experiences of students with VI in classrooms.

Adult Influences. Four students (Henry, Turner, Emma, and Olivia) indicated that adults influence their AT use. Indeed, devices can introduce additional distractions. Turner no longer used a braille notetaker because the lack of a visual display prevented her teachers from keeping her accountable for her device usage ("Well, with the BrailleNote, since you could hide the screen on it pretty easy to just pretend to work but not actually work and be doing something else"). Emma indicated that her parents did not want her to use her cell phone as AT due to potential distractions it may cause her ("My mom doesn't let me use my phone here because she doesn't trust me with it."). Olivia also indicated that her parents influenced the type of AT use based on future cost considerations ("My mom don't want me to [use a braille notetaker]"). Her parents' forethought focused on their future responsibility in purchasing technology after Olivia graduated. In her case, the cost difference between laptops and notetakers was thousands of dollars; with cost receiving more considerationg than usability. The presence of an intellectual disability may introduce needs for guidelines on appropriate device use. In Henry's situation, he determined when to use his AT based on his teacher's recommendation ("My teacher told me too."). The different ways adults influenced AT use highlight that adults desire technology that is productive and affordable. Input from educators and parents in selecting AT could provide support and foster adult influence that promotes AT use.

CHAPTER IV

Discussion

Educators' consideration of AT for students with VI is important legally (IDEA, 2004) and because of the potential AT has in facilitating access to classroom content and instruction (e.g., Kapperman et al., 2002; Smith & Kelly, 2014; Tuttle & Carter, in press). Moreover, educators are also tasked with supporting AT in classrooms. A strong understanding of student and classroom factors that impact AT use is critical for ensuring students utilize needed technology. This study examined middle and high school students with VI's classroom experiences and perspectives across three school districts and one state school for the blind to identify (a) characteristics of AT use in core-content classes, (b) academic and social experiences of students with VI who use AT, (c) contextual variables or student behaviors associated with AT use, (d) perceived benefits of AT, and (e) perceived factors that influence AT use. These findings extend the body of research for AT use of students with VI in several important ways.

First, observational data suggest that AT use for students is highly individualized. AT usage was characterized by differences in use among students, across observations, and functions that students performed on AT devices. Students' use of AT varied widely across students (i.e., 10.4% to 87.6% of total observation intervals). Variations in AT use across students indicate students have very different needs that influence reliance upon AT devices. Moreover, many students AT use varied widely across observations. The average range of AT use was 31.4% of observations. The wide range of AT use across students suggests that contextual factors, such as classroom routines and instruction, impact AT use. This was reinforced in interviews when students described the role their skills and abilities, classroom experiences, and personal preferences played in shaping their AT use. Indeed, the AT literature affirms that students' ability, technology experience, severity and types of disabilities, and personal preferences are all student factors that affect the adoption of AT devices (Lee & Vega, 2005). This finding affirms the need for high-quality AT assessment when selecting AT devices and prescribing AT services (Sui & Presley, 2020).

High usage for most students (i.e., six students used AT for half or more of observed intervals) suggests that AT played an important role in facilitating the participation of students with VI in core-content classes. However, AT use data likely reflect the "best-case scenario" for students because I chose the location of classroom observations based on teacher recommendations where students were most likely to use AT. Furthermore, previous research indicates the proportion of students with VI who are assigned AT remains relatively low (Kapperman et al., 2002; Kelly, 2009; Tuttle & Carter, in press). Wider consideration of AT use might be warranted, given assistive technology's critical role in most of these students' classroom participation.

