TECHNOLOGY USE AS A SUPPORT TOOL BY SECONDARY STUDENTS WITH AUTISM: A MIXED METHODS INVESTIGATION

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ABSTRACT

Susan H. Hedges: Technology Use as a Support Tool by Secondary Students with Autism: A Mixed Methods Investigation
(Under the direction of Drs. Sam Odom and Kara Hume)

The majority of students with Autism Spectrum Disorder (ASD) are leaving high school ill prepared to integrate successfully into adult life, which comes at a huge cost, not only to themselves and to their families, but also to society at large. Technology supports have the potential to improve their outcomes and thus enhance their quality of life. Knowing that most individuals with ASD have an affinity for technology and that technology is becoming more portable, less expensive, and more widely available, makes it an attractive potential support. Previous studies of the technology use by adolescents with ASD focused primarily on discretionary use. This mixed methods study investigated the use of technology as a support tool by high school students with ASD.

In the first phase, 243 students from 30 high schools in North Carolina, Wisconsin and California completed questionnaires regarding their technology use. Based on the survey results, ten students were purposefully selected and interviewed regarding their perceptions of the benefits and barriers to their technology use as a support. The combined results revealed that teens with ASD are bringing internet capable technology with them to school and using it at school and at home to support their independence, improve their social opportunities and to reduce their anxiety and stress. These results provide important information for researchers and practitioners about the potential of technology use to improve

the lives of individuals with ASD and underline the need for efficacy studies of these uses of technology.

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In the words of one of my participants: “I think technology is the best industrial thing in our world because it gives us joy and curiosity into great things.”

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Chapter 1

Introduction

For many individuals with Autism Spectrum Disorder (ASD), technology holds a special attraction (Mineo, Ziegler, Gill, & Salkin, 2009; Porayska-Pomsta et al., 2012; Shane & Albert, 2008). Recent technological innovations have made technology more accessible than at any time in history. Researchers are taking advantage of this attraction and developing technology-aided interventions that support learning and independence of individuals with ASD (Shane et al., 2012). Research has shown that adolescents with ASD use technology as a form of entertainment (Kuo, Orsmond, Coster, & Cohn, 2013; MacMullin, Lunsky, & Weiss, 2015; Mazurek, Shattuck, Wagner, & Cooper, 2012; Orsmond & Kuo, 2011) and also that technology-aided interventions can be effective at meeting some of the social, communication, and behavioral needs of adolescents (Odom et al., 2014). Few studies, however, have examined the everyday use of technology by high school students with ASD as a support tool.

Technology has the potential to support students with ASD in a variety of ways. Texting, email, and cell phones can encourage communication (Ayres, Mechling, & Santosti, 2013). A student who is reluctant to attend an Individualized Educational Program (IEP) meeting with a room full of adults may feel more comfortable doing so via Skype (Keintz, Goodwin, Hayes, & Abowd, 2012). Facebook, Twitter, Instagram, and other social media

tools can help facilitate social interaction (Gillespie-Lynch, Kapp, Shane-Simpson, Smith, & Hutman, 2014). Keeping up with school club activities on Facebook can be less intimidating than a phone call to a club member. Calendars, reminder alarms, timers, and other organizational applications can help to increase independent functioning in schools and the community (Gentry, Wallace, Kvarfordt, & Lynch, 2010; Myles, Ferguson, & Hagiwara, 2007). There is now a range of new technologies and applications with the potential to support high school students with ASD as they transition to adulthood. This mixed methods study describes the forms of technology used by high school students with ASD and their purposes. It includes their perceptions of the benefits as well as possible barriers to technology use. The goal of this study is to provide insights to researchers, parents and practitioners that may aid in the broader implementation and uptake of such supports for students with ASD.

Statement of the Problem

High school students with ASD in the United States (US) have some of the poorest post-school outcomes of any disability category (Howlin, Goode, Hutton, & Rutter, 2004; Shattuck et al., 2012). According to the National Longitudinal Transition Study 2 (NLTS2), when students with ASD leave high school, the majority live at home and have minimal work and/or social activity (Mazurek et al., 2012). In their cost analysis, Leigh and Du (2015) propose that the annual cost to society for individuals with ASD who do not achieve independence is $268 billion. For the families and individuals themselves, the cost in terms of impact on quality of life can be substantial (Heijst & Geurts, 2015). Finding effective ways to support these individuals to improve their independence and quality of life is critical (Gerhardt & Lanier, 2011). Unfortunately there is a dearth of research on evidence-based

interventions and practices to meet the wide range of needs (academic, social, behavioral) of high school students with ASD as they transition to adulthood (Test, Smith & Carter, 2014).

Purpose of the Study

Technological advances have the potential to lead to more effective supports and to improve the quality of life for students with Autism Spectrum Disorder (ASD). Knowing that many individuals with ASD have an affinity to screen-based technology (Ploog, Sharf, Nelson, & Brooks, 2013), possible strengths in the areas of visual perception (Shane & Albert, 2008) and visual search (Kaldy, Giserman, Carter, & Blaser, 2013) and that technology is becoming more portable, less expensive, more widely available, makes it an attractive potential support. However, the typical use (e.g., in school, home, and community) of technology as a support by students with ASD remains largely unexplored. To address the gap in the literature, the purpose of this study is to describe the use of technology by high school students with ASD as a support tool to help them learn, communicate, socialize and be more independent at school and at home.

The rationale that underlies this research is that knowing how high school students with ASD are using technology throughout their school day will provide important information for researchers and practitioners. For example, if many students with ASD are carrying smartphones or tablets to school every day but not using these powerful tools to help with organization and to facilitate independence, gaining insights into the perceived barriers from the users not only helps focus intervention research agendas but can provide useful information to practitioners and policy makers. Proxy reports, typically parents and teachers, are used for the majority of research involving the experiences of students with ASD, yet the perspectives of the individuals in question can lead to a fuller understanding of their needs

(Kirby, Dickie & Baranek, 2015). As this study focuses on technology use by students with ASD, it is important to gather perspectives from the users themselves.

There are several expected outcomes of this research. First, it will provide a description of current technology use as a support by high school students with ASD. To date, the literature has focused on discretionary technology use by individuals with ASD, but not planned use of technology to support engagement and participation in school and community settings. Next, this study will include insights from the individuals themselves into the perceived benefits of and possible barriers to its use, which may inform the development of future interventions, practices, and policies. This contribution will be significant because new technologies such as iPads and Smartphones, are ubiquitous, non-stigmatizing, portable, relatively affordable, and appear to be well received by students with ASD. These technologies may potentially provide support in a wide range of areas including: communication, social skill building, executive functioning, job skills development, and academics.

Research Questions

This study used an explanatory sequential mixed methods design (Creswell, 2015). It began with a survey of high school students with ASD participating in a larger study conducted by the Center on Secondary Education for Students with Autism (CSESA) about their technology use. The survey led to more in-depth questions that were addressed through qualitative interviews of a sample of ten of the participants. The following research questions were addressed.

1. How do adolescents with ASD use technology as a support?
    a. What forms of technology are being used?

b. For what purpose is technology being used?

c. How often is technology being used?

2. What do students perceive as benefits of technology use as a support?
3. What do students perceive as barriers to the use of technology as a support?
4. Are there associations between technology usage, and student's perceptions of benefits, students' perceptions of barriers, intellectual ability, enrollment status, students' household income, gender, and/or race/ethnicity?

Defining Technology as a Support

For the purposes of this study, technology as a support is defined as "any electronic item/equipment, application, or virtual network that is used to intentionally increase, maintain, and/or improve daily living, work/productivity, and recreation/leisure capabilities of individuals with autism spectrum disorder" (p. 96, Wong et al., 2014). This definition was developed by the Technology Working Group of the Center on Secondary Education for Students with ASD (Odom et al., 2015). It incorporates existing definitions of assistive technology as set forth by the US government (PL108-364, www.gpo.gov/fdsys/pkgPLAW-108pub1364.htm) and the Canadian Association for Occupational Therapy (2012). As other surveys of technology use by individuals with ASD have focused primarily on discretionary use (e. g., entertainment) (Kuo et al, 2013; Mazurek et al, 2012; MacMullin et al., 2015; Shane & Albert, 2008), this study will focus on technology use that supports learning, independent functioning, social interaction, and communication in the school and home environments.

Conceptual Model

This study is situated in the conceptual framework developed by the CSESA Technology Working Group (2013; see Figure 1). This model uses the domains of human (individual, family, service provider), activity (daily living, work, leisure), and technology (electronic item, equipment, application, virtual network) to organize thinking about technology use for individuals with ASD. Where these three domains overlap is the ideal user-activity-technology match. This model is heavily influenced by persuasion theory prominent in the field of human-computer interaction (Fogg, Lee, & Marshall, 2002). The two key concepts in persuasion theory are expertise and credibility. That is, the tool provides a useful function and it is effective. For example, if an alert is scheduled in a smart phone to remind a student to turn in his homework at the beginning of class each period and the act occurs daily without fail and the student is successful, the tool is demonstrating expertise and deemed credible. Were the alert to occur and the student does not turn in the homework, then credibility would be lost.

Organization of the Dissertation

In this chapter (Chapter 1), I provide an introduction, statement of the problem, purpose of the study, research questions, and conceptual framework. Chapter 2 provides a review of the literature and research related to technology-aided interventions, the affinity for technology by individuals with ASD, how technology relates to the core features of autism, the use of technology in support of learning, and the need to include individuals with ASD in research about their needs. Chapter 3 describes the research design, methodology, procedures, and instruments used to collect and analyze the data. Chapter 4 presents the results of the analyses of the quantitative phase of the study, the student surveys, and the findings from the qualitative phase of the study are presented in Chapter 5. Finally Chapter 6

contains a discussion of the conclusions drawn from a synthesis of the two study phases, recommendations for practitioners, suggestions for future research and limitations of the work.

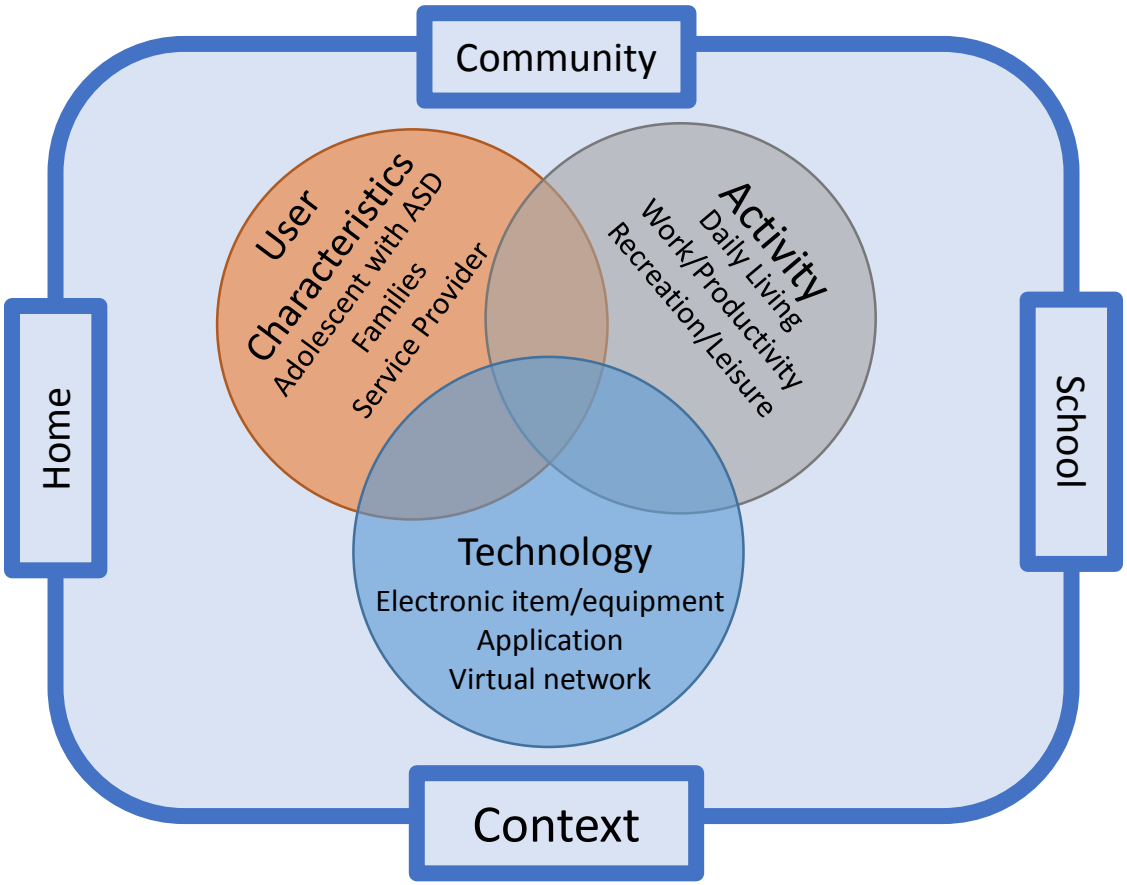


Figure 1. Conceptual framework for technology use for adolescents with ASD (Odom et al., 2014)

Chapter 2

A Review of the Literature

Autism is a neurodevelopmental condition involving deficits in social communication with restricted interests and behaviors (American Psychiatric Association [APA], 2013). ASD is considered the fastest growing developmental disability with a 289.5% increase in the number of children being diagnosed over the last twelve years (CDC, 2014). The current prevalence estimate from the Centers for Disease Control (CDC) is 1 in 68 of children 17 and under (Baio, 2014). While the cause of the increase is unknown, it is believed to be due at least in part to improvements in diagnosis as the disorder is better understood. Other potential explanations, such as environmental factors (CDC, 2014) as well as immune deficiencies (Napoli, Wong, Hertz-Picciotto, Giulivi, 2014) are receiving wider attention.

A recent survey conducted by the CDC found that children in the age range of 14-17 as likely to have a diagnosis of ASD as younger children (Blumberg et al, 2013). Thus high schools are being challenged to meet the unique needs of these individuals as they move through school and on to the post-school environment. It is essential that schools and educators be well prepared to support the successful transition of students with ASD to adulthood as the stakes are high. There are wide ranging estimates of the financial burden of supporting individuals with ASD across the lifespan (at least $268 billion annually in the U.S.; Leigh & Du, 2015). In addition, there are costs in terms of quality of life for individuals with ASD and their families. Correlational research has found some of the major predictors

of the poor outcomes are closely associated with the core characteristics of ASD, namely, functional behaviors (Shattuck et al., 2012) and social communication deficits (Howlin et al., 2004). The Individuals with Disabilities Education Act (IDEA) has charged high schools with the responsibility of preparing students with disabilities with the tools they need to transition successfully into adulthood as active members of society (IDEA, 2004). High schools are the front line in the transition process for students with disabilities and in many cases their last hope for receiving support. With more than 80% of individuals with ASD living at home up to eight years after leaving high school and the majority unemployed or underemployed and having limited social interactions (Shattuck et al., 2012), the need for effective supports and interventions to improve these outcomes is urgent.

Autism Spectrum Disorder and Technology

Children with autism across the spectrum are attracted to technology, in particular screen-based technology, often for the purpose of playing video games or watching animated movies (Kuo et al., 2013; Mazurek, et al., 2012, Shane & Albert, 2008). For this reason there is increased attention in intervention research on the use of technology especially for young children (Ploog et al., 2013). Most recently, there is an emerging body of evidence that new technologies, in particular handheld devices such as smartphones and tablets, can be effective in promoting independence for adolescents with ASD (Hume, Boyd, Hamm, & Kucharczyk, 2014). This suggests these supports could be an important avenue for improving post-school outcomes. Handheld devices are especially appealing as they are relatively low in cost and widely used, even in low-income households (Keintz et al., 2014).

The use of technology as a support for students with ASD is an area showing great promise although the evidence remains sparse as researchers struggle to keep up with the

rapid pace of innovation (Grynszpan, Weiss, Perez-Diaz, & Gal, 2013). Yet if one considers 1) the attraction of certain forms of technology, 2) the way technology can address the defining characteristics of ASD, and 3) the role technology plays in 21st century education and society, prioritizing technology based interventions and supports should be high on the autism research agenda (Bolte, Golan, Goodwin, & Zwaigenbaum, 2010).

The evidence base for technology interventions. There has been a dramatic increase in the amount of research involving technology use in support of individuals with ASD as illustrated by a set of recent reviews (DiGennaro Reed, Hyman & Hirst, 2011; Grynszpan et al., 2013; Fletcher-Watson, 2014; Keintz et al., 2014; Knight, McKissick, Saunders (2013); Mechling, 2011; Pennington, 2010; Ploog et al., 2012; Ramdoss et al., 2011; Ramdoss et al., 2011; Ramdoss et al., 2012; Wainer & Ingersoll, 2011). The number of studies involving technology interventions for individuals with ASD has skyrocketed from approximately 200 in 1995 (Keintz et al., 2014) to roughly 1350 in 2013 alone (King, Thomeczek, Voreis, & Scott, 2014). Although, this research has led to the identification of some "promising practices", only a small number of studies have met the quality standards for evidence-based practice (Gersten et al., 2005; Horner et al., 2005).