Second, students with VI who used AT participated in a range of experiences. For example, students used technology in a variety of core-content classes (i.e., English and language arts, social studies, math, chemistry, and physics), where students participated in different work tasks and instruction groupings. Some instructional experiences were more common than others. For example, students were often expected to engage in written work (M = 54.8%) and work independently (M = 40.2%). However, the proportion of work tasks and instructional groupings varied widely across students and observations. The myriad of expectations and experiences students come across affirms the need for flexible, high-tech AT devices identified in the literature (Bull, 2004; Goldrick et al., 2014). Devices that can perform a multitude of functions allow technology to be applied across a myriad of contexts and meet the wide-ranging expectations students encounter in classrooms. Indeed, students used devices to perform numerous functions, including accessing assignments, texts, emails, and learning platforms. Flexibility in AT devices can also facilitate solutions for meeting individualized needs (Ortiz-Barrios et al., 2020). However, it should be emphasized that every student required multiple devices to meet all their educational needs, a finding that has been documented in previous literature as well (D'Andrea, 2012; Tuttle & Carter, in press).

Third, several factors were associated with or influenced AT use. In particular, AT was used more during written and reading tasks (M = 60.4% and 47.4%, respectively), independent instructional groupings (M = 70.2%), and while students were actively engaged (M = 58.9%). While AT was used across tasks and formats by different students, these four factors seemed conducive to higher AT use by students. One implication of these findings is that certain instructional formats likely provide more opportunities for using AT than others. These findings might be particularly relevant for introducing technology in core-content classrooms to new users. When students first learn AT, initial support in a classroom where teachers frequently utilize writing tasks and independent groupings could ensure sufficient opportunities for new users to practice and develop technology skills.

Another implication was that technology was not wholly required for all students to be actively engaged in classroom instruction. Indeed, students described alternative supports that were available to them in classrooms during interviews. The presence of other supports influenced their AT use when students preferred using these supports. This is reinforced by observational data in adult one-on-one settings, where students used devices far less (M =

33.5%) than independent instructional groupings (M = 70.2%). The individual needs of students necessitate that a variety of supports are used in classes and technology is not the only consideration for providing access in classrooms. However, students will likely have less access to adult support than they will to technology and peers. Moreover, the literature identifies correlations between social skills and AT use with future rates of employment (Kelly, 2009; McDonnall, 2011). Thus, consideration must be given to the social impact and longevity of supports selected for students.

Findings in this study also suggest that high levels of AT use are not characterized by highly social AT users. Use of AT was relatively low when interacting with peers (M = 27.5%) compared to use during other observational variables. Moreover, students identified that certain types of technologies and how they are used might foster social stigma, consistent with findings in AT abandonment research (e.g., Parette & Scherer, 2004; Shinohara & Wobbrock, 2016). Collaboration with peers has been cited as a potential benefit of AT. But these findings, along with others, may suggest AT may not be delivering on this potential (e.g., Tuttle & Carter, 2020). Research must evaluate whether intentional support and intervention to integrate peer interaction and technology can ameliorate this tension.

Fourth, students perceive technology as providing a wide range of benefits, including basic access to classroom information, improving classroom task efficiency, and providing opportunities to develop other skills. Students recognized the role technology played in providing access to information, which is a fundamental purpose of AT identified in the literature (Kamei-Hannan et al., 2017; Sui & Presley, 2020). This finding reaffirms similar qualitative findings in the field that show AT fulfills the function of providing access to information (e.g., Cooper & Nichols, 2007; Frankel et al., 2017). Students also affirm previous research that indicates technology enables students to complete work faster than non-technological methods (D'Andrea & Sui, 2015). This is a critical benefit of AT, given that research has found that students with VI often take longer to complete work, especially while using braille (e.g., Corn & Koenig, 2002; Emerson et al., 2009; Harris-Brown et al., 2015). Students also described skills they gained from using technology, including the technology itself, time management skills, and problem-solving skills. The literature on AT highlights a myriad of potential skills that can be developed with the aid of AT (e.g., Green et al., 2011; Kamei-Hannan et al., 2020; McCarthy et al., 2016; Radecki et al., 2020). Although a plethora of literature exists on educators' perceived benefits of AT, little research has examined students' perspectives. Students' perceptions of technology are critical to adopting AT successfully (Lenker & Paquet, 2003; Sui & Presley, 2020). Students must identify technology as providing a distinct advantage over other supports. Oftentimes, recognizing the potential future benefit of technology is insufficient for students to adopt technology (Lenker & Paquet, 2003). This issue came up in conversations with Owen. He chose not to use AT despite recognition of potential benefits because he did not immediately experience those benefits as a new AT user. Identification of students' perceived benefits can make educators aware of features of technology salient to students and increase the likelihood of AT adoption.