In 2012, Wong and colleagues at the National Professional Development Center on Autism Spectrum Disorder (NPDC ASD), in a comprehensive review of the literature found only 20 studies that met quality criteria for efficacy for technology aided interventions and instruction (TAII; NPDC, 2012) for children between the ages of 3-22. Twelve out of the 20 studies included adolescent participants. A team of 154 trained external reviewers established the evidence by using methodological criteria based on the Council for Exceptional Children Division for Research quality indicators (Gersten et al., 2005; Horner et al., 2005). That

criteria includes indicators such as a match between research question and dependent variable, comparability of groups (for group design), adequate demonstrations of experimental control, which includes three demonstrations of a functional relationship between the independent and dependent variables (for single case design [SCD]; Kratchowill et al., 2013).

Building on that review to include studies completed after 2011, Odom and colleagues (2015) found only three additional studies that used technology-aided interventions and instruction specifically for adolescents with ASD (14- 22). Further, the Odom et al. (2015) study included video modeling, video prompting, and video self-modeling in their search, which led to an inclusion of an additional 20 studies. Video modeling (VM) is considered a separate evidence-based practice from TAII by the NPDC for ASD (Wong et al., 2012). Significantly, in the Odom et al. study, eleven of the new video modeling studies made use of handheld technologies such as iPhones, iPads, laptops, and personal digital assistants (PDA).

Although so few studies met the criteria, the variety of technology forms as well as range of goals used in those studies represent the broad possibilities for technology as a support for high school students with ASD. Even for those technologies on the verge of extinction today (e.g. pagers), the same approach can be easily adapted for use with more current handheld technologies (e.g. smartphones). While several studies involved the use of desktop computers, the same or similar interventions can be delivered using cheaper and more flexible technologies such as laptops and tablets meaning that these studies represent uses for technology that are possible to implement in current and future contexts.

Affinity for technology by individuals with ASD. Much of the enthusiasm surrounding the use of new technologies (e.g. smartphones, tablets) to support children and youth with ASD is undoubtedly due to the affinity children with ASD exhibit for screen-based media (Kuo et al., 2013). Studies have revealed that screen-based technology use is a primary and preferred discretionary activity for the majority of children (Shane & Albert, 2008) and adolescents with ASD (Kuo et al., 2013; Mazurek et al., 2012; Orsmond & Kuo, 2011). Using data from the first wave of the NLTS2 (2001), Mazurek et al. (2012) found students with autism (ages 13-17) were significantly more likely to engage in television watching and video games during their leisure time than students from three other disability categories (intellectual disabilities, learning disabilities, and communication disorders). More recently, Kuo and colleagues (2013) found 98% of the teens with ASD surveyed spent approximately five hours per day on a computer, primarily engaged in playing video games and surfing the web, and two hours per day watching television, primarily cartoons and comedy shows (Kuo et al., 2013). A study comparing the screen-based technology use of adolescents with ASD to their typical siblings, found participants on the spectrum were heavier users (4.5 vs. 3.1 hours per day respectively) (Mazurek & Wenstrup, 2013). Another likely indicator of the strong affinity for technology was born out in the NLTS2 data that revealed those students with ASD who attend 4-year college (roughly 12%) ended up majoring in computer science at a rate much higher than the general population (16.22 vs. 6.6%; Wei, Yu, Shattuck, McCracken, & Blackorby, 2013).

Other survey studies of technology use and ASD have revealed potential negative impacts. In a study of parent attitudes toward computer use at home, Fletcher-Watson and Durkin (2015) found that 60% of parents (n=178) had problems with their child being

obsessed with technology. However, 92% of those same parents felt their child benefitted from technology use. Mazurek and Wenstrup (2013) found boys with ASD had more problematic video game use compared to a comparably-aged group of typically developing boys as reported by their parents. In another comparative study of adolescents with ASD and typical peers, MacMullin et al. (2015), found parents of children with ASD (n=139) reported more often that computer use was having a negative impact on their children, in comparison to reports of parents who had typically developing children (n=172). For boys with ASD aged 8 – 18 years, Engelhardt and Mazurek (2014) found that problematic video game use was predictive of oppositional behavior. In another study, parents reported their children with ASD had difficulty disengaging from role playing video games, getting angry when interrupted from these games, and playing longer than intended (Mazurek & Engelhardt, 2013). The same study noted however that violent video game use was not a significant predictor of oppositional behavior. In a study of cyber bullying and students with ADHD and/or Aspergers/, Kowalski and Fedina (2011) found 21% of their 42 participants (age range 10-20) reported experiencing cyber bullying in the most recent two month period and roughly six percent reported that they had perpetrated cyber bullying themselves during the same time frame. In the same study, only nine percent of parents reported ever discussing cyber bullying with their child. Unfortunately this study combined results for students with ADHD and those with Aspergers so it is not possible to determine to what extent these results reflect the experiences of individuals with ASD.

Again using the NLTS2, Mazurek et al. (2012) found that in addition high discretionary usage of screen based media by secondary students with ASD; the use of social media was lower than it was for most other disability categories. However, correlates with

demographic factors revealed the odds ratios were significantly higher for internet browsing, email, or chat for students with ASD who were female (2.6), Hispanic (.03), or those with higher functional cognitive skills (1.3). In a recent internet-based study of the perceived benefits of computer-mediated communication, adult respondents with ASD were 72% female leading to an inference that females with ASD may prefer using the internet to communicate more than males (Gillespie-Lynch et al., 2014). These findings suggest there may be differences in technology use among groups of students with ASD, which would be important to investigate.

Technology and the core deficits of ASD. The third area that is raising hopes about the promise of technology as a support for adolescents with ASD is the way it can address the core deficits of autism and promote independence. ASD is an umbrella term for developmental disorders characterized by deficits in two major areas as defined by the Diagnostic and Statistical Manual of Mental Disorders (5th ed., DSM-V; American Psychiatric Association [APA] 2013). The first is in the social domain impacting both communication and social interaction, and the second is broadly described as restricted, repetitive patterns of behavior or interests. Social and communication difficulties are often characterized by challenges in the reciprocal nature of social interactions and understanding nonverbal social behaviors of others (APA, 2013). Restrictive and repetitive behaviors and interests include stereotypic behavior or speech, compulsive adherence to routines, and/or highly fixated or circumscribed interests and may also be characterized by hyper- or hypo-reactivity to sensory input (APA, 2013). These core deficits challenge individuals with ASD in a myriad of ways across the lifespan. During adolescence and into adulthood one area greatly affected by social and behavioral deficits is independence (e.g. self-management,

self-advocacy, initiating or reciprocation in social interactions). Being able to act independently is critical for successful transition to adulthood (Hume et al., 2014).

Technology to address social deficits. There are a variety of ways technology can ameliorate the social difficulties experienced by adolescents with ASD. First and foremost, it can provide freedom from social demands (Grynszpan et al., 2014) by reducing the quantity and complexity of student-teacher interactions. For example, students with ASD might benefit more from instruction delivered via a computer so they do not have to simultaneously engage in social interaction with the teacher (Ramdoss et al., 2011). Social media, email and texting can expand opportunities for social interactions as it can be far less intimidating for students with ASD who often struggle to engage in face-to-face relations (Mazurek & Wenstrup, 2013). Similarly videoconferencing technology can help reduce anxiety and improve engagement in Individualized Education Program (IEP) meetings by allowing participation from another location (Keintz, et al., 2014). Virtual environments are showing promise as a way to practice community based social interactions such as ordering food from a cafe (Bellani, Fornasari, Chittaro, & Brambilla, 2011).

In several studies, researchers have found that interactive multimedia on desktop computers is a helpful tool for teaching understanding of emotions, mental states, and face reading, all areas that are often difficult for individuals with ASD (Faja et al., 2008; Golan & Baron-Cohen, 2006; Silver & Oakes, 2001). These challenges have been described collectively as a deficit in a Theory of Mind (Baron Cohen, 2001) and are often thought to be the major confounder of social relations for individuals on the spectrum. In a study by Golan and Baron-Cohen (2006), participants with ASD in one group were trained to recognize emotional states using a software program at home with weekly group meetings with a tutor

and compared to a control group that received content via a face-to-face social skills group without any technology support. The group using technology improved significantly in recognition of voices and number of emotional concepts compared to the control group. More research is needed to see if these effects are maintained over time.

Technology to address communication challenges. Technology is proving to be a major support in the area of communication especially for non-verbal individuals with ASD and therefore merits discussion separate from the social domain even though the two can be related. Speech generating technology has helped facilitate the communication of some non-verbal individuals with ASD and is now available in a new form as relatively inexpensive apps for smartphones, iPods, and tablets, making it more widely accessible. This is a major advancement in the field as nonverbal individuals on the spectrum have had limited choices of supports for communication in particular ones that were easily portable, highly individualized, and affordable (Shane et al., 2012). Although the empirical base for these commercial products (e.g. Proloquo2Go) is only emerging, it is showing good results (Kagohara et al., 2010). In a study using the newest generation of technology as a speech-generating device (iPod with an app), Kagohara et al., 2010, employed a behavioral intervention (e.g. delayed prompting) to improve the participant's ability to use the device in order to improve communication.

Even for individuals who are verbal, communicating via email or text may be less intimidating and help to increase the ability to communicate important wants and needs (Gillespie-Lynch et al., 2014). Other ways technology can improve communication for transitioning youth with ASD is through consistency of clearly defined tasks and visually cued instructions that can reduce misunderstandings caused by multiple verbal instructions

(Grynszpan et al., 2013). These features can be especially important in academics and also in the world of work.

Technology to address restrictive and repetitive behavior. Researchers anticipate potential positive outcomes for students with ASD from technology especially in the areas of motivating task engagement and increasing independence and positive behaviors (Ayres et al., 2013; Mazurek & Wenstrup, 2013). This may help reduce the occurrence of restrictive and repetitive behaviors (RRBs) that can be especially beneficial in the complex and often chaotic high school environment.

Researchers have found deficits in executive functions to be positively related to restrictive and repetitive behavior in students with ASD (Vries & Geurts, 2012). The demanding academic secondary school environment can increase demands on executive functions such as organization, planning and working memory of any student but especially for students with ASD. Gentry, Wallace, Kvarfordt, and Lynch (2010) provide a prime example of how technology can help to bypass executive function deficits by teaching adolescents with ASD to program their portable handheld technologies with reminder alarms and to record appointments. Other studies suggest the potential for mobile technologies in the areas of improving independent transitioning with the help of alarms (Palmen, Didden, & Verhoeven, 2012), and supporting independent functioning in the classroom by recording homework in a handheld device (Personal Digital Assistant [PDA]; Myles et al., 2007). Even though the PDA has all but been replaced by the more versatile iPod touch or smart phone, the concept can easily be adapted to the newer technologies.

Sensory issues are common in individuals with ASD and can limit the individual's ability to function throughout life (Baranek, G. T., Little, L. M., Diane Parham, L., Ausderau,

K. K., & Sabatos-DeVito, M. G., 2014). Individual sensory profiles can vary greatly and include both hyper- and hypo-reactivity in a single person. There is still much to understand about the brain processes involved in sensory processing in individuals with ASD (Haigh, Heeger, Dinstein, Minshew & Behrmann, 2015), and interventions to address sensory issues lack a robust evidence base. New technologies are showing promise especially in the area of reducing hypersensitivity by helping students with ASD control environments that are overstimulating. For example a student can take a virtual class sitting in a comfortable environment to avoid a classroom with distracting fluorescent lighting (Wentz & Krevers, 2012). Another example is listening to music through headphones to drown out distracting peripheral sounds (Robertson & Simmons, 2015).

Technology use to promote independence in youth transitioning to adulthood. Technology can help to bypass challenges and improve independent functioning in a variety of ways using a variety of different tools. For example, Taylor and colleagues (2004) used a pager to prompt individuals who may be lost or wandered off in the community to produce a card to seek help from nearby community members. The study authors noted that the same concept could be applied to more current technology such as smart phones (Taylor et al., 2004). Another study using video images of highly desired items as motivators demonstrated improved task completion with two students with ASD and co-occurring ID (Mechling, Gast, & Cronin, 2006). The experiment was conducted comparing task completion times between the video motivators and tangible motivators. The study authors could not conclude if the improvement in task completion was motivated simply by the use of video as an activity or the fact that the students themselves appeared in the video images doing a favorite activity and suggested that as an area for future research. Additionally, handheld technologies can

make it easier to deliver video modeling (VM) in schools and in the community (Bereznak, Ayres, Mechling, & Alexander, 2012). VM has been shown to be effective in supporting adaptive and vocational skills in adolescents with ASD and is considered an evidence-based practice by the NPDC for ASD (Wong et al., 2014). These new technologies can make it possible for individuals with ASD to work autonomously and are highly motivating and can lessen the frustration that can arise from making mistakes (Ingersoll & Wainer, 2013).

The use of covert audio coaching (CAC) has been used effectively in community settings to improve job performance (Allen, Burke, Howard, Wallace, & Bowen, 2012; Bennett, Ramasamy, & Honsberger, 2013). As previously stated, a visual strength and preference for things visual has been a major justification for focusing on technology as an intervention for individuals with ASD. However, CAC lacks a visual component. Perhaps it is a "good fit" because it reduces the need for social (e.g. face-to-face coaching) interactions, an area of deficit for individuals with ASD. What is promising about this technology is that it allowed for a more unobtrusive and less stigmatizing form of prompting and/or coaching resulting in significantly increased job performance in both studies. Using commonly available smart phones and earbuds or headsets can make the use of CAC technology a cost effective job coaching solution. Other areas where it may prove useful is in the classroom as a prompting tool for teachers to increase on-task behavior. This could help reduce the stigmatizing presence of paraprofessionals shadowing students in inclusion classrooms (Cihak, Fahrenkrog, Ayres, & Smith, 2009).

Using a very different form of technology to improve vocational skills and thus foster independence, Strickland, Coles, & Southern (2013) used virtual reality technology to improve participant performance in job interviews. The JobTIPS employment training

program included web accessed content delivery along with job interviewing practice sessions in a virtual world space using avatars. Strickland and colleagues suggest this technology has a lot of potential in helping individuals with ASD improve their social and adaptive skills through practice in the low stress and highly motivating environments of virtual worlds.

Finally, using multimedia tools (PowerPoint and video) on a desktop computer, Richter and Test (2011) found improved knowledge acquisition, engaged student focus, and improved comprehension of social situations for students with ASD and co-occurring ID. These technologies could be helpful tools for teachers to improve academic and other knowledge acquisition for students with ASD and cognitive deficits as they are widely available in classrooms. Despite the small number of interventions that met effectiveness criteria, they represent the potential these tools hold in supporting the needs of students with ASD.

Technology Use in Schools to Support Learning for Students with ASD. Although the use of technology for teaching and learning is rapidly expanding in general education classrooms, the extent to which it is being used as a support for children and youth with disabilities has not been substantially explored (O'Malley et al, 2013). In the early 2000s, the NLTS2 found that students with disabilities, despite having computers in at least some of their academic classrooms, "rarely" or "never" used them (Newman, 2007). Undoubtedly computer use has increased over the years since this study and a greater variety of technologies have entered classrooms today to support students with disabilities. However, there are no current national studies that report this change.

The consideration of the use of technology to support learning should be an inherent part of the educating of students with ASD. IDEA "authorizes activities to support the research, development, dissemination and use of technology with universal design principles so that technology is accessible and maximizes access to and participation in the general education curriculum [34 CFR §300.704(b)(4)]" for students with disabilities. The ubiquitous use of screen-based technology by all teens can reduce the social stigma and increase the acceptability of technology-based interventions for adolescents with ASD who are increasingly educated in mainstream classrooms (Hume et al., 2014).

While there are no empirical studies on the efficacy of online learning for adolescents with ASD, it has been hypothesized that students with ASD will do well in the online environment (Sabella & Hart, 2014). Several reasons have been suggested including the increase in motivation and engagement from the use of computers, the reduction in pressure to perform socially, as well as a reduction in sensory overload that can happen in the typical classroom with multiple sounds, fluorescent lighting, and various scents and textures (Sabella & Hart, 2014). Potential drawbacks of learning online include the distraction of other activities available on the same computer used for learning, which could require a high level of monitoring.

Adolescents in particular are high adopters of technology with at least 95% of teens online and 74% accessing the internet via mobile devices such as smartphones and tablets at least occasionally (Madden, M., Lenhart, A., Duggan, M., Cortesi, S., & Gasser, U. 2013). Adolescents with ASD are included in these statistics and studies have corroborated their widespread discretionary use of computers and other screen-based technology (Mazurek et al., 2012; Kuo et al., 2013). Unfortunately intervention research has been slow to examine

the efficacy of the use of technology as a form of support for high school age individuals with ASD. Even though there is limited empirical evidence of the effect of technology as an intervention, it is clear that it has the potential to lead to new, more individualized supports to meet the needs of high school students with ASD.

Gathering Perspectives of Individuals with ASD

So often in autism research, including many of the studies described above, parents and service providers are the proxy reporters for the experiences of children with ASD (Milton, Miles, & Pellicano, 2012). Including the individual's perspective is important to researchers as it may vary from that of the caregiver or practitioner and thus impact how interventions and supports are designed and implemented (Pellicano, 2014). A recent study on quality of life (QOL) for teens with ASD found significant differences on several subscales between parent and adolescent reports (Clark, Magill-Evans, & Koning, 2015). The authors suggest qualitative research may help to bridge the gap between the different perspectives.

Issues surrounding self-report relate to the deficits associated with autism including communication difficulties, comprehension (interpreting items), social functioning (understanding emotions of others; Tavernor et al., 2013), and ability reflecting on their own affective states (Theory of Mind; Happe, 1993). Despite these concerns, the voices of youth and adults with ASD have been included successfully in previous studies (Carter et al., 2015; Daniel & Billingsley, 2010; Clark et. al., 2015; Kirby et al., 2015) and this is the perspective that will be featured in this work.

Chapter 3

Methods

This investigation used a mixed methods research design to describe the technology use of high school students with autism. The investigation began with questionnaires gathering quantitative data followed by qualitative interviews with select survey respondents in order to further understanding of the survey findings. Sample characteristics, procedures, instrument development, and data analysis techniques for both phases are described below in separate sections for the two distinct phases.

Research Design

The rationale for mixing methods is that neither a quantitative nor qualitative method is sufficient on its own to address complex questions of practices (use of technology) in institutional cultures (schools) and contexts (Trainor, 2011). Specifically, this study uses a sequential explanatory mixed methods design consisting of two distinct phases with the priority given to the quantitative phase.

In the first phase, high school students with ASD completed a quantitative questionnaire. The goal of the quantitative phase was to describe the range of technology use as a support and to investigate possible significant associations with particular characteristics of the sample. Using the results of the survey, specific probing questions were developed for the semi-structured interviews in the second (qualitative) phase of the study. The strength of this approach is that the two phases build upon each other, the quantitative data and results

provide a general description of the research problem, while the qualitative data and its analysis help to refine and explain those statistical results by exploring participants' views in more depth (Creswell, 2015).

The quantitative and qualitative methods were integrated at two distinct stages. The first stage was at the beginning of the qualitative phase when the qualitative interview questions were further developed based on the results of the survey findings. Additionally, the participants for the qualitative interviews were selected purposively based on their use of technology as reflected in the survey results. The second stage of integration of methodologies came during the synthesis of the results of the study overall (Creswell, Plano Clark, Guttman, & Hanson, 2003) and will be presented in the discussion in Chapter 6. A visual model of the procedures for the sequential explanatory mixed methods design of this study is provided in Figure 2.

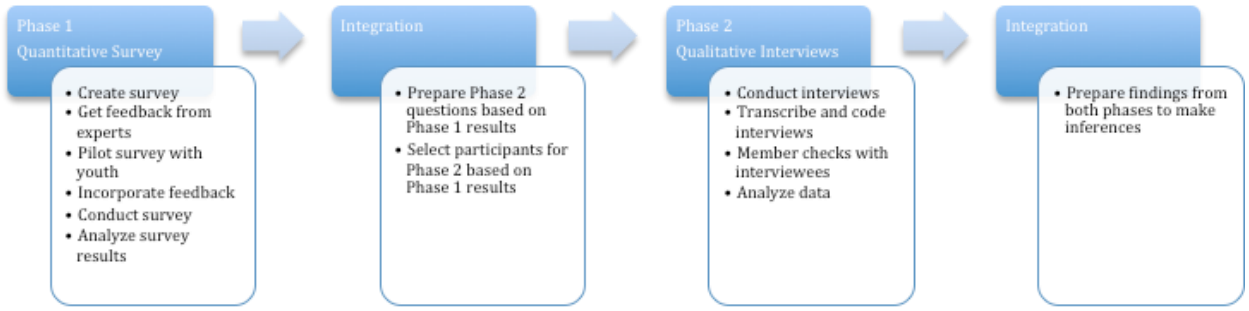


Figure 2. Explanatory Sequential Mixed Methods Design.

There are several advantages of the sequential explanatory mixed methods design. First, as it proceeds from one stage to the next rather than simultaneously, as in a concurrent mixed methods design, it is more manageable for a single researcher to conduct requiring fewer resources at any one time point (Creswell, 2002). Next, it is useful for exploring quantitative results in more detail and in particular any unexpected results from a quantitative study (Morse, 1991). Third, it is particularly advantageous when a researcher has the ability to return to the same participants for the follow-up qualitative study. The major disadvantage is the amount of time it takes to conduct (Ivankova, Creswell, & Stick, 2006).

Phase 1 Quantitative Methods

Selecting the sample. The questionnaires were administered to 252 out of 281 high school students with ASD enrolled in a study currently conducted by investigators with the Center on Secondary Education for Students with Autism Spectrum Disorder (CSESA). CSESA is a research and development center funded by the Institute of Education Science (IES), which is part of the U.S. Department of Education. The CSESA study is a randomized controlled trial of a comprehensive treatment model for high school students with ASD. Although the study involves two cohorts of schools and students with ASD, this study used participants from the first cohort exclusively as they were the only ones recruited at the time. The first cohort is being conducted in a total of 30 schools (15 control and 15 intervention) spread equally across three states (California, Wisconsin, North Carolina). Twenty-nine students were missing from cohort 1 on the day of testing due to illness or were no longer enrolled. Nine of the 252 participants who were present either refused or were unable to answer the questions. Thus a total of 243 questionnaires were completed and included in the analysis.

CSESA participants were recruited amongst all eligible students at their schools by special education staff. To be eligible participants must have had at the time of enrollment a current primary or secondary designation of autism on their Individualized Education Program (IEP). Additionally they must have had at least two years remaining in high school to ensure participation for the duration of the two-year intervention study, and no uncorrected severe hearing or vision impairment. Students with a 504 plan (under Section 504 of the U.S. Government Rehabilitation Act of 1973) who did not have an active IEP were excluded from this study.

Participant characteristics. The demographic characteristics of CSESA cohort 1 are reported in Table 1. The sample is primarily male (84%), average age 17, white (75%), non-Hispanic (83%), and from upper income families (52%). The majority of participants (78%) are without intellectual disability and the majority (61%) are on a track to graduate with a regular education or "standard" versus "modified" diploma type, meaning they are educated in inclusive settings for the majority of the school day. The average Social Communication Questionnaire (SCQ) score is 17 with a standard deviation of 7.74 which indicates that some participants have scores below the cutoff of 15 that is typically used for a diagnosis of ASD. In this study however, and as previously stated, the criteria for "Autism" eligibility was dependent on the primary or secondary IEP disability category designation.

Table 1

Participant Characteristics as a Percentage of the Sample (n=243)

Characteristic	% (n)
Gender: Male (n=243)	84 (205)
Age: mean 17 (range 14-22)	

Race (n=202)	
White	74 (149)
African American	10 (20)
American Indian/Alaskan Native	2 (5)
Asian	3 (6)
Multiracial	8 (16)
Other	3 (6)
Ethnicity (n=203)	
Non-Hispanic	83 (169)
Income* (n=201)	
Low	20 (41)
Medium	28 (56)
High	52 (104)
IQ (n=241)	
IQ: mean 85 (SD=26.42)	
>70	78 (188)
Diploma track (n=243)	
Standard	61 (149)
SCQ (n=223)	
SCQ mean 21 (SD=7.74)	

*Low=$0-39k, Medium=$40-99k, High=$100 and above; SD=Standard Deviation

Measures. Demographic information was collected from participant caregivers as an initial assessment for the CSESA study participation in the fall of 2014. A copy of the demographic questionnaire can be found in Appendix A. Only the responses to the questions regarding gender, ethnicity/race, and income from the form were analyzed in this study. The CSESA demographic form included six categories of annual household income, but for this study categories were combined and reduced to only three defined as low (up to $39k), medium ($40-99k) and high ($100 and above).

Intellectual ability was determined by the participants' scores on the Leiter-3, a nonverbal measure of intelligence, also administered by CSESA assessors in the fall of 2014. For this study, the continuous Leiter scores were converted to the categories of "with" or "without intellectual disability" based on the commonly used cutoff score of 70 and below for intellectual disability (ID; APA, 2013). Autism diagnosis was verified based on a primary or secondary Autism designation in the IEP and a requirement for initial study eligibility. Because these measures were previously collected as a part of the CSESA study, it helped to reduce the burden on participants when completing the questionnaire.

Development of the survey instrument. A well-designed survey will encourage participation and reduce cognitive burden (Tourangeau, Rips, & Rasinski, 2000) thus reducing nonresponse and measurement error (Groves, 1989). The survey instrument was developed using the tailored method of questionnaire design (Dillman et al., 2009). It was screened by experts in the field of survey research followed by experts in the area of educating secondary students with autism. Finally the instrument was piloted with high school students with autism to check for the ease of use and appropriateness of the questions. The steps of the instrument development are outlined below.

The purpose of the tailored design is to establish survey procedures that will build a positive interaction with the respondent to encourage response by considering the nature of the respondent population and variations within it. An important element is a carefully chosen first question that is short, enticing, and easy to answer to draw in the participants and keep them moving through the survey (Dillman et al., 2009). In the case of students with ASD, there is variability in cognitive ability therefore a handout of visual examples of technology tools referenced in the survey was placed in front of the students (see Appendix

B) to support recall. Building rapport and reading aloud by the assessors were both intentionally recommended by the researcher to tailor the survey to the specific audience in an effort to improve the accuracy of the responses (Dillman, Smyth, & Christian, 2009).

Three survey experts from the Odum Institute for Research in Social Science, UNC at Chapel Hill, were asked to read through the instrument and to provide feedback on the survey design and implementation procedures. Based on their feedback several questions were reworded for simplicity. The suggestion was made to reorganize the questionnaire design so that questions were grouped into distinct categories and given shaded bars with headings to help reduce the cognitive load on the participants. Two matrices were simplified for added clarity on the suggestion of the experts.

Experts on educating students with autism were consulted on the appropriateness of the topics for the intended audience. Several adjustments were made to the questionnaire as recommended by the screeners. Suggestions included adding in a broader range of technology tools and more specificity in describing those tools, for example, a "cell phone with internet" and a "cell phone without internet" instead of simply "cell phone". Another suggestion was made to include a digital camera as a technology tool. Making the question "Have you ever felt someone wasn't being nice to you using technology?" into an optional open ended question by adding, "Yes, give a short description" and including a text box allowed for more information to be gathered regarding this important issue. A question about using technology during break time to relax was also added into the survey. After the above changes were made, a modified version of the questionnaire was developed for those students who needed additional supports to enhance comprehension. The adapted version included

some visual elements, and had increased font size. Some questions had a reduced number of answer choices.

Next, a pilot test of the instruments was conducted with six high school students with ASD to ensure the clarity and appropriateness of the individual questions (Fowler, 2014). Friends and family members of CSESA team members were conveniently recruited for this pilot test and the survey was revised based on the pilot test results. Suggestions included adding a "maybe" category for the question about "plan to go to college" and adding more options into the social/communication uses of technology such as "twitter" and "snapchat". Several of the pilot testers were observed going through the survey rather hurriedly and this prompted the researcher to give the option to assessors to read the questions aloud to help slow down the pace of survey completion. The adapted version was simplified further and more visual aids added based on the difficulty a pilot tester had completing questions that were more abstract. The final full survey had 30 questions (see Appendix C) and the adapted version had 12 (see Appendix D).

Procedures and data collection. CSESA assessors administered the survey in paper form as they collected post-assessment data for the CSESA project. The assessors were doctoral students in the fields of education and psychology and trained by CSESA staff on administering the assessments. The assessments were administered at school and typically conducted in a private office or room where the assessor and student would be undisturbed.

The assessors had the ability to interact freely with the participants to develop rapport. They were encouraged to read the survey questions aloud to the participants to enhance comprehension of the questions and to help prevent students from rushing through the survey. Instructions were provided to the assessors (see Appendix E) to help them

increase the accuracy of participant responses. Assessors were encouraged to write in the responses if dictated by the student. Before beginning the survey, assessors were asked to place the handout of technology visuals (Appendix B) in front of the student and say: "For this survey, you will be asked about how you use technology. Technology can mean a lot of things, but for this survey, technology will mean electronic technology. Take a minute to look at examples of this type of technology." Finally, instructions were provided to help assessors decide who should be administered the adapted survey version. The adapted version was to be used only for students who had a reading comprehension level at or below the third grade. Assessors had access to that information from the project coaches or other CSESA team members. The survey took participants approximately 15 minutes to complete.

Data analysis methods. The researcher screened the questionnaires by hand for missing data. Missing items were marked with an ".m". Next the researcher entered the data into UNC's Qualtrics (2015) Research Suite to prepare for analysis. For the purpose of reliability, another graduate student then verified 100% of the data and this researcher corrected all errors. Total errors were less than .5 percent of the total number of items. Finally, in preparation for analysis, the data were downloaded as a data file from Qualtrics (2015) and uploaded into STATA (version 14) for analysis.

All statistical analysis of the quantitative results was completed using STATA (version 14) data analysis and statistical software. Frequency tables were generated for all questions. Next the data were examined for possible relationships between variables. Associations between the survey questions of technology use, benefits and barriers, and, the variables of race/ethnicity, gender, household income, cognitive ability, and diploma track

were statistically examined to look for significant effects (Thompson, Diamond, McWilliam, Snyder & Snyder, 2005).

Some survey questions were open ended to gain a broader understanding of the variety and specificity of the technologies being used as well as opinions about technology use (survey questions 6, 22, 26, 29). These data were sorted into categories and will be reported in the results section. Next the methods used to conduct the qualitative portion of this study are described.

Phase 2 Qualitative Methods

Qualitative research can provide a deeper understanding of the individual's experience and in the context of mixed methods research designs can be helpful in illuminating quantitative findings (Bolte, 2014). There is an acknowledged need in the area of autism research for the individuals themselves to contribute in such a way to provide more authentic perspectives (Benford & Standen, 2011; Bottema-Beutal, Mullins, Harvey, Gustafson & Carter, 2015).

The qualitative phase of this sequential mixed methods study was shaped by the analysis of the quantitative survey data in phase one. Specifically, the sample was selected based on the survey findings and the interview protocol was developed after reviewing the survey results. The decision was made to offer email as an optional interview mode to the planned phone interview as the majority of survey respondents indicated they use technology to communicate including email.

To ensure credibility of results it is essential to apply scientific rigor when conducting qualitative research just as it is in quantitative studies. For this study, recommendations by Brantlinger and colleagues (2005) for qualitative interview studies in the field of special

education were followed in implementing the procedures, data collection and analysis. Brantlinger et al.'s quality indicators for qualitative interview studies include:

- selection of the appropriate participants,
- development of reasonable interview questions,
- use of adequate mechanisms to record and transcribe the interviews accurately,
- fair and sensitive representation of the participants in the final report, and
- use of sound measures to ensure confidentiality.

Elaboration on the implementation of these methods follows.

Sampling strategy. A pool of potential candidates for the qualitative interviews was purposefully selected from the survey participants in Phase 1 based on the results of the survey. The sampling reflected two criteria: information rich participants and maximum variation.

Information rich. First and foremost, all of the candidates for the qualitative study were selected based on their ability to best answer the research questions because they were "information rich" (Patton, 1999). This was determined from examining their responses to the survey questions. For example, it was important to select survey participants who had indicated heavy use of technology at school and home as well as those who indicated perceived barriers to technology use at school. Students who used the text boxes in questions 6, 22, and 27 were prioritized as they had demonstrated the ability to communicate their thoughts and opinions about their technology use beyond checking off a pre-determined survey response. A list of 49 potential interview participants was created and then prioritized further based on maximum variation sampling.

Maximum variation. A maximum variation sampling strategy was used to capture the demographic heterogeneity of the sample as well as the range and variety of experiences of the survey respondents (Savin-Baden & Major, 2013). Thus a second round of selection occurred to capture differences in gender, race/ethnicity, family income level, and cognitive abilities. A final list of 24 potential participants was prioritized who were both "information rich" and representative of the heterogeneity of the survey sample population.

Participant characteristics. The final sample included ten participants who responded to the request for interviews. The participants are predominantly male (80%), white (70%), non-hispanic (90%), and come from families with fairly evenly distributed range of family incomes. The sample is predominantly on a standard diploma track (90%), meaning they are educated primarily in inclusive settings, and with an IQ greater than 70 (90%). Four of the participants had SCQ scores below the standard cutoff of 15 that is typically used for a diagnosis of ASD, however, the IEP primary or secondary categorization of "Autism" was used for participation in this study. Participant characteristics are reflected in Table 2. Recruitment procedures will be discussed below in the section on procedures and data collection.

Table 2

Participant Characteristics as a Percentage of the Sample

Characteristic	Student (%)
Gender: Male	80
Age: mean 16 (range 15-18)	
Race	
White	70
American Indian/Alaskan Native	10
Asian	10
Multiracial	10

Ethnicity: Non-Hispanic	90
Income*	
Low	40
Medium	30
High	20
Standard Diploma	90
IQ: mean 100 (SD=15.19)	
>70	90
SCQ (n=8)	
SCQ mean 15 (SD=5.23)	

*Low=$0-39k, Medium=$40-99k, High=$100 and above; SD=Standard Deviation

Development of the interview protocol. The final interview protocol was determined after the survey results were analyzed to explain the results obtained in the quantitative phase. The survey revealed the majority of respondents bring technology to school and use it throughout the school day for a variety of reasons, including to stay organized, complete assignments, communicate, socialize and relax. Therefore questions were included about the perceived benefits of using technology at school as well as possible negative aspects to technology use. The survey findings had revealed just over half of participants felt that technology can be distracting at school so questions were included to further elucidate this finding. Questions were included about the role technology plays in enhancing participants' social lives because, according to the survey analysis, the majority of respondents are using technology to communicate and to socialize. Limited access to technology did not feature prominently in the survey results therefore it was not a focus of the interview protocol however one question was included that provided participants a space to reflect on access. A list-generating question was added as the first question of the protocol to help the participants recall the different ways they use technology before they proceeded to

answer questions about its use. This technique is used in survey research for face-to-face interviews and can be useful in helping interviewees recall information needed to formulate their opinions (Tourangeau, Rips, & Rasinski, 2000).