Fifth, students still face perceived challenges in utilizing AT. Challenges in using AT included accessibility and technical issues, limited technology skills, and few technology supports. Students reported that information they received sometimes could not be accessed on a device and that device issues sometimes emerged. Educator concerns related to the reliability of classroom technology are documented in the literature (e.g., Andrei, 2017; Williams, 2009; Wood et al., 2005). However, there is little empirical data suggesting that technology reliability is a major issue that impedes learning. Moreover, malfunctioning of AT devices sparsely occurred during observations of AT use. Interestingly, students also identified potential perceived benefits from technology malfunctioning through the development of problem-solving skills. In short, the adversity experienced due to technology use is likely minor.

Students also identified not knowing how to utilize technology in certain circumstances. Students' descriptions of these situations indicated that they lacked the knowledge and experience to perform tasks devices could carry out. This finding reinforces the importance of technology skills in AT use (Riemer-Ross & Wacker, 2000). However, few studies and resources focus on the instruction that equips students to use AT effectively (Arthanat et al., 2017; Tuttle & Carter, 2022). Device manuals and checklists are often teachers' best resources for preparing students to operate devices in classrooms. Moreover, observational data suggest more technology support could be provided in classrooms for students learning new technology. While few technology supports were observed, findings were consistent with the literature in indicating prompting may be effective for increasing technology behaviors (e.g., Ivy & Hatton, 2014; Lancioni et al., 2007). In-class AT instruction would allow educators to focus on the direct application of AT skills required for classroom routines. These sorts of supports could have a drastic impact on AT usage for new learners.

Limitations and Implications for Research

This study has several limitations that should be considered when interpreting results. First, findings provide a restricted picture of AT use in the classroom. Recruitment occurred in the Fall of 2021 and was impeded by district and school policies in response to the Delta and Omicron variants of COVID. Recruitment was prolonged to establish a minimum goal of 10 participants. However, the small sample size impacts the generalizability of these findings. Moreover, few participants (20%) were identified with additional disabilities. The literature suggests that the prevalence of students with VI and additional disabilities is much higher (65.3%; Hatton et al., 2013). Future research should examine a larger and more diverse sample size regarding the presence of additional disabilities.

Second, observations were restricted to just one of each student's core-content classes. Observations across different contexts would generate a more complete picture of AT use because assistive technology opportunities and patterns may vary across classrooms. Moreover, there may be a positive bias in AT use as I observed most students in classrooms where TVIs reported that AT use was most likely. More general AT use levels are likely lower than the levels identified in this study. Additionally, researchers could identify more detailed patterns of factors associated with AT. For example, classroom subjects may have emerged as a factor related to AT use. Future studies could incorporate multiple observation settings within students to capture more general levels of AT use and to identify more detailed patterns in AT use across contexts.

Third, there are limitations in the measures used to capture AT use and classroom experiences. Observational measures are complex for students with VI, who often don't exhibit the same visual cues for classroom behaviors (e.g., eye contact, visual scanning) as sighted peers. For example, behavioral cues such as making eye contact with the teacher or looking at the board would likely have underestimated certain behaviors if I used definitions of academic engagement in previous studies (Carter et al., 2011). To address this issue, I split definitions for academic engagement to isolate errors from passive engagement. However, the interpretability of passive engagement is still limited due to the possible inflation of coding behaviors (e.g., being unable to detect a lack of focus without students displaying overt distraction). Likewise, interactions with peers who had additional disabilities were limited to students with visible disabilities due to restrictions around collecting records on students who were not directly involved in the study. Thus, participants' interactions with classmates with disabilities is likely an underestimation, while interactions with classmates without disabilities may be slightly overestimated. Future research should consider ways to improve the observational measurement of behaviors among students with VI.