Prior to data collection, the protocol was circulated to the dissertation committee for their input. Suggestions were incorporated including rewording several of the questions to reduce bias and simplifying language to make it more appropriate for the intended audience. Additionally, it was pilot tested both in-person and by email with two adolescents with ASD (male and female) to help gauge the clarity of the questions and to test the feasibility of email as an interview medium. Two questions were eliminated as they were misinterpreted by one of the pilot testers. Both of the pilot testers provided more detailed responses using email compared to the in-person interviews. The final protocol had only nine questions but some questions had multiple parts (see Appendix F).

Conducting interviews by email. The major justification for giving participants the option to complete the interview via email was based on the results of the survey. The majority of survey respondents (94%) indicated they use technology to communicate with friends and family. Furthermore, 64% said they communicate using email. Many also reported using text messaging (69%) and social media such as Facebook (48%) to communicate but these were not considered appropriate mediums for this study as texting can be cumbersome for long responses and Facebook is meant to be a communal space and could result in loss of confidentiality. Face-to-face interviews were not considered practical due to the locations of the participants (California, Wisconsin, and North Carolina). Previous studies that have used email as an interview medium with individuals with ASD have found that it can elicit a more detailed response compared to face-to-face interviews (Benford,

2008; Bottema-Beutel et al., 2015). In addition, email interviews allow for convenience in scheduling and location for the interviewee, allowing them to participate from an environment that is safe and familiar (Bottema-Beutel et al., 2015), as well as a flexible pace, allowing participants to complete it at their own speed on their own schedule (Benford & Standen, 2011). For example if a respondent gets distracted or needs a break, it is easy for them to finish an email interview at a later time. Bagatell (2010) reported that individuals with autism can be more comfortable communicating in writing in an asynchronous fashion as it provides time to process the questions and formulate responses. Downsides to email interviews with individuals with autism are mostly centered on the loss of control of the interviewer. If a respondent veers off subject in an unrelated direction it is not possible to bring them back on course. Or if an interviewee misinterprets the meaning of a question, the interviewer will not be able to correct this mistake unless allowed to submit follow-up questions. Some individuals with ASD can be brief in their answers to questions so it is important to craft questions in such a way as to elicit as detailed a response as possible. It is for this reason that certain features were built into the interview including explicit instructions to respond with complete sentences and encouragement to provide at least three responses if possible along with permission to ask follow-up questions if any answers were not clear to the researcher.

Procedures and data collection. Parents of the 24 selected potential participants were first contacted by email and provided information about the qualitative interviews (see Appendix G). If they were interested in knowing more, they were asked to click on a link that would take them to a Qualtrics (2015) webpage for more information about the study. On that webpage was an addendum to the original research participation consent form (see

Appendix H) providing parents with additional information about the study and contact information in case they had questions. If the parent agreed to allow their child to participate, they would provide their child's email address in an online form. Next, the child was contacted by email with similar information about the study (see Appendix I) and asked to click on a link to a Qualtrics (2015) webpage to read an addendum to their original assent to participate in the study (see Appendix J). If they were still interested to participate at that point, they were instructed to click on the "Agree" button and to select the method by which they would like to participate. Their choices were by phone or by email. None of the participants selected to be interviewed by phone. Specific instructions were provided to the participants informing them that their participation was valid only if they used complete sentences in their responses. Additionally, they were informed that they might receive follow-up questions if any of their responses were unclear. All participants were informed they could opt out of the interview at any point. After satisfactory completion of the interview, participants were emailed a code for a $20 Amazon gift card and a link to redeem it.

Confidentiality is maintained by storing all data on a secure server and secure hard drive. Any hardcopies of data are kept locked in a file cabinet. All data not required for further research program purposes will be shredded or deleted at the end of the five-year CSESA project.

The UNC Institutional Review Board (IRB) approved these procedures and the addendums to the original consent and assent forms. After two weeks passed and only five students had participated, a reminder was sent to the parents. By the end of three weeks, seven students had completed the interview. Next, parents of the remaining 25 purposefully

selected potential candidates for the interviews were contacted. By the end of week six, ten interviews were completed out of a candidate pool of forty- nine.

Data analysis. For the qualitative analysis, data collection and analysis proceeded simultaneously (Merriam, 1998). The data were coded and analyzed for themes as each interview was completed using NVivo for Mac (2014) qualitative software analysis package following a constant comparative approach (Lincoln & Guba, 1985). The analysis proceeded as follows: (1) preliminary exploration of the data by reading through the transcripts and writing memos; (2) coding the data by segmenting and labeling the text; (3) using codes to develop themes by combining similar codes; (4) connecting and interrelating themes; and (5) constructing a narrative (Creswell, 2002). There were no new themes detected after the seventh interview was coded and a sufficient variation in the sample demographics was achieved, therefore recruitment ceased after interview number ten.

Trustworthiness

Credibility measures are an important part of qualitative research to help establish the trustworthy nature of the research and its findings. In this study, several credibility measures were used including methodological and data triangulation and peer debriefing (Brantlinger et al., 2005). Using different research methodologies to address the same questions and multiple data points can broaden the understanding of the research topic (Savin-Baden & Major, 2013). In this study triangulation was accomplished through the use of multiple methods and the merging together of the findings from the separate studies in the written discussion of the research questions. The qualitative interviews were used to help explain the results of the survey. Member checks were not necessary for this particular study as the participants all selected to be interviewed by email thus creating their own transcripts. Three

CSESA team members provided peer debriefing by reviewing a draft of the coding and theme development and provided written feedback that was incorporated into the results. In particular, several subthemes were combined to refine their meaning. For example, under the theme of "improve social opportunities", the subtheme of "bridge physical distance to friends and family" was merged with "the opportunity to expand friendships beyond people in your neighborhood" to form one subtheme related to "bridge distance". One peer de-briefer reviewed a draft of the results to insure it accurately reflected the data. See Appendix K for a final list of the codes. The final themes and subthemes will be addressed in chapter 5.

Chapter 4

Quantitative Results

This chapter summarizes the results from the survey completed by high school students with ASD for the purpose of describing their technology use in supportive ways both in and outside of school. The results are organized as they relate to the four research questions.

Univariate analysis was used to profile the personal and demographic characteristics of the sample (see Table 1, Chapter 3) and provide the frequency of use, and opinions of the benefits and barriers to technology use. Bivariate analysis (Pearson's chi square) was used to look for associations between participant characteristics and each question. The results of these analyses were used to inform the second stage of the study in which a sub-sample of the respondents was interviewed in more depth about their survey responses. The results of the qualitative interviews are presented in Chapter 5.

It should be noted that the number of respondents varies for some questions due to the different versions of the surveys. For the full survey version (30 questions) there were 174 respondents. For the modified version (12 questions matching the full version) there were 69 respondents. Combined there were 243 respondents. As noted previously, the criteria to determine which participant would receive the modified version was determined by the student's reading level.

Research question 1. How do adolescents with ASD use technology as a support?

Survey questions regarding supportive uses of technology were focused primarily but not exclusively on uses in the school setting as that is where students spend most of their time in preparation for their transition to adulthood. The majority of survey respondents (97%) said they use technology at school. The most frequently reported reasons for using technology in that particular setting included: to look things up, to type things up, to make presentations, and to relax at lunch and during breaks. More broadly, the majority of respondents (94%) indicated they use technology to communicate and socialize. In the home setting, respondents use technology less to support learning, nonetheless, the majority are using technology in supportive ways in that environment. The results for this question will be organized in the following way: the forms of technology used at school, the purposes and frequencies of technology use at school, technology use to communicate and socialize, and, technology use in the home environment.

What forms of technology are students bringing to school? On most days, 84% of respondents bring technology to school with them and overall 66% report bringing an internet capable device. Seventy-one percent usually bring either a smartphone or a regular cell phone to school. Respondents were permitted to enter text in an "other" category. Ten percent of students wrote in other forms of technology including items such as: augmentative and alternative communication device (8), headphones (3), and calculator (2). Results can be found in table 3.

Table 3

Forms of Technology Students Bring to School

Technology Form	Percent	Frequency
Smart phone	51	127
Tablet	25	64
Game device	24	63
IPod or MP3 player	24	61
Laptop	22	56
Cell phone without internet	20	54
Digital camera	11	29
Other	9	24

n=243

What forms of technology are students using at school? Survey respondents primarily use internet capable tools at school such as desktop computers (82%), laptops (64%), smartphones (47%), interactive whiteboards (41%), and tablet devices (39%). Some respondents indicated they use game devices (22%), iPod touch or MP3 players (20%), digital cameras (15%), and regular cell phones (13%) at school. In the "other" textbox, four percent of respondents (11) indicated that they used other technology such as: augmentative and alternative communication devices (AAC), calculators, headphones, Chromebooks, flat screen TVs, projectors, printers, and video cameras. See table 4 for full results.

Table 4

Forms of Technology Used by Students at School

Technology Form	Percent	Frequency
Desktop computer	82	204
Laptop computer	64	159

Smartphone	47	113
Smartboards	41	102
Tablet devices	39	99
Game devices	22	57
iPod or MP3	21	52
Digital camera	15	40
Regular cell phone	13	35
Other	4	11

n=243

For what purpose and how often is technology being used? The first research question included sub-questions regarding the purpose and frequency of technology use in school. Specific uses were suggested to respondents for staying organized and completing assignments along with text boxes for them to write in other ways they use technology for these purposes. A separate question was included with a text box regarding other uses of technology at school to support learning and be more successful.

Technology use to stay organized. As noted in table 5, survey respondents indicated they are using technology to stay organized at school at least some days if not every day in the following ways: as a calendar (63%), a camera (63%), to take notes (62%), as a timer (55%), an alarm (51%), video or sound recorder (46%). Other ways (6%) noted in the text box regarding organization were: assignments on Google drive, checking school email, record class lectures, to check grades, to find info about seasonal sports. One student wrote, "I preferably type everything."

Table 5

Frequency of Using Technology to Stay Organized

Using technology to stay organized	Everyday M-F (%)	Some Days (%)	Never (%)
As a calendar	20	43	35
As a planner	11	32	57
As an alarm	31	20	49
As a timer	16	39	44
As a camera	20	43	36
As a video recorder or sound recorder	14	32	53
To take notes	23	39	37

n=174

Technology use to complete assignments. Support for learning is the area where the most respondents are using technology at school. Table 6 below breaks down how they are using it to help them complete assignments at least some days if not every day in the following ways: to look things up (98%), to type things up (94%), to make presentations (88%), to turn in assignments (78%), and to work with other students (64%). Fifteen percent of students wrote in the textbox other uses of technology to complete assignments including: Google classroom, YouTube, calculator on phone, email questions to teacher, group project, print things out, to check spelling, double check if assignments are done, to participate in school surveys.

Table 6

Frequency of Using Technology to Complete Assignments

Using technology to complete assignments	Everyday M-F (%)	Some Days (%)	Never (%)
To look things up on the internet	58	40	2
To type things up	50	43	6
To make presentations (e.g. PowerPoint)	25	63	11
To turn in assignments	32	46	22
To work with other students (e.g. Google docs)	16	48	36

n=174

An additional question was included asking if there are any other ways respondents use technology at school to help them learn and to be more successful. Survey respondents (33%) entered a variety of comments that can be grouped into the following categories: organization, assignment completion, communication, stress reduction, and leisure. For example, students wrote in that they use technology to stay organized by recording a class to go over later, use their phone to take a picture of assignments, and to check grades. To complete assignments, one student indicated using technology to do research such as to look up articles for current event assignments, another to look up information to write papers. One student wrote, "I read about technology, watch analysis and news of tech and browse Wikipedia and Intel's ARK Database." Other students mentioned using technology specifically to complete writing assignments. One student noted that "iPads work extremely well as writing tools when using a keyboard." Six students mentioned math related help such as calculators but also educational websites like Khan Academy, a counting money app, and

using eBook versions of math textbooks. Other comments related to assignment completion included: to take online tests, to study for tests using Quizlet (an iPad app), and dictionary apps.

Some students mentioned using technology to communicate by email with teachers (4) and parents (2) and other students (2) for help. Several students (6) mentioned using technology to help motivate them and in particular that listening to music helps them to stay focused. According to one respondent, "I use my phone to listen to music because it helps me stay on track during work times," and another student wrote, "I listen to music on my iPad to keep me motivated." Some students said they used technology to help them "de-stress" by looking at the wallpaper or "to provide a source for a break." Other students mentioned using technology for leisure activities such as watching YouTube videos, listening to music, posting photos, and playing video games. Pursuing special interests were also mentioned in this open-ended question. According to one student, "I look up songs I am interested in learning," and another wrote, "I have used [Adobe] Photoshop to help me be more of a digital artist."

Online learning. The full survey (n=174) had a section with questions specifically related to online learning. Approximately 30% of respondents had taken an online class and most reported it was for science, technology, and math related classes (40%), but a wide variety of other subjects were mentioned as well. More than half of the respondents (55%) indicated they would like to take an online course in the future.

Using technology to communicate and socialize. The majority of survey respondents (94%) reported using technology to communicate and to socialize at home or at school (n=243). As noted in table 7, they are using the phone, text, social media and email.

Table 7

Using Technology to Communicate and Socialize

Technology Tool	Percent	Frequency
Phone	79	196
Text	69	171
Email	64	159
Facebook	48	120
Video calls (like Skype, Facetime)	42	106
Do not use technology to communicate	6	21

n=243

Many survey respondents are active on social media such as Facebook, Skype, and Facetime, and other web or phone based social media. In the full survey (n=174), in addition to the above selections, 46 respondents indicated they use Instagram or Snapchat and 30 respondents said they use Twitter. Sixty four students wrote in the text box other ways they use technology to socialize and communicate including YouTube (21), Kik (6), Steam (6), Vine (5), Google + (2), Tumblr (2). In the adapted survey, 14 students (6%) indicated they use an AAC device.

Using technology at home as a support. This survey section began by asking students more broadly about ways they are using technology at home. Respondents indicated

that “watching YouTube and other online videos” was their primary use of technology (93%). Next in prominence was “looking things up on the internet” (89%), followed by “playing video games” (85%). Less than half of respondents said they use technology to wake up in the morning (45%). See table 8 for the full results.

Table 8

How Teens Use Technology at Home

Use of technology at home	Percent	Frequency
To watch YouTube or other online videos	93	226
To look things up on the internet	89	216
To play video games	85	207
To wake me up in the morning	45	109

n=243

Also at home, in the full survey students indicated they are using technology to support their learning by checking class or school websites (61%), turning in assignments (59%), keeping track of homework assignments (53%), for reminders, calendar, planner (45%), communicating with teachers (39%), and collaborating with other students (36%). Table 9 provides the full results.

Table 9

How Teens Use Technology at Home

Other uses of technology at home	Percent	Frequency
To check class or school website	61	106
To turn in assignments	59	102

To keep track of homework assignments	53	93
To find out what other people are doing	48	83
For reminders/calendar/planner	45	78
To communicate with teachers	39	68
To work with other students	36	62

n=174

Twenty-eight students wrote in other ways they use technology at home including: designing parts using a 3D printer, listening to music, night vision goggles, playing on game sites, making stories, 3D modeling, submitting art to an online art gallery, goofing around, making videos to post online, taking personality quizzes, reading fan fiction, relaxing, role playing, using timers, drawing and posting it online

In a separate question, students were asked about special apps or software they used, besides for playing video games, and 45% of respondents (n=174) wrote in specific items that fell into several categories: learning, organization, completing assignments, relaxation, art, music, sports, games, and independence. Samples of their responses are in table 10 below.

Table 10

Special Applications or Software, Besides Video Games Used at Home

Category	Software/app/website
Information/ educational	solar system app, app w/presidents, software for reading books, software for learning languages, weather app, counting money app
Completing assignments	Dragon Speaks software for writing, google docs, iCal, google translator, mobile dictionary
Organization	the Homework app, notepad, recording app for notes, Task app, Power School to check grades

Relaxation	white noise app to help sleep, fan sound to help sleep, healing rhythms, music videos to calm down, anime shows to de-stress, tap titan app to relieve anger
Art	Adobe Photoshop, Visual Studio, draw and paint tool, photo apps, photo editor apps, art studio
Music	Spotify, Pandora, iTunes, Music Tube, ditty (to make songs)
Sports	ESPN, Team Stream, MLB.com, NFL stats

Research question 2: What do students perceive as benefits of technology use as a support?

Students felt that technology use at school was beneficial in a variety of ways. As noted in table 11 below, they acknowledged that technology makes learning easier (91%), makes learning fun (89%), they like having their phone at school so they can contact a parent (66%), they can use it during lunch or breaks to relax (87%) or to play with friends (47%).

Table 11

Benefits of Using Technology at School

Opinion	Percent	Frequency
Technology makes learning easier	91	223
Technology makes learning fun	89	218
Like having phone at school to contact parents	66	161
Use technology during lunch or breaks to relax	87	151*
Use during lunch or breaks to play with friends	47	82*

n=243; *n=174

Thirty-nine students wrote in their opinions about using technology at school in a text box. Most responses were related to barriers to technology use and will be discussed below. Those

responses that spoke to the benefits of technology use at school (11) fit the following categories: helpful (7), and use it for leisure (4). One student wrote, "It makes assignments go faster," and another wrote, "I listen to music at lunch and while I'm working on my assignments."

Benefits of using technology for communication and socializing. Asked the reasons why they use technology to communicate or socialize (n=174), the majority of respondents indicated: to talk to friends (82%) and family members (72%), to keep up with what's going on (56%), to make new friends (52%), find people with their same interests (50%), to avoid talking to people face-to-face (36%), to communicate with teachers (36%). Full results are presented below in table 12.

Table 12

Benefits of Using Technology for Communication and Socializing

Reasons use technology to communicate	Percent	Frequency
To talk with friends	82	142
To talk with family members	72	126
Keep up with what's going on (like Facebook)	56	98
Make new friends	52	91
Find people with my interests	50	87
So I don't have to talk f2f with people	36	63
To talk with teachers	36	62
Other	14	24

n=174

Twenty-four students wrote in other reasons for using technology to communicate or socialize, including: "to keep people-myself in the loop", "social networking", "let people know about events", "long distance friends from my old school", and "to post artwork".

Benefits of online learning. Students who had taken online courses for credit were asked why they liked learning online. The majority indicated it had to do with having more control over their time. Less than half of respondents said they liked online learning because it reduced social interaction.

- 62% said because they could take as much or as little time as needed (32)
- 56% said because they could do the coursework anytime (29)
- 25% said because they did not have to interact with other students (13)
- 17% said because they did not have to interact with the teacher (9)

Other reasons for taking online courses that were written into the text box (11) included: "it was efficient", "something I was interested in", "faster", "to learn new stuff", "I could listen to music while on-line".

Research question 3: What do students perceive as barriers to the use of technology as a support?

Access to technology at school. Forty three percent of respondents said they did not have access to technology in all classes. Eleven percent said their school did not provide technology and 8% said they did not have wi-fi access at school. Another form of access is knowing how to use the technology. Thirty-one percent indicated they did not have people at school to help them learn to use technology.

Other barriers to technology use at school. A little more than half of the students (57%) felt that technology use can be distracting at school and 28% felt that using technology to learn was hard. See table 13 below for results on the barriers to technology use at school.

Table 13

Barriers to Technology Use at School

Opinion	Percent	Frequency
Technology can distract me	57%	*99
Not allowed to use technology in all classes	43%	106
There are not people at school to help me learn to use technology	31%	76
Using technology to learn is hard	28%	68
The school does not provide technology tools to use in school	11%	28
No wi-fi access at school	8 %	*14

*n=174

Other comments the respondents wrote in regarding barriers to technology use at school could be categorized in two ways: responsible use (10), and, the distracting nature of technology (8). Regarding responsibility, one student wrote, “Don't go on Facebook if you're supposed to be working on an assignment”, another wrote “students shouldn't use it during class unless the teacher tells you to.” Regarding the distraction factor of technology one student wrote: “distracting to self and others”.

Bad experiences using social media. Having a bad experience using technology can be a barrier to technology use. When survey respondents were asked, “Have you ever felt that someone wasn’t being nice to you using technology (texting, Facebook, email, etc.)?,” 28% (n=174) indicated they had had a bad experience online and gave a brief description. Some of the descriptions included: “called me a fagot, I told them to shut the fuck up”, “a few mean

comments on YouTube", "people in my class, I told them their rap sounded like crap. Then they said my music sounded like baby music", "being ignored when asking people what they're doing", "that's pretty much the whole internet in a nutshell", "they're bullying me and teasing me on Facebook when I was younger", "someone was being a jerk to me on Facebook, I unfriended him", "don't let it bother me, people are sometimes mad people."

Research Question 4. Are there associations between technology usage, student's perceptions of benefits, and students' perceptions of barriers, respectively, and participant characteristics of intellectual ability, students' household income, gender, and race/ethnicity and enrollment status?

A numbers of significant associations ($p<.05$) using Pearson's chi square test were found between survey questions and the respondent characteristics of enrollment status, intellectual ability, gender, and household income. These are presented in Tables 14, 15, 16 and 17. It should be noted that as the number of respondents varied by question, findings of significant associations do not apply to all participants but only to those responding to the specific question.

Enrollment Status. Compared to students on a modified diploma track in the sample, students who are on a standard diploma track (educated primarily in inclusive settings) were more likely to bring internet capable technology with them to school (χ^2 [1, N= 243]=7.01, p=.008), and to consider technology a distraction (χ^2 [1, N=172]=7.69, p=.021). Students on a modified diploma track were more likely than students on a standard track to use

technology in all classes (χ^2 [2, N=243]=35.43, *p*=.000). See Table14 for the cell values of these associations.

Table 14

Associations Involving Enrollment Status Differences

Question	Response	Standard Diploma	Modified Diploma
Bring internet capable technology to school	YES	133 (89%)	72 (77%)
	NO	90 (62%)	9 (33%)
Allowed to use technology in all classes	YES	61 (41%)	75 (80%)
	NO	87 (58%)	19 (20%)
There are people at school to help learn to use technology	YES	86 (58%)	78 (83%)
	NO	62 (42 %)	14 (15%)
Say using technology to learn is hard	YES	28 (19%)	39 (41%)
	NO	116 (78%)	53 (56%)
Say technology can distract	YES	90 (62%)	9 (33%)
	NO	52 (36%)	17 (63%)

Intellectual ability. Compared to students with IQ scores of 70 or greater in the sample, students with IQ scores less than 70 were more likely to report they are able to use technology in all classes (χ^2 [2, N=241]=12.64, *p*=.002), and that there are people at school to help them learn how to use technology (χ^2 [2, N=241]=12.47, *p*=.002). On the other hand, students with IQ scores of 70 or greater were less likely to say that using technology to learn is hard (χ^2 [2, N=241]=26.46, *p*=.000). See table 15 for the cell values of these associations.

Table 15

Associations Involving IQ Differences

Question	Response	IQ 70 or above	IQ < 70
Able to use technology in all classes	YES	94 (50%)	41 (77%)
	NO	93 (49%)	12 (23%)
People at school to help learn to use technology	YES	117 (62%)	46 (87%)
	NO	69(37%)	6 (11%)
Using technology to learn is hard	YES	37 (20%)	29 (55%)
	NO	146 (78%)	22 (42%)

Gender differences. Female respondents were more likely than male respondents to report there are people in school who help them to learn to use technology (χ^2 [2, N=243]=6.26, *p*=.044). Male respondents were less likely to report that someone was not nice to them on the internet (χ^2 [2, N=172]=7.41, *p*=.025) compared to females. Further, female respondents were more likely than males to use technology to communicate and socialize with friends (χ^2 [1, N=173]=4.36, *p*=.037). See table 16 for the cell values of these associations.

Table 16

Associations Involving Gender Differences

Question	Response	Female	Male
People at school to help learn to use technology	YES	33 (85%)	132 (64%)
	NO	6 (15%)	70 (34%)
Someone wasn't nice on internet	YES	13 (50%)	36 (25%)
	NO	13 (50%)	105 (72%)
Using technology to socialize with friends	YES	25 (78%)	31 (21%)
	NO	1 (4%)	116 (79%)

Family income. Compared to other respondents, students from families with a medium income (between $40-99k) were more likely to take an online course for credit (χ^2 [4, N=142]=9.97, *p*=.041). See table 17 for the cell values of these associations.

Table 17

Associations Involving Family Income Differences

Question	Response	Low=up to $39k	Medium=$40-99k	High=$100 +
Take an online course for credit	YES	17 (53%)	25 (69%)	39 (53%)
	NO	9 (28%)	8 (22%)	31 (42%)

Technology use as a perceived area of strength

There were other findings from survey that were not explicitly tied to the research questions yet their findings provide useful information regarding student perceptions of their technology use. The very first question of the survey asked students if they thought they were "good at using technology?" and 95% (232) said yes. The full survey (n=174) asked students about the role technology might play in their future. Seventy-six percent (132) indicated they would like to have a job using technology. Ninety four percent (163) indicated they are considering going to college and of those 72% (118) indicated they would like to study a technology-related subject. The most popular technology related subject was video game design (65%) followed by computer science (35%) and web design (34%) and engineering (34%). Forty-three students (36%) wrote in other technology related subjects that interested

them including: animation, graphic design, filmmaking, music engineer, sound engineer, astronomy, and meteorologist. See table 15 below for the results.

Table 18

Preferred Technology Related Majors of Survey Participants

Technology related college subject	Percent	Frequency
Video game design	65	77
Computer Science	35	41
Web design	34	40
Engineering	34	40
Architecture	16	19
Other technology	36	43

n=118 (those who indicated they were considering going to college and interested in studying a technology related subject)

Summary

The results from the survey revealed that some students with ASD are using technology in a wide variety of ways to help them bypass areas of weakness to be more independent and successful in school and to socialize. They are using technology in many of the same ways and same rates as their typical peers. They are texting and using social media and taking advantage of technology to find friends online who have their same interests. They are using technology to explore and cultivate their interests and to enhance their communication. Surprisingly the perceived barriers regarding access to technology were not widespread. Equally surprising, unpleasant experiences online were not widely reported. However more than half of respondents did acknowledge that technology can be distracting

and this stands out as an area in need of attention if technology is to be promoted as a support tool for students with ASD.

The next chapter presents the results from the qualitative interviews with selected survey respondents and then Chapter 6 provides a synthesis of the quantitative and qualitative results in the discussion.

Chapter 5

Qualitative Results

Qualitative interviews were conducted as the second phase in this mixed methods study. The purpose was to gain deeper insights into the first phase survey results regarding the use of technology as a support by high school students with ASD. The majority of survey respondents reported they are using technology in a variety of ways including to help them stay organized, complete assignments, communicate, socialize, and to relax. What was not clear from the survey was what the students perceived as important benefits. For example, many students reported using technology to complete assignments but it was not clear if they perceived that technology use as beneficial or more specifically that it helped them to face some of their challenges. They also reported some barriers to technology use in particular that technology can be a distraction, but how and in what context was not clear.

Ten survey respondents agreed to participate in the qualitative interviews and all of them chose to do so by email. The questions focused on research questions 2 and 3, the perceived benefits and barriers to technology use as a support. Before responding to the questions, students were asked to list all the ways they use technology throughout a typical school day to aid their recall of technology use. Most respondents reported using technology, primarily smartphones and laptops, throughout the entire day. Some of the responses included: “watch YouTube while I eat breakfast”, “listen to music during lunch,” along with other uses such as to take notes, do homework, do research, check grades, text friends, play

games between classes, watch shows and play video games before bed. The interview questions distinguished between benefits and barriers in the school and home environments, but the themes that emerged from the data overlapped in both settings so the results are presented together.

Three overarching themes, along with nine sub-themes emerged regarding the perceived benefits of using of technology as a support tool. For perceived barriers to technology use only one overarching theme emerged along with three sub-themes all related to the distracting nature of technology. See figure 3 for a presentation of the themes and their sub-themes. See table 19 for a matrix of the themes and their sub-themes showing which participant contributed to which theme/subtheme. Each of these themes and sub-themes will be discussed below.

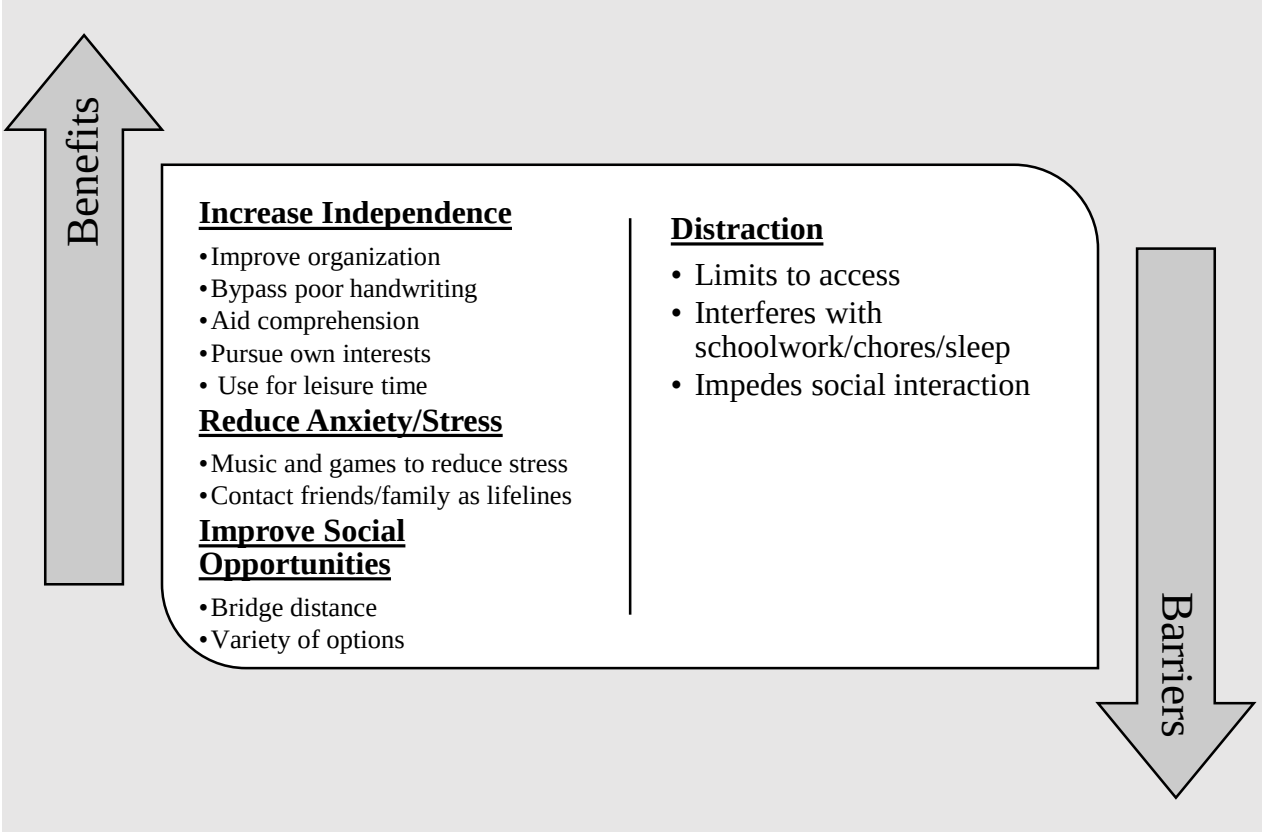


Figure 3. The benefits and barriers to technology use as a support

Table 19

Matrix of participant contributions to themes

Theme	1	2	3	4	5	6	7	8	9	10
Independence										
• Improve organization	X		X	X		X	X	X	X	X
• Bypass poor handwriting							X	X	X	X
• Aid comprehension		X	X	X		X	X			
• Pursue own interests	X	X				X				X
• Use for leisure time		X		X			X		X	X
Reduce Anxiety/Stress										
• Music and games to reduce stress	X							X	X	
• Contact friends/family as lifelines		X		X						
Improve Social Opportunities										
• Bridge distance	X		X	X		X			X	
• Variety of options		X	X	X	X	X	X		X	X
Distraction										
• Limits to access	X			X		X	X	X	X	X
• Interferes with schoolwork/chores/sleep	X	X	X	X		X	X	X	X	
• Impedes social interaction						X	X	X		

Research question 2. What do students perceive as benefits of technology use as a support?

High school students with ASD, according to the survey, use technology in a variety of ways throughout the school day to help them complete assignments, stay organized and generally find it makes learning easier and fun. Survey respondents also indicated they like using it to relax during lunch or breaks and many like having a phone at school so they can contact a parent if needed. At home, some respondents indicated they use technology in supportive ways including to look up things on the internet, to check class or school websites, to turn in assignments, and to keep track of homework. Regarding communication and socializing, survey respondents said they use technology not only to talk to friends and family but also to make new friends, and find people with their same interests. Because of the restrictive nature of survey questions which provide limited response choices, the qualitative interviews were used to gain insights into what students perceived as the major benefits of technology use as a support tool and why.

Interview participants were asked to describe the most helpful ways that technology is used at school and at home and this resulted in the interpretation of the following three major themes: to increase independence, to reduce anxiety and stress, and to improve social opportunities.

Using technology to increase independence. Using technology in ways that increase independence was by far the most common finding from the interviews. These perceived benefits were noted across home and school environments and manifest in a wide range of areas. In particular, respondents felt that technology is helping them to bypass weaknesses associated with their autism in three distinct ways: (1) to help with organizational struggles

(executive dysfunction), (2) to overcome poor handwriting (graph-o-motor weakness), and, (3) to provide an immediate resource to help aid understanding (weak central coherence, theory of mind) of school work or other areas causing confusion. Technology is helping in two other ways to increase independence by providing a means to cultivate areas of interest (e.g. graphic arts), and, to provide respondents with something enjoyable to do when they find themselves without other meaningful activities (e.g. play games on iPhone when finished with classwork).