Additionally, I observed only a select few contextual factors and student behaviors. There are likely factors beyond those identified in this study, such as the length of time students used their technology, the type of instructional technology utilized in general education classrooms, the clarity of task instructions, and teachers' familiarity with a device. Future research should expand explorations on factors that influence AT use. Moreover, the classroom experiences are not contrasted with peer comparison data. Thus, it is difficult to contextualize the classroom experience of the students with VI in this study. For example, the patterns of social interactions across students may have been low, but without peer data, I am unable to provide a normative range of behaviors in these classrooms. Future research should collect observational data on sighted peers to provide normative context for the behaviors of students with VI.

Finally, iterative data sampling and member checks are considered the best approaches for qualitative research (Corbin & Strauss, 2008). Due to limitations in the timing of the study and to limit the length of data collection to a single semester, my qualitative data were not sampled and analyzed in an iterative fashion (i.e., I did not conduct multiple interviews with students with revisions from preliminary findings) and I was unable to conduct full member checks. I addressed this limitation by incorporating intermediate member checks with students to clarify students' statements during and after interviews. I also incorporated multiple examples in my analyses to ensure the conceptual depth of each category. Future research should incorporate iterative data collection and full member checks to elicit additional opportunities to identify confirming and/or disconfirming evidence and further strengthen the trustworthiness of findings.

Implications for Practitioners

Findings from this study have several important implications for practitioners. First, findings identified AT use for students with VI to be connected to classroom engagement and participation, particularly in independent groupings. Written implementation plans are important to program planning and ensuring AT use across contexts (Zabala, 2020). Findings in this study highlight areas in which TVIs can identify opportunities for supporting AT and provide recommendations to classroom teachers. For example, TVIs might recommend incorporating more independent written tasks as an instructional strategy so students with VI can rely on technology for classroom participation. Likewise, educators might provide additional support during small groups to foster collaboration and foster/support technology use in contexts where students are not using their technology.

Second, practitioners need to provide students with additional AT support. Students identified a myriad of challenges they face in utilizing AT, but received limited classroom support for addressing these issues. Intentional interventions are likely required to increase technology support. One example could be the use of peer support arrangements (Tuttle & Carter, 2020). Peers trained to support students with VI's AT use could be a feasible way for adults to facilitate increasing AT use. Peers could be familiarized with technology during training sessions and provided reference sheets on the types of support they should provide across classroom routines. Educators also need to teach students the language to articulate AT needs (Kamei-Hannan et al., in press). Given that data suggest AT support may only be intermittently required, students need to be able to advocate and request support. Students being able to communicate technical and accessibility issues precisely should increase the efficient resolution of issues feasibly.

Third, findings affirm the value of AT use in core-content classes. Previous research suggests that only a portion of students with VI are recommended AT (Kapperman et al., 2002; Kelly, 2009; Tuttle & Carter, in press). Heavy reliance on AT, high levels of academic engagement, and numerous perceived benefits provide educators with numerous reasons for considering and recommending AT to students with VI. Teachers are already legally required to consider AT for students (IDEA, 2004). However, the literature suggests that high-tech AT has broad applicability across students with varying needs (Tuttle & Carter, in press) and findings in this study affirm previous research that devices can be used in a myriad of ways and contexts (Abner & Lahm, 2002).

Conclusion

Findings from this study contribute to the AT and VI literature in several ways. Results illustrate that AT is an important tool for participating in core-content classes and that classroom factors, such as reading and writing tasks and independent instructional groupings, provide students with the most opportunity to use AT. Students affirmed the benefit of AT for classroom participation and the development of additional skill sets. Opportunities for improving AT services, such as increasing technology support in classrooms, are also identified.