Improve organization. A prominent sub-theme related to increasing independence was using technology to help with organization especially to do things like reduce the amount of papers to manage daily. One student was emphatic in making this point saying he wanted to "… make paper as close to obsolete as I can manage. This is helpful because I lose papers due to their weight and quantity." Also related to losing papers, another student wrote about his preference for using the computer for assignments over pen and paper saying: "so I can send it [an assignment] to the teacher and not lose it." Several students mentioned using their computers to type up notes. One student described using a folder system "so I know where to find my notes when I need to find them." Several students mentioned using technology to monitor their progress in school by checking online gradebooks thus making it unnecessary to rely on teachers or parents to keep them on track. One student explained how he uses his Chromebook "to check on grades, that way I know if I should be working extra hard on a class, or if I need to review some material."

Bypass poor handwriting. Another sub-theme that emerged was how technology is helping to overcome poor handwriting specifically to aid in completing schoolwork both at school and at home. One student wrote: "I use the computer for writing English papers

because it corrects my spelling and punctuation and because my handwriting is bad." Echoing this thought, another student wrote, "I use my Chromebook to take notes in many cases because my handwriting isn't the best, and I need to be able to read it." Another student specifically referred to his "dysgraphia", or inability to write legibly, as a most helpful reason for using technology at school. Also related to fine motor issues, several students mentioned using their phones to take pictures of things such as notes instead of copying them out by hand. One student explained how he uses his phone to "take a photo of what is on the Smart board because some of the diagrams for certain classes can be hard to draw, so instead, I just take a photo."

To help with understanding. The third sub-theme was the use of the internet to support comprehension. Half of the interviewees mentioned overcoming issues with comprehension in class by using the internet to seek clarification. One student wrote, "I use my Chromebook to look up information for class because if I don't exactly understand something taught in class, I can search it up online and get more clarification."

Pursue own interests. A fourth sub-theme related to independence was using technology to pursue their interests. One student wrote about how technology had helped him to write and produce music, become a graphic artist, and to "efficiently manage multiple blogs/sites as an admin." Another student wrote how he watches basketball on television "to enjoy sports because it is great to learn lovely skills to become an athlete." Another student uses his laptop to research interests "like Pokémon [*sic*] and videos on game playing."

Use for leisure time. The final sub-theme linked to independence was using technology for entertainment when respondents find themselves without a meaningful activity both at school and at home. This can be perceived as such because in the absence of

a structured activity preordained by others, individuals must choose how to spend their time thus exercising their independence. Several students mentioned playing games on their phones or laptops during downtime at school. One student explained how he takes pictures and videos of his dogs "so then I can look at them when I'm done with my work at school." At home several respondents described using video games as a form of entertainment in lieu of other things to do. According to one respondent, "whenever i don't have plans outside of home I play videogames until I get contacted by my friends on the phone to hang out." Another student reflected, "I use my technology for video games to entertain me when I'm at home because I don't have many friends".

Using technology to improve social opportunities. Technology use to socialize was featured prominently in the interview protocol because 94% of survey respondents had indicated they use some form of technology, if not multiple forms, for this purpose. Interviewees were asked if they thought technology had improved their social life and the majority of respondents said it did and described how they thought it had. The two sub-themes were: using technology to overcome the barrier of physical distance, and, the convenience and flexibility of technology communication tools making them more conducive to use.

Bridge distance. A common subtheme of improving social opportunities was using technology to bridge physical distance to maintain relationships and make new connections. Several interviewees remarked on the importance of using technology to stay in touch with friends and family who are at a physical distance. One respondent explained how he uses his cell phone to talk to family who live "out of state and my friends cause [*sic*] both are important to me like in the afternoon after school i [*sic*] like talking to them to know how

they are doing and before bed I tell them good night and i [*sic]* miss u [*sic]* and all that." Three students wrote about how not driving can impact getting together with friends but that technology helps to overcome the distance. One student explained: "We both can't drive and live about 4 miles apart and can only see each other at school. So we can keep in touch during the weekend and holidays." For others, the benefit of technology to their social lives was the opportunities it presents to engage with others beyond the local community and to meet new people with similar interests. One student wrote: "I can communicate with the world. Social media can introduce a person to more types of people, culturally, than maybe they could meet in their local community." Another student described his social life online: "My social life is on youtube when I post videos and on instagram i [*sic*] love like talking to my friends on there and when im [*sic*] messaging people about something then im [*sic*] very social. I have some friends who are video friends, we just talk about games and YouTube."

Variety of communication options. The second sub-theme related to the social benefits of technology was the sheer variety of options technology provides for communication and how that facilitates and enhances social opportunities. One student wrote: "I use my phone to FaceTime so then I can see the other person's face." Another wrote, "I use my PC to chat with my friends because it is a fast way to get in contact with people I know so we can discuss about getting together sometime, or getting on a game together." Another student explained: "I take pictures of myself or with my friends send them on Instagram or snapchat because it's fun." One student said he preferred to email people as a way to "extend his social circle." Others wrote about preferring texting to talking with friends. One interviewee mentioned preferring using technology to communicate rather than face-to-face encounters.

Using technology to reduce anxiety/stress. The third major theme related to perceived benefits of technology use is how it can serve to reduce stress and anxiety especially in the school setting but also at home. The survey had revealed that 87% of respondents use technology at school during breaks or at lunch to relax. Several survey respondents wrote in open answer spaces describing specific ways they use technology to help them deal with social emotional challenges both at school and at home. These included listening to music to calm down, looking at specific screen savers to de-stress, playing specific games, and listening to specific sounds provided by apps designed for relaxation and to promote sleep.

Some of the same uses of technology for stress reduction were elaborated on during the qualitative interviews. The two sub-themes that emerged from the theme of anxiety and stress reduction were: 1) listening to music or playing games to reduce stress, and 2) using technology to communicate with family or friends to answer troubling questions that come up throughout the course of the day.

Music and games to reduce stress. Four students mentioned listening to music or playing games to help manage stress. One student wrote, "I get anxious without being occupied by something such as music." Another wrote: "I just listen to music and it is just background noise that I find soothing. It helps me drown out the annoying sounds of yelling students." One student wrote that he plays Star Trek Online on his computer to help him "relax at the end of the day and keep my stress down."

Contact friends/family as lifelines. Similarly to help with anxiety, some students perceived as beneficial having the ability to text or call parents or friends while at school or even at home after school when parents were at work. One student wrote: "I call my mom

when I have a question ...the questions are school questions and questions about getting nice acquaintances when growing up." Another student wrote: "I make telephone calls because I have trouble with questions and I need to learn to trust my own gut."

The interview respondents had more to say regarding their perceived benefits than barriers to technology use. However, when asked specifically their opinions on the distracting nature of technology both at home and at school, barriers to using technology as a support tool became more apparent.

Research question 3. What do students perceive as barriers to the use of technology as a support?

The survey results revealed students perceived fewer barriers to than benefits to their use of technology at school. Less than a third reported having difficulty in knowing how to use technology to learn and not having people at school to help them learn to use technology. Roughly one tenth of respondents reported a lack of access to physical technology tools and no wi-fi access at their school. However, almost half of survey respondents indicated they were not allowed to use technology in all classes. The one survey finding regarding barriers that garnered more than half of respondents (57%) was the acknowledgement that technology can be distracting. It was this finding that led to the decision to probe around the issue of distraction in the qualitative interviews.

Interview respondents were asked whether or not technology was a distraction to them from what they were "supposed to be doing" in the home and school environments separately. More respondents admitted to being distracted by technology at home (7) than at school (2). However, it was clear from their responses regarding barriers to technology use at school that their teachers and administrators viewed it as a distraction and not just to the

students with ASD but to students more broadly. There were reports of certain classes where the whole class was forbidden to use technology and also reports of school wide blocking of certain sites through the use of filters. These restrictions to technology access (barriers) were impacting the students with ASD from using their technology tools in beneficial ways.

Technology use as a distraction. The overarching theme regarding barriers to technology use as a support is related to the distracting nature of technology, whether perceived or real. There are three sub-themes in this area: 1) limits to access, 2) distracts from what should be doing, and, 3) interferes with social opportunities.

Limits to access. The predominant barrier to using technology as a support as reported by the respondents was from limits placed on technology use, especially by school staff, due to their belief that technology is distracting students from their schoolwork. This occurred at school in two significant ways. One way was that specific teachers restricted use of personal technology tools during class and the other was that school administrators blocked specific websites school wide to keep students from visiting those sites while at school. Two students mentioned parents restricting their use at home.

Most students said that individual class rules interfered with their ability to use their own devices in at least some classes. Several students mentioned that teachers restrict usage of phones in class because some students "forget to turn them off" and they ring at inappropriate times. Respondents commented on how these usage rules varied from class to class. According to one student, "sometimes I can use technology as much as I need to, while others [classes], I'm not allowed to even have a device out." Another student was outraged because he wanted to use his laptop to play music (through earbuds) during class complaining that his math teacher "can't grasp the fact that I need to split my attention to

stay focussed [*sic*] and she gets pissed...This Macbook can't run music while shut so it always looks like I'm off task (whether or not i [*sic*] actually am)." Another student described how she listens to music in the hall in between classes and "sometimes keep the earbuds in if the teacher lets me during the class to shut out some of the noise from the classroom but usually they won't let me."

The second way the sub-theme of limits to access was portrayed was through the blocking of specific websites preferred by respondents by school administration. Some of these websites, it was claimed, were useful for completing school related activities. Regarding this issue a student complained: "The school computers are however made obsolete through bricking [blocking] various useful and necessary applications through administrative firewalls." Echoing that sentiment, another explained, "my school has a site blocker that sometimes blocks websites that I need to access to for class." One student described how he likes to use YouTube at lunch "but I can't because some youtubers [*sic*] are blocked because some teachers got them block. The school wi-fi, even on your phone it won't let you on some sites." Similarly, another student wrote, "the school system blocks everything making their computers and my internet unusable."

Even though seven out of the ten students wrote that technology was not a distraction at school, the remaining three described how they play video games at school to the detriment of their schoolwork and social life. According to one student, "I like to play video games but they will not let me play them during class and I can't bring my DS to school anymore." Another student admitted, "I play video games on my phone during study hall, which sometimes puts off homework."

Mostly students reported that technology is not personally distracting for them at school, that they are able to follow the rules and do their school work when they are supposed to and then when their work is completed, they will use technology to play games or socialize. According to one student, "I usually pay good attention in class, and when I have the time to play on my phone, and know I don't have other things to do, I usually do play on my phone." Similarly, another student wrote: "No, technology is not a problem for me in school because I understand the proper times and reasons to use my computer, phone, or handheld gaming system."

Interferes with schoolwork, chores, and sleep. Interview respondents reported that technology was distracting them from what they should be doing, such as schoolwork, chores, or even sleeping, predominantly in the home setting. One student wrote, "Sometimes I play video games and procrastinate doing my homework. This doesn't help because I tend to not get the practice I need for upcoming assessments." Also impacting school performance, another student remarked how using technology for entertainment could lead to bad grades "because your [*sic*] not doing homework at home." Another student explained how distracting technology can be causing her to "lose track of time needed to do homework when I am talking to my friends on my cellphone." Also referring to the distracting potential of technology, another student mentioned how video games and listening to music "makes me preoccupied and makes me be off task for the things I should be doing like chores or projects." Similarly, another student mentioned how "I get so involved in a program on the computer that I forget to finish my assignments, and I can lose track of time."

Regarding the use of technology interfering with sleep, a student wrote, "Well when is not helpful is when u stay up on it all night and don't go to bed and when u are sleeping

and u dont[*sic*] hear your alarms then u[*sic*] would be late for school." Another student wrote: "I like to stay up to about 12:30 watching YouTube videos which can mess up my sleep schedule." Similarly, another student wrote: "Fun technology makes it hard for me to go to bed on time and then it's hard for me to get up in the morning."

Impedes social interaction. The third area where the distracting nature of technology was a perceived barrier to its use as a support was how it could interfere with face-to-face interactions at school, home and in the community. In the school setting, one respondent said that technology "makes me less likely to socialize with my classmates," while another admitted, "Sometimes I play video games on my phone between classes, which limits social interaction."

At home, another student admitted, "While I can use it to plan getting together with others, I often put off getting together with people instead to play video games." Echoing that sentiment, another student said, "When I play video games, I do put off getting together with others, limiting social interaction."

Other students felt that while their parents might think that technology can be distracting, they themselves did not always agree. According to one student, "when my parents call me to come to dinner, or lunch or breakfast, I am often involved with listening to music or looking at a video or playing a game and I can't seem to break away. I have my priorities and they are different from theirs." Similarly, reflecting on differing priorities from parents, another student wrote: "In church I play video games and that annoys my parents but at least I go to church and I'm not really big on church."

How to reduce the distraction factor of technology. When interviewees were asked to describe things they do to keep technology from distracting them at school, there were three replies: read a book, put it away, and, turn it on airplane mode.

When asked about ways they keep from being distracted by technology at home, two students indicated their parents put limitations on their technology use for them. One explained, "I am only allowed to play video games on the weekend because I get so involved with the games and I lose track of time and I forget to do my homework." Another replied, "I don't keep it from distracting me but sometimes my parents take it away from me as punishment." Other remedies for distraction included doing lunges, reading books, drawing, or simply prioritizing activities. "I get what I have to do done before I get onto a device," one student wrote. Another respondent had a suggestion for others: "If a person is distracted by technology at home, then that person could ask a parent, sibling, or friend to help them set up a schedule to use the technology."

Three of the ten respondents wrote that technology was not a distraction at home. According to one interviewee, this was because he had "no restrictions on laptop and iPhone use at home," and another explained it was because he is "not required to concentrate as often at home." The third respondent reported that excessive technology use is not a problem for him at home "because my mom has taught me how to monitor my usage and she is a support system for keeping me using technology in the proper way."

Summary

The qualitative interviews helped provide more focus to the wide range of supportive uses of technology by students with ASD that resulted from the survey. It is through the second phase of this study that it becomes clearer how technology can help students with

ASD increase their independence, enhance their social opportunities and reduce their anxiety and stress. A synthesis of the findings from the survey and qualitative interviews along with a discussion of the implications for practitioners and suggestions of areas for future research follows in chapter 6. The limitations of this mixed methods study will be addressed.

Chapter 6

Discussion

High school students with ASD were surveyed and interviewed to gain insights into how students with autism use technology in their everyday lives in supportive ways especially at school but also at home. Previous research primarily focused on discretionary use of technology at home and revealed that the majority of adolescents with ASD enjoy using technology for entertainment (Mazurek et al., 2012), especially to play video games (Kuo et al., 2013), and some were using social media but at a rate far below their typical peers (Mazurek & Wenstrup, 2013). Information was lacking, however, on the ways youth with ASD use technology as a support tool to enhance learning and independent functioning. The results of the survey portion of this study revealed that respondents are using technology in various ways across settings to help them to stay organized, complete school assignments, communicate with teachers, make new friends, reduce stress, and to help them fall asleep and wake up. Further, the interview portion of this study probed deeper into the technology use to see what respondents believed are the biggest benefits of its use and what are possible barriers keeping them from using it more as a support. A synthesis of the survey and interview results is discussed below along with the implications for practice and research and the limitations of this study.

Technology Use by High School Students with ASD

It is clear from this survey that much has changed since the NLTS2 survey, which revealed that students with disabilities "rarely" or "never" used computers in their classrooms (Newman, 2007). Today, many students with ASD are using not only their school's computers but quite often their own devices to support their learning and independence throughout the school day. One student summed up his enthusiasm regarding the benefits of technology saying "I think technology is the best industrial thing in our world because it gives us joy and curiosity into great things."

The teens in this study are using technology in ways similar to typical teens as reported in the 2015 Pew Research Center's survey of teens, technology and friendship (Lenhart, Smith, Anderson, Duggan, & Perrin, 2015). They are using technology, especially handheld technology, to improve their social opportunities by engaging in a variety of social media outlets, and to reduce their anxiety by listening to music, using calming apps, and by having it as a lifeline to contact friends and family for advice. In some ways, this study reveals that technology is flattening the world for teens with ASD so their lives are looking more similar to their neuro-typical peers than previously reported.

Benefits of technology use for teens with ASD

The three most significant findings from this descriptive study are the wide variety of ways teens with ASD are using technology to1) increase their independence, 2) enhance their social opportunities, and, 3) relieve their anxiety and stress, all areas that can be challenging for individuals with ASD. This last finding emerged unexpectedly from the comments that survey respondents wrote into the questionnaire when asked if there were other ways they used technology besides those listed as response options. It emerged again as a major finding

in the qualitative interviews. These findings provide much needed information not only for researchers but also for practitioners, parents and policymakers.

Using technology to increase independence. Issues surrounding independence can be some of the most debilitating for individuals with ASD no matter what their cognitive abilities (Hume et al., 2014). High school students with ASD scored the lowest on measures of independent functioning of any disability category according to the NLTS2 (Newman, 2007). Further, this national longitudinal study found that eight years after leaving high school, the majority of students with ASD were still living at home with their parents and had low levels of employment and social engagement (Shattuck et al., 2012). Difficulties with independence for individuals with ASD can manifest in many ways including the areas of self-management, self-advocacy, initiation of conversations and even initiating simple but necessary activities such as doing homework and waking up in the morning. Participants in this study indicated how using technology helped them overcome some of their weaknesses, which in turn should result in increased independence. Some of these uses included:

- using word processing to bypassing poor handwriting to be more productive writers,
- using a laptop in class to take notes and keep track of documents,
- using the internet to find answers to questions,
- using the internet or software to pursue their own interests, and,
- making their own choices about what to do at times when they have no structured activities planned.

Some of these benefits of technology use to promote independence will be elaborated on below.

Fine motor impairments impacting handwriting are common in individuals with ASD (Bhat, Landa, & Galloway, 2011; Mayes & Calhoun, 2007). Fortunately, today's technology offers a variety of options such as keyboarding, voice-to-text software, and voice recording, so that poor handwriting should no longer be considered a handicap. Creating written output is an important aspect of academic success at the secondary level and even more so in higher education. Using technology to bypass issues with poor handwriting can help students with ASD reduce their need for accommodations (e.g. scribe) and become more independent students thus improving their opportunities for success in adulthood.

The co-occurrence of Attention Deficit Hyperactivity Disorder (ADHD) is common in individuals with ASD (Leitner, 2014). A recent study found that children with ASD and comorbid ADHD had greater problems with adaptive behavior resulting in poorer quality of life (Sikora, Vora, Coury, & Rosenberg, 2012). Finding ways to reduce attentional and organizational struggles is critical to improve outcomes for individuals with ASD. Some students in this study are using handheld devices to help address their ADHD symptoms by using timers, alarms, and calendar features. Simply by reducing the amount of paper they need to keep track of by using a computer to keep their documents organized was cited as a major benefit of using technology at school. Several students in both the survey and in the interview mentioned using music to help them "focus," especially to reduce the distraction of other competing sounds. Some students spoke of difficulties getting permission to do this as their teachers and parents often saw the music itself as a distraction. While there are no studies on the use of music by students with ASD to improve attention while learning, there is research on auditory sensitivity in ASD which may help to explain why noisy environments can be so distracting for these students (Foster, et al., 2016).

Having a circumscribed interest is a defining feature of autism and often viewed negatively but it can also be a way for individuals with autism to increase their independence by developing a career path (Winter-Messiers, 2007). Hans Asperger (1991), in his observations of his patients, wrote: "Their unswerving determination and penetrating intellectual powers, part of their spontaneous and original mental activity, their narrowness and single-mindedness, as manifested in their special interests, can be immensely valuable and can lead to outstanding achievements in their chosen areas." (p. 88). Having the tools to pursue their interests independently on the internet or with the aid of special software can be important in helping adolescents develop their areas of interests that may one day lead to employment. In this study, unprompted, one student shared a link to music he had written, performed and released online, while another shared her artwork on a website she had created.

Ways technology can facilitate social opportunities. The journalist Harvey Blume wrote in the New York Times in 1997, "In cyberspace, many of the nation's autistics are doing the very thing the syndrome supposedly deters them from doing-communicating." Even though researchers have paid scant attention to the impact of social media on the social lives of youth with ASD, the majority of teens in this study are active in a wide range of social media outlets at rates that are approaching those of their typical peers. Two aspects of social media stood out in this study. First, it facilitates social connections by bridging physical distance, providing access to a greater sphere of potential friends especially people with similar interests. Second, the sheer variety of options to communicate is helping to facilitate more social interactions.

Driving, the proverbial rite of passage into adulthood for most teens, is the rare exception for youth with autism (Feeley, Deka, Lubin, & McGackin, 2015). This lack of mobility restricts independent movement of the individual and can be limiting to their ability to interact socially with friends. For adults with ASD who have left school and are living at home with parents, limited social activities can have a profound impact on their quality of life (Orsmond, Shattuck, Cooper, Sterzing & Anderson, 2013). Feelings of loneliness related to poor quality of social relationships have been reported in adolescents with ASD (Locke, Ishijima, & Kasari, (2010). Fortunately many of the teens in this study are finding social media helpful in bridging distance to friends by using the wide variety of tools available to stay in touch. Social media has also opened up the potential pool of friends far beyond the local community. This can be particularly helpful for individuals with ASD who may have restricted interests and therefore enjoy meeting people with those same interests who may not live in close proximity.

The different options for socializing make it easy for teens to keep up with what is going on with their friends. They may share of only a few words, an emoticon, or a photo, as a way of socializing, which may be more compatible for individuals with ASD than more intimate and verbal face-to-face encounters. These newer methods of social interaction might also be used to improve communication with teachers and employers to help support success in adulthood (Benford & Standen, 2011).

Technology to reduce anxiety and stress. Anxiety is one of the most common comorbid conditions in adolescents with ASD. It can have a profound impact on the individual's ability to function (White et al., 2014) and can lead to problematic behavior (Stevenson, Quinton, & South, 2015). In this study, a number of respondents reported using

technology to help them "relax" and "de-stress" by listening to music or by playing games. Having the ability to contact their parents on their cell phone during the school day was also found to help with anxious moments. A recent feasibility study on the efficacy of delivering a real time stress management intervention with a handheld device to adults with ASD showed promising results (Hare, Gracey, & Wood, 2015). Using a cognitive behavioral therapy approach, the device was timed to prompt the individual to report their feelings at different intervals throughout the day. Results showed improved mood and less anxious thinking. Similarly, having pre-recorded messages by family or friends might be another way to help de-escalate a stressful situation.

Participants in this study, both in the survey and in the interviews, noted the use of music to be especially soothing and useful at school to help with stressful situations and in particular to drown out other sounds that were considered disturbing. Respondents also mentioned using a variety of apps that use specific sounds (e.g. white noise) to help them get to sleep. These uses of specific sounds to create a calming effect are not well discussed in the literature but are likely related to the common hypersensitivity to auditory stimuli in individuals with ASD (Foster et al., 2016). A recent qualitative study of adults with ASD regarding their sensory perceptions found that participants who were agitated by a variety of different sounds, both soft and loud, often used music as a preferred method to calm themselves (Robertson & Simmons, 2015).

There is a wave of excitement surrounding the potential of technology to help individuals with ASD ameliorate some of their deficits mostly due to the near universal affinity for technology of individuals on the spectrum. However, there are also calls for tempering the excitement and to remain vigilant for unintended consequences of technology

use (Ramdoss et al., 2011). One area where caution has been advised has been around the excessive use of technology at the expense of other activities (Mazurek, Engelhardt, & Clark, 2015; Mazurek & Wenstrup, 2012; McMullin, Lunsky & Weiss, 2015), which will be discussed below.

Barriers to technology use

In addition to describing perceived benefits of technology use, this study set out to discover what barriers might exist for teens with ASD in using technology tools in supportive ways. The findings overwhelmingly revolved around one theme of the distracting nature of technology. However, the student perception differed somewhat in how that was manifest at school and at home and therefore each setting will be discussed separately.

Distraction at school. In the classroom technology distraction is now known as *cyberslacking* (Aakash, Fiore, & Fischer, 2015). Even though the majority of respondents have access to technology tools, many described how there are times throughout the day in which they are not permitted to use them, whether by teachers, parents, or de facto by the blocking of certain websites. The reason for these restrictions all related to the perception that technology was a distraction from their prescribed activities. At home some teens described being so caught up in their game playing that it interfered with school-work, chores, family life, and even sleep. Whatever the case, perceived or real, the distractive nature of technology was reducing the opportunities for it to be used in supportive ways. This finding aligns with the CSESA Technology Work Group's conceptual model of the ideal user-technology-activity match. For example, a student checking Facebook on her cell phone in class is a mismatch of the technology (Facebook) and the user (student) with the activity (academic lesson). At lunch (activity), the student (user) tweeting friends (technology) would

be an ideal user-technology-activity match and therefore would not be distracting and be acceptable.

As more students have access to technology in the classroom, more research is being done to examine its impact on learning. There are several recent studies related to the distracting nature of technology in the classroom and its effects on learning (Aagaard, 2015; Aakash et al., 2015; Ravizza, Hambrick, & Fenn, 2014). Past research found that having access to technology in the classroom improves learning outcomes (Samson, 2010; Trimmel & Bachmann, 2004), while more recent studies are finding the negative effects outweigh the benefits (Kraushaar & Novak, 2010; Sana, Weston, & Cepeda, 2013). Obviously, in the school context, it would be impossible to control the off-task technology use of all students all the time so either teachers and administrators place limits, or, they accept that some students will be off task at least some of the time. Rather than restrict its use, educators might do well to focus efforts on helping youth transitioning to adulthood learn to use their technology responsibly (Aakash et al, 2015).

Distraction at home. Technology was less distracting at school than at home. This finding emerged from the interviews. Several students explained that at school they are able to follow the rules and not be off-task during class. Some blamed their rule breaking peers for the imposed restrictions. However, in the home setting students admitted to being distracted by their technology from things they were supposed to be doing such as homework and chores. Some even mentioned that technology impacted their ability to socialize and to get sufficient sleep. It is plausible that students with ASD are less likely to be distracted by technology in class when the teacher establishes clear rules. This perceived difference in distractibility between school and home merits attention. For those individuals who are being

distracted by technology whether at home or at school, perhaps having clearly defined rules regarding their technology use could be helpful in managing the distractive nature of the technology in that environment.

Cyberbullying, a potential barrier to technology use by teens with ASD. Bullying victimization has long been a concern for individuals with ASD mostly due to their deficits in the area of social interactions and in social perception (Humphrey & Symes, 2010). Prevalence rates of bullying ranged from 46-94% across studies in a recent literature review (Sreckovic, Brunsting, & Able, 2014). In a study of teens and technology use, the Pew Center for Research found that 32% of teens report having experiences that could be described as cyberbullying, that is, annoying or threatening activity such as receiving threatening messages, having messages forwarded to others without consent, having embarrassing photos posted, or having rumors circulated (Lenhart, 2007). While there appears to be an absence of literature specifically on ASD and cyberbullying, this study found only 28% percent of participants indicated they had had a bad experience using social media. Further, many participant descriptions of the experience did not always fit the definition of bullying. None of the students said they had stopped using social media because of these experiences and many hearteningly explained how they handled it using appropriate techniques such as defriending or blocking an offender, reporting the incident to an adult, or simply ignoring it. This finding gives some evidence that efforts at teaching students to be safe online may be working and should be encouraged as an important part of the school curriculum.

Associations to Technology Use

There were few associations to technology use found in this study between the individual survey questions and the selected variables of race, ethnicity, gender, household

income, IQ, and diploma track. The most frequent associations were between the diploma types, meaning between students served in inclusive settings who graduate with a standard high school diploma, and students who graduate with a modified diploma and are most likely to be served in separate settings. Students served in inclusive settings were more likely to bring their own technology to school, to report having restrictions placed on their technology use, and to admit that it could be a distraction. Students on a modified diploma track were more likely to say that they had people at school to help them "learn how to use technology" and that "using technology to learn is hard." Future studies may want to investigate the differences in technology use between students served in inclusive and modified settings.

There were two areas where gender differences were found. Paralleling findings amongst typical teens, females in this study were more likely than males to use technology to socialize (Lenhart, 2015), and more likely to report that someone was not nice to them using social media (Lenhart, 2007). No associations were found for the variables of race and ethnicity. Perhaps this is because of the low numbers of participants in the various race and ethnic groups. It could also be because, as in the mainstream, almost all teens in the US today, despite race and ethnicity, have access to some form of technology and are using it to connect to the internet and social media (Lenhart, 2015).

Implications

A recent paper on the future directions for autism research noted that for transitioning adolescents and adults with ASD, using a "neurodiversity model", one with an emphasis on fostering strengths and awareness, is perhaps more appropriate than the deficit or medical model (Damiano, Mazefsky, White, & Dichter, 2014). The work of Cosden, Koegel, Koegel, Greenwell and Klein (2006) on strength-based assessment for children with ASD has

demonstrated that incorporating strengths or special interests into social interactions and academic assignments can improve responding and decrease problem behaviors. Courchesne and colleagues (2015), based on their work using strength-based assessments including visual search and embedded figures tests, recommend strength informed approaches in the educating of children with ASD. In this study, 95% of respondents perceived they are "good" at using technology. Further, the majority want to major in a technology-related subject in college and have a job using technology. Leveraging the use of technology because many individuals with ASD perceive it as an area of strength may lead to its broader application to support the needs of these individuals not only in school but as they transition to adulthood.

There is a wide range of uses for technology in the post school environment. Learning to use calendar, alarm and other organizational functions to keep up with school assignments can easily translate to higher educational environment and be equally valuable in the work environment to keep up with tasks. Communicating with a teacher via email can translate to communicating with a boss about a difficult issue at work or simply to provide an update. Using social media to meet new friends and to keep up with what is happening can be even more valuable in adulthood when there are fewer organized social opportunities.

Recommendations for practice. The use of technology has the potential to support positive post-school academic and career outcomes for students with disabilities, however, this requires that students have access to and learn to use technology in ways that contribute to their positive outcomes (Burgstahler, 2003). An important finding from this study is that many students with ASD, especially those in inclusive settings, report they are using technology in supportive ways. However, roughly 70% of the students felt they were not getting help at school to learn to use technology. Further, the finding that some teachers are

banning technology use in their classrooms altogether points toward the need to find effective coaching and supports for teachers to successfully incorporate technology use as a part of their instruction (Muyingi, 2014). In a study of teacher attitudes toward technology use to support learning at the high school level, Capo & Orellana (2011) suggest school leadership could provide a more positive approach to technology integration as opposed to focusing on the negative aspects through stringent rules and blockages. The study posits that teachers may interpret these restrictions as threatening to their job security thus reducing their willingness to provide access in the classroom (Capo & Orellana, 2011).

One way that schools might consider approaching technology integration is through the adoption of the Universal Design for Learning (UDL) framework. The benefit of this approach is that it is designed for general education classrooms to aid the integration of diverse learners. UDL is an educational framework that promotes a learning environment that accommodates individual learning differences most often through the use of technology (Domings, Crevecoeur, & Ralabate, 2014). The concept of UDL comes from the field of architecture and is founded on the goal of accessibility for all students (Mace, Storey, & Mueller, 1998). Classrooms that use the UDL model can provide flexibility by incorporating collaborative partnerships, technology tools, and differentiated instruction. UDL increases access to learning by reducing physical, cognitive, intellectual, and organizational barriers to learning and is characterized by multiple means of representation, expression, and engagement to appeal to individual student interests. The most recent reauthorization of the Individuals with Disabilities Education Act (IDEA, 2004) calls for "activities to support the research, development, dissemination and use of technology with universal design principles so that technology is accessible and maximizes access to and participation in the general

education curriculum [34 CFR §300.704(b)(4)]." The most efficient means of creating a classroom based on UDL is through the incorporation of technology. Because individuals with ASD are drawn to and often adept with screen-based technology, the UDL framework may be good fit for educating students with ASD in general education classrooms (Domings, Crevecoeur, & Ralabate, 2014).

Directions for future research. The aim of this study was to provide insights to researchers to help focus research agendas in the midst of hype about the potential benefits of technology for these individuals. While the perceptions of students about their technology use as a support tool is important, it will also be helpful to survey the perspectives of other stakeholders, in particular parents and educators, to confirm some of these findings. It will also be essential to do efficacy studies of the perceived benefits of technology tools to see if they are actually improving outcomes. For example, research questions for the future could be:

- Is using technology tools such as reminder alarms and calendars helping to increase independent functioning thus reducing the need for special education services?
- Is listening to music having a measurable effect on reducing anxiety symptoms?
- Do increased social interactions lead to a reduction in feelings of loneliness and depression?

Another area on which researchers might focus is online learning. There has been an absence in the literature regarding the suitability of online learning for students with ASD. In this study roughly a third of survey respondents reported having taken an online course for credit previously and just over half of the respondents indicated they would like to take an online course in the future. These results suggest that online learning may be an area of

opportunity for students with ASD. Thinking beyond high school, online learning has the potential to provide access to postsecondary education for those students with ASD who struggle with the highly social demands of life on a college campus and may be avoiding higher education altogether. Future studies should investigate the efficacy of online learning for students with ASD.

Limitations

There are four primary limitations to this study. First the findings based on self-report and student perception of the benefits of technology use were not confirmed by teacher or parent report. Self-report is gaining more attention as a valuable tool in autism research although it is not without its challenges (Elsabbagh et al., 2014). For example, studies have shown differences in the reports of individuals with ASD and their parents. In a quality of life study, adolescent reports varied significantly from their parents, in both directions, on several scales (Clark, Magill-Evans, & Koning, 2015). In another study, individuals with ASD reported their social skill abilities more favorably than their parents (Kalyva, 2010). This study tried to mitigate the inconsistency in self-report by using follow up interviews with a subset of the sample to confirm their survey responses. Future studies should triangulate student, parent, and practitioner perspectives regarding the benefits and barriers to technology use by high school students with ASD to see where the results align.

Second, there is a lack of diversity in this study that is typical for autism research (Pierce et al., 2014). Though all eligible students in the public high schools participating in the CSESA research study were invited to participate, it may take more culturally specific efforts to attract a broader representation that reflects the true demographics of students with ASD in the US (Zamora, Williams, Higareda, Wheeler, & Levitt, 2016). Also related to

diversity, students with IQs of 70 and above, often corresponding with those educated in inclusive settings, were overrepresented. It is very likely the use of technology by these students differs from those students with lower cognitive functioning. Future studies may want to explore technology use specifically by students with ID to see how their experiences may differ.