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APPENDIX A

Sample Email

Dear __________,

My name is Michael Tuttle. I am a doctoral candidate at Vanderbilt University studying for a degree in Special Education. I am writing to apply to conduct research in [School District]. I want to provide you with some information about my study.

My interest is in how students with visual impairment use technology to access and participate in instruction. Our study involves direct observations of students' assistive technology use in an academic classroom, followed by a short interview with students about their technology use. I will conduct three class-length observations of students with visual impairments. Our observations in the classroom will be conducted unobtrusively. After I have completed our observations, I will conduct a 30-minute interview with students that address students' perspectives on their AT use. I hope to capture a clear portrait of AT use among middle school and high school students with visual impairment to inform teachers about practices and knowledge they can use to improve and evaluate their current services.

I expect only a few students from your school district will participate (around ___ or less). I understand the current climate of schools may affect research policies in your district. I can assure that observers will all be vaccinated and adhere to any policies surrounding COVID (i.e., wearing masks, maintaining 6 feet of distance from students and faculty, and limiting the number of personnel who participate in observation intervals). I can also be flexible about the timing of our observations. Specifically, I ask that you might consider a tentative acceptance of our study pending when visitors are allowed in school buildings.

Thank you,

[Signature]

APPENDIX B

Observational Measures, Codes, and Brief Definitions

Device use	
AT Use	The student is physically oriented toward and operating their device
Malfunctioning	A student has indicated their device is not in a working state
Device proximity	Students have some form of AT out on their desk
Technology Support	Interactions with peers or adults encouraging a student to use a device
Work task	
Listening	Orienting toward a speaker/device to receive information without responding (includes listening to videos or audiobooks)
Discussion	Orienting toward a speaker or partner with the expectation to listen and respond to information
Reading	Tactilely or visually reading from a handout, textbook or material
Written work	Reading and writing a worksheet, workbook, notebook/journal, or writing down responses to verbally/visually presented questions
Hands-on activity	Students participate in an instructional activity with physical materials other than paper/devices (e.g., 3 dimensional shapes, lab equipment)
Other	Tasks do not meet the definition of any of the previous codes
No task	No instructional task is presented including transitions and down time
Proximity/interaction partner	
Classmate	Another student enrolled in the class without visible disabilities
Classmate with disabilities	Another student enrolled in the class with visible disabilities
Teacher	The primary instructor of the class
Special Educator	A teachers present in the classroom to assist students with disabilities
Paraprofessional	A support staff in the classroom to assist students with disabilities
Instructional grouping	
Large group	Working with more than seven other students but fewer than all students
Small group	Working in a group of two to six other students
Peer one-on-one	Working with one other student
Adult one-on-one	Receiving instruction directly from an adult
Independent	Working alone without assistance from others
No Instruction	No instruction is provided to a student or they finished all assigned work
Gone	The student is not present in the classroom
Academic engagement	
Actively engaged	Physical/verbal response to an educator's directions or assigned activity
Passively engaged	Listening to lectures or instructions provided by the instructor
Not engaged	Engaging in unassigned activities or not responding to directions

APPENDIX C

Assistive Technology Observation Sheet

Device
U: The student is using their AT device
P: Device is in proximity to focus student
M: Device is Malfunctioning

Work Tasks
L: Listening
D: Discussion
R: Reading
W: Written work
H: Hands-on activity
O: Other
N: No task

Proximity/Interaction Partner
C: Classmates without disability
D: Classmates with disability
T: Teacher (general educator)
S: Special Educator
P: Paraprofessional

Instructional Grouping
LG: 8 or more students (or majority)
SG: 2 to 7 students
A1: Adult 1-on-1
IN: Student is NOT working with other students
NI: No instruction
G: Gone from room

Academic Engagement
A: Actively engaged, student is working on an assigned activity
P: Passively engaged, student is listening to a class lecture or discussion
N: Not engaged, student is not working or is participating in an activity not assigned by the general educator