Third, this study did not investigate explicitly the negative aspects of technology use. While a question was asked in the survey about having an experience when someone was not nice using technology, it did not explicitly use the term "bullied", nor did it define the term "bullied" thus the results are not useful to add to the literature on bullying and students with ASD. Technology use has the potential to be a great support but it may come with a variety of negative consequences that merit the attention of researchers, practitioners, and parents.

Lastly, regarding the use of Pearson's chi square test to examine associations between survey questions and respondent characteristics, the findings do not apply to all participants but only to those responding to the specific question.

Conclusion

Contrary to previous research, this study revealed that high school students with ASD are using technology in a variety of supportive ways. Study participants reported using technology in school and home settings to increase their independence, reduce their anxiety, and improve their social opportunities. They also reported bringing powerful technology tools with them to school every day but finding barriers to its use through school and classroom restrictions on technology use. Practitioners may benefit from coaching and support on integrating technology to aid learning while reducing the distracting nature of

technology. Future efficacy studies on the benefits of technology use as a support tool by high school students with ASD are needed.

APPENDIX A: DEMOGRAPHIC QUESTIONNAIRE

Child and Family Demographic Form

Child Demographic Information

1) Child's first and last name: _____

2) Child's date of birth: __ __ / __ __ / __ __ __ __
(Month) (Day) (Year)

3) Child's current chronological age: _____ years old

4) Child's current grade in school. *Choose one answer.*

☐(9)	9th grade
☐(10)	10th grade
☐(11)	11th grade
☐(12)	12th grade
☐(13)	Other ***Specify:*** _____

5) Select your child's gender. *Choose one answer.*

☐	Male
☐	Female

6) Select your child's ethnicity. *Choose one answer.*

☐	Non-Hispanic or Non-Latino
☐	Hispanic or Latino

7) Select your child's race. *Choose one answer.*

☐	American Indian/Alaskan Native
☐	Asian
☐	Black or African-American
☐	Native Hawaiian or other Pacific Islander
☐	White
☐	Multi/Biracial ***Specify:*** _____
☐	Other ***Specify:*** _____

Child Diagnoses

8) Select your child's current diagnoses. *Check all that apply.*

☐(1)	Anxiety disorder
☐(2)	Asperger's syndrome
☐(3)	Attention deficit disorder/hyperactivity (ADD/ADHD)
☐(4)	Autism
☐(5)	Bipolar disorder (manic-depression)
☐(6)	Cerebral palsy
☐(7)	Childhood disintegrative disorder
☐(8)	Depression
☐(9)	Fragile X syndrome
☐(10)	Intellectual disability (also referred to as cognitive disability or mental retardation)
☐(11)	Learning disability
☐(12)	Obsessive-compulsive disorder
☐(13)	Oppositional defiant disorder
☐(14)	Pervasive developmental disorder (PDD-NOS)
☐(15)	Rett syndrome
☐(16)	Schizophrenia
☐(17)	Selective or elective mutism
☐(18)	Tourette syndrome
☐(19)	Tuberous sclerosis
☐(20)	Other ***Specify:*** _____

9) Write the age (in years and months) at which your child was first diagnosed with an autism spectrum disorder (autism OR Asperger's syndrome OR PDD-NOS). *If your child has received more than one of these diagnoses, please write the earliest age of diagnosis.*

Age of diagnosis with ASD	____ years, ____ months of age

10) Select the professional who first diagnosed your child with an autism spectrum disorder (autism OR Asperger's syndrome OR PDD-NOS).*Select one.*

☐(1)	Developmental Pediatrician
☐(2)	Neurologist
☐(3)	Pediatrician
☐(4)	Psychiatrist
☐(5)	Psychologist at clinic
☐(6)	Psychologist at school
☐(7)	Clinic-based assessment team
☐(8)	School-based assessment team
☐(9)	Other ***Specify:*** _____
☐ (10)	Unknown

Home or Community-Based Services

11) Indicate the services and supports that your child is currently receiving ***outside of school*** (at home, in a clinic, or out in the community). *Select 'no' or 'yes' for each of the services. If you select 'yes', indicate the number of minutes per month of service that your child currently receives.*

	Type of service/support	**No**	**Yes**	**Minutes per month**
11.1	Speech/language	☐	☐	_____ minutes/month
11.2	Occupational therapy	☐	☐	_____ minutes/month
11.3	Physical therapy	☐	☐	_____ minutes/month
11.4	Counseling	☐	☐	_____ minutes/month
11.5	Social Skills Group	☐	☐	_____ minutes/month
11.6	Vocational Rehabilitation	☐	☐	_____ minutes/month
11.7	Other ***Specify:*** _____	☐	☐	_____ minutes/month

Parent/Caregiver Demographic Information

Fill out both columns for your child's two primary caregivers. *Select one answer for each question.*

Caregiver 1 (CG1)

12.1 Relationship to child:

☐	Father
☐	Mother
☐	Other ***Specify:*** _____

13.1 CG1's Ethnicity (*Select one)*

☐	Non-Hispanic or Non-Latino
☐	Hispanic or Latino

14.1 CG1's Race (*Select one)*

☐	American Indian/Alaskan Native
☐	Asian
☐	Black or African-American
☐	Native Hawaiian or other Pacific Islander
☐	White
☐	Multi/Biracial ***Specify:*** _____
☐	Other ***Specify:*** _____

15.1 CG1's Highest level of education completed *(Select one)*

☐	5th grade or lower
☐	6th to 8th grade
☐	Partial High School
☐	High School Graduate *or* GED
☐	Associate degree *or* Technical Training *or* Partial College
☐	Bachelor's degree
☐	Master's *or* Doctorate *or* other professional degree

Caregiver 2 (CG2)

12.2 Relationship to child:

☐	Father
☐	Mother
☐	Other ***Specify:*** _____

13.2 CG2's Ethnicity (*Select one)*

☐	Non-Hispanic or Non-Latino
☐	Hispanic or Latino

14.2 CG2's Race (*Select one)*

☐	American Indian/Alaskan Native
☐	Asian
☐	Black or African-American
☐	Native Hawaiian or other Pacific Islander
☐	White
☐	Multi/Biracial ***Specify:*** _____
☐	Other ***Specify:*** _____

15.2 CG2's Highest level of education completed *(Select one)*

☐	5th grade or lower
☐	6th to 8th grade
☐	Partial High School
☐	High School Graduate *or* GED
☐	Associate degree *or* Technical Training *or* Partial College
☐	Bachelor's degree
☐	Master's *or* Doctorate *or* other professional degree

16) Select the category that matches your household's pre-tax income in 2013.

☐	< $20,000
☐	$20,000-$39,999
☐	$40,000-$59,999
☐	$60,000-$79,999
☐	$80,000-$99,999
☐	> $99,999

This is the end of the questionnaire. Please look it over for questions you may have skipped and complete those as well.

Thank you for completing this form!

APPENDIX B. EXAMPLES OF TECHNOLOGY FOR STUDENT SURVEY

For this survey, you will be asked about how you use technology. Technology can mean a lot of things, but for this survey, technology will mean electronic technology. Take a minute to look at examples of this type of technology.

LAPTOP COMPUTER

DESKTOP COMPUTER

TABLET DEVICE

Augmentative Communication Device (AAC)

SMARTPHONE

iPod/MP3

SMARTBOARD

GAME DEVICE

SOCIAL MEDIA

APPENDIX C. FULL SURVEY INSTRUMENT

CSESA Technology Use Survey-Student Version

We want to learn more about how you use technology (computers, cell phones, internet, etc.) to help you learn and to be successful. Your answers to these questions are really important to us.
Take your time and think carefully about your answers.

How You Use Technology at School

1) Are you are good at using technology?

   ☐ Yes ☐ No

2) Check off ***ALL*** the types of technology you *bring with you to school* most days.

   ☐ Laptop
   ☐ Tablet device (like an iPad or Kindle)
   ☐ Cell phone with internet (like an iPhone or Galaxy)
   ☐ Cell phone without internet
   ☐ Game device (like a Nintendo DS)
   ☐ iPod or MP3 player
   ☐ Digital camera
   ☐ Other (please list)
   _____
   ☐ I don't bring any technology to school

3) Check off ***ALL*** the types of technology you *use at school*.

   ☐ Laptop
   ☐ Desktop computer
   ☐ Smart Board
   ☐ Tablet device (like an iPad or Kindle)
   ☐ Cell phone with internet (like an iPhone or Galaxy)
   ☐ Cell phone without internet
   ☐ Game device (like a Nintendo DS)
   ☐ iPod or MP3 player
   ☐ Digital camera
   ☐ Other (please list) _____
   ☐ I don't use technology in school

4) The questions in this box are about using technology at school to **stay organized**.

Check how often you use technology tools:	**Everyday M-F**	**Some Days**	**Never**
as a calendar			
as a planner			

as an alarm			
as a timer			
as a camera			
as a video recorder or sound recorder			
to take notes			
Other (please explain)			

5) The questions in this box are about using technology at school to **complete** **assignments**.

Check how often you use technology tools:	**Everyday M-F**	**Some Days**	**Never**
to look things up on the internet			
to type things up (like Word or Google docs)			
to make presentations (like PowerPoint)			
to turn in assignments			
to work with other students (like Google docs)			
Other (please explain)			

6) Are there any other ways you use technology **at school** to help you learn or to be more successful?

(please list here)

_____

_____

_____

7) Do you use technology during lunch or breaks to relax?

☐Yes ☐No

8) Do you use technology during lunch or breaks to play with friends?

☐Yes ☐No

How You Use Technology for Online Learning

9) Have you ever taken an online course for school credit?

☐Yes (Name of course/s)
_____

☐No (skip to question 12)

10) Did you like learning online?

☐Yes

☐No (skip to question 12)

11) Why did you like learning online? (Please check all that apply)

☐ I did not have to interact with students.
☐ I did not have to interact with the teacher.
☐ I could do the course work anytime.
☐ I could take as much or as little time as I needed.
☐ Other (please explain)
_____

12) Would you like to take an online course in the future?

☐ Yes
☐ No

Access to Technology at My School

13) I am allowed to use technology in all of my classes.

☐ Yes ☐ No

14) There are people in my school who help me learn to use technology (like computers, cell phones, tablets).

☐ Yes ☐ No

15) My school provides technology tools for me to use in school.

☐ Yes ☐ No

16) There is wi-fi access at school.

☐ Yes ☐ No

My Opinions about Using Technology at School

17) Technology makes learning easier.

☐ Yes ☐ No

18) Technology makes learning fun.

☐ Yes ☐ No

19) I like having my phone at school so I can contact my parent(s) if I want or need to.

☐ Yes ☐ No ☐ I don't have a phone

20) Using technology to learn is hard.

☐ Yes ☐ No

21) Technology can distract me.

☐ Yes ☐ No

22) If you have any other opinions about using technology at school please share them with us on the lines below.

How You Use Technology to Communicate

23) Check off ***ALL*** the ways you use technology to communicate or to socialize (at home or at school).

☐ phone
☐ email
☐ text
☐ video calls (Face Time, Skype or Google Hangout)
☐ Facebook
☐ Twitter
☐ Instagram or Snapchat
☐ Other communication/social media (please list)_____
☐ I don't use technology to communicate or socialize (skip to question 26)

24) Have you ever felt that someone wasn't being nice to you using technology (texting, Facebook, email, etc)?

☐ Yes, give a short description

_____

_____

☐ No

25) Check off ***ALL*** the reasons that you use technology to communicate or socialize.

☐ to talk with friends
☐ to make new friends
☐ to find people with my interests
☐ to talk with family members
☐ to talk with teachers
☐ to keep up with what's going on (like on Facebook)
☐ so I don't have to talk face-to-face with people
☐ Other reasons you use technology to communicate or socialize (please list)_____
_____

How You Use Technology At Home

26) Please check ***ALL*** of the ways you use technology when you are at home.

☐ to keep track of homework assignments
☐ to check class or school website
☐ to work with other students on projects
☐ to turn in assignments
☐ to communicate with teachers
☐ to communicate with friends
☐ to find out what other people are doing
☐ to look things up on the internet
☐ for reminders/calendar/planner
☐ to play video games
☐ to watch You Tube or other online videos
☐ to wake me up in the morning
☐ other _____
☐ I do not use technology at home

27) List any special apps (applications) or software you like to use <u>besides for playing games</u> below. For example, an app to help you de-stress, or an app to help you stay organized.

_____
_____

How You Might Use Technology in the Future

28) In the future, would you like to have a job using technology?

☐ Yes ☐ No

29) Do you plan to go to college when you finish high school?

☐ Yes ☐ Maybe ☐ No (you are done with this survey)

30) Would you like to study a technology-related subject?

☐ Yes ☐ No

If yes, please check which subject you would like to study.

☐ computer science
☐ video game design
☐ web design
☐ engineering
☐ architecture
☐ other (please list)_____

THE END

THANKS FOR FILLING OUT THIS SURVEY!

Technology Survey

We want to learn more about how you use technology (computers, cell phones, internet, etc.) to help you learn and to be successful. Your answers to these questions are really important to us.
Take your time and think carefully about your answers.

1) Are you good at using technology?   

☐ Yes ☐ No

2) What types of technology do you bring with you to school?

☐ Laptop 
☐ Tablet device (like an iPad or Kindle) 
☐ Smart phone (like an iPhone or Galaxy) 
☐ Regular cell phone 
☐ Game device (like a Nintendo DS) 

☐ iPod or MP3 player 
☐ Camera 
☐ Augmentative Communication Device 
☐ Other (please list) _____
☐ I do not bring any technology to school.

3) Check off all the types of technology you **USE** at school?

☐ Laptop 

☐ Desktop computer 

☐ Smartboard 

☐ Tablet device (like an iPad or Kindle) 

☐ Cell phone with internet (like an iPhone or Galaxy) 

☐ Cell phone without internet 

☐ Game device (like a Nintendo DS) 

☐ iPod or MP3 player 

☐ Camera 

☐ Augmentative Communication Device 

☐ Other (please list) _____

☐ I do not use technology in school.

Access to Technology at My School

4) I am allowed to use technology at school.

☐ Yes ☐ No

5) There are people in my school who help me learn to use technology.

☐ Yes ☐ No

6) My school provides technology tools for me to use in school.

☐ Yes ☐ No

My Opinions about Using Technology at School

7) Technology makes learning easier.

☐ Yes ☐ No

8) Technology makes learning fun.

☐ Yes ☐ No

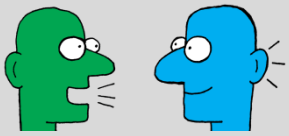
9) Using technology to learn is hard.

☐ Yes ☐ No

10) I like having my phone so I can contact my parent(s) if I want or need to.

☐ Yes ☐ No ☐ I don't have a phone

Technology to Communicate or Socialize



11) Check off ***ALL*** the ways you use technology to talk or to socialize.

☐ email 

☐ phone

☐ text 

☐ Facebook 

☐ Skype 

☐ Augmentative Communication Device 

☐ Other (please list)_____

☐ I don't use technology to communicate or socialize

Technology At Home

12) Check off ALL the ways you use technology at home?

☐ to talk to family and friends 

☐ to look things up on the internet 

☐ to play video games 

☐ to watch videos

☐ to wake me up in the morning 

☐ other _____

☐ I do not use technology at home

CSESA Technology Survey-Student Version

Instructions for Assessors

This survey is a part of the CSESA Supplemental Study on Technology Use in High Schools by and for students with ASD. The purpose of the student version is to learn more about what types of technology teens with ASD are using and all the ways they are using technology to learn and increase their independence.

In order to maximize the accuracy of the responses, please read the questions aloud to the students to help them attend to all response options. Students take so many multiple choice tests that many have developed the habit of finding the first correct answer and moving to the next question. In this survey, many of the questions ask for students to check all responses that apply. There are some “other, please list” response options. Assessors may write in the responses as dictated by the student. Before beginning the survey, place the sheet of technology visuals in front of the student and say something like:

“For this survey, you will be asked about how you use technology. Technology can mean a lot of things, but for this survey, technology will mean electronic technology. Take a minute to look at examples of this type of technology.”

How to decide which survey version to use?

The adapted version is for students who have a low elementary comprehension level.

APPENDIX F. QUALITATIVE INTERVIEW PROTOCOL

I'm going to ask you some questions. When I use the word "technology", I am mostly thinking about computers and laptops as well as tablet devices (like iPads) and smartphones.

I am asking you these questions because I want to understand **what you think are the good things and bad things about using technology.**

First of all, I would like you to write down all the WAYS you use technology. Just list these things below. I included some times of day to help you remember. It's ok if the list is long. Take your time and start by thinking about:

When you wake up in the morning-
When you go to school-
In each of your classes-
Between your classes-
At lunch-
After school in the afternoon-
Then in the evening, up until you go to bed-

Question 1. Now look at the list you made above. Tell me the 3 MOST helpful ways you use technology at SCHOOL and describe WHY it is helpful. You don't have to have 3, you might have more or less, it's okay, but try for 3.

Here's an example: I use my laptop to type up my notes in history class which is helpful because my handwriting is not very good and the teacher might have trouble reading it. Then I can keep track of my notes on the laptop rather than have a bunch of papers to keep track of.

(*full sentences please*)

1.
2.
3.

Question