	Device	Work Tasks	Proximity	Instructional Grouping	Social Interactions	Technology Supports	Academic Engagement
1	U P M	L D R W H O N	C D T S P	LG SG IN A1 NI G	C D T S P	P A	A P N
2	U P M	L D R W H O N	C D T S P	LG SG IN A1 NI G	C D T S P	P A	A P N
3	U P M	L D R W H O N	C D T S P	LG SG IN A1 NI G	C D T S P	P A	A P N
4	U P M	L D R W H O N	C D T S P	LG SG IN A1 NI G	C D T S P	P A	A P N
5	U P M	L D R W H O N	C D T S P	LG SG IN A1 NI G	C D T S P	P A	A P N
6	U P M	L D R W H O N	C D T S P	LG SG IN A1 NI G	C D T S P	P A	A P N
7	U P M	L D R W H O N	C D T S P	LG SG IN A1 NI G	C D T S P	P A	A P N
8	U P M	L D R W H O N	C D T S P	LG SG IN A1 NI G	C D T S P	P A	A P N

Class Activities:

Unusual Events:

Devices Used:

Additional Notes/Comments:

APPENDIX D

Technology Support Checklist

Check off all technology support behaviors offered by classroom adults (i.e. interventionist or general education teacher) and/or peers observed *at any point* during the entire class period. Adapted from Abner and Lahm (2002).

Adult Support(s)	**Peer Support(s)**	**Technology Supports**	
❑	❑	Monitoring the student's AT use	
❑	❑	Verbally reorients the student to their digital location (e.g., telling the student if they are on a menu vs. in a document or explaining how to navigate to an application)	
❑	❑	Explicitly teaching a specific technology-related skill (i.e., a skill not previously learned)	
❑	❑	Reviewing a device or application command (e.g., keyboard shortcut for spell check)	
❑	❑	Retrieving the students' work from the device (e.g., printing or emailing a document for a student)	
❑	❑	Writing down a student's answers on a device	
❑	❑	Assisting in notetaking on a device	
❑	❑	Setting up AT equipment (e.g., turning on devices, adjusting settings, or opening applications)	
❑	❑	Redirecting the students' use of the device when they are off-task.	
❑	❑	Prompting to use an AT device	
❑	❑	Prompting the use of a feature of a device/application	
❑	❑	Initiating use of an AT device for games.	
❑	❑	Troubleshooting an issue on a device.	
❑	❑	Modifying an assignment so that it can be completed on a device.	
❑	❑	Encourages collaboration with other students using the AT device.	
❑	❑	Describes or explains inaccessible content (e.g., an image or information in a video)	
❑	❑	Reminds student of proper device care (e.g., making sure workspace clean and dry)	
❑	❑	Provides feedback on students work located on AT device	
❑	❑	Other:	

Other:

APPENDIX E

Functions of Technology Checklist

Check off all ways you observed technology being used *at any point* during the entire class period. Adapted Tuttle and Carter (in press).

Uses		
	Functions of Technology	
❑	Screen enlargement	
❑	Screen reader (e.g., JAWS, NVDA, VoiceOver, etc.)	
❑	Refreshable braille	
❑	Document scanning	
❑	Word processing	
❑	Calculation	
❑	Internet use	
❑	Email/messaging	
❑	Spreadsheet/database	
❑	Note taking	
❑	Access to digital text (i.e., a literary book or textbook)	
❑	Access to assignments (e.g., a worksheet or prompt that requires the student to complete work on their device)	
❑	Calendar/planning application (e.g., setting a timer or an alarm as a reminder)	
❑	Recreation (e.g., games, social media, or any form use unrelated to class content)	
❑	Augmented Communication (e.g., an electronic picture selection system; this does not include general communication such as messaging apps or social media)	
❑	Peer collaboration (technology allows students to share class content; e.g., cloud applications or presenting information across multiple forms of media)	
❑	Adult collaboration (similar to peer collaboration, but collaborative partner is an adult)	
❑	Switch use (e.g., a push button or some other alternative input to control a device)	
❑	Educational platforms/applications (e.g., Clever, Read180, iBraille Challenge, etc.)	
❑	Dictionaries or thesaurus (could also include using a voice assistant, such as Siri, to look up the meaning of a word).	
❑	Printing or embossing	
❑	Presentations (e.g., PowerPoint, Keynote, etc.)	
❑	Other:	

Other:

APPENDIX F

Interview Guiding Questions for Assistive Technology Observational Study

1. **Describe how you currently use AT.**

What forms of technology do you currently use?

- Enlargement devices (e.g., screen magnifiers, video magnifiers, distance viewing cameras)
- Braille devices (e.g. refreshable braille displays, braille notetakers, etc.)
- Tablets
- Laptops
- Desktops
- Smartphones
- Math and science technologies (e.g., talking calculators, lab equipment, etc.)
- Embossers/printers
- Digital textbooks (e.g., DAISY text player, NLS player, BARD application, etc.)

What tasks do you complete with these technologies?

- Reading
- Writing
- Communicating
- Researching
- Presenting
- Calculating

How do you decide which technology to use?

- Strategies your teacher taught
- Personal preference
- Teacher's directions
- Features/qualities of the device
- Which classroom you are in
- What devices are available

Where do you use these technologies?

- Math
- Science
- English and Language Arts
- Social Studies
- Electives/related arts
- Study hall/free time
- Cafeteria

How does your AT use look different across contexts?

- Core-content classes
- Electives
- Extra-curricular activities
- Home

How has your “technology toolkit” changed over time?
How long have you used these technologies?

2. Describe the AT instruction and supports you currently receive.

- Classroom support
- Touch typing practice
- Instruction on how to use devices over certain topics:
  - Screen enlargement
  - Screen reader
  - Document scanning
  - Word processing
  - Calculation
  - Internet use
  - Spreadsheet/database
  - Using calendars/reminders
  - Email
  - Printing/embossing

How did you learn how to use your technology?

- Self-taught?
- TVI?
- Other teachers?
- Parents?
- Peers?
- Others?

How has your TVI supported you in using or learning technology?

- General education teachers?
- Parents?
- Peers?
- Anyone else?

What are you currently learning about technology?

- Screen enlargement
- Screen reader
- Document scanning
- Word processing
- Calculation
- Internet use
- Spreadsheet/database
- Using calendars/reminders
- Email
- Printing/embossing

What has been the most helpful thing you’ve learned about technology? Least?

What type of instruction has been most helpful for learning technology? Least?

3. What are the benefits of your technology?

In what ways does your technology help you in school?
Reading
Writing
Calculations
Presenting
Collaborating with peers
Completing class assignments
Submitting class assignments
Getting information off the board
Accessing graphics
Accessing textbooks

In what ways does your technology help outside of school?
Doing homework
Communicating with teachers
Communicating with peers
Navigating
Relaxing/recreation

Follow up: Could you do *those things* without your technology?
How is your participation in *those things* different because of technology?

What skills or knowledge have you gained as a result of using technology?
Problem-solving skills
Productivity skills
Time-management skills
Organization skills
Communication skills

How has using technology changed you as a person?
How have the benefits of your "technology toolkit" changed over time?

4. What are the challenges in using your technology?

In what ways have you experienced difficulty using technology in school? Outside of school?
Reading
Writing
Calculations
Presenting
Collaborating with peers
Completing class assignments
Submitting class assignments

Getting information off the board
Accessing graphics
Accessing textbooks
Devices malfunctioned
Not provided information on a device

Follow up: Would you experience *those challenges* without your technology?

Have you ever not wanted to use a specific technology? If so, why?
Have you ever desired access to an assistive technology that you didn't receive?
Follow up: If yes? Why do you think you didn't receive access to that technology?
Too expensive
You already had a similar tool
A teacher preferred a different device
You were never asked your opinion

What suggestions do you have for improvements to your "technology tool-kit"?
What suggestions do you have for improvements in your experience with technology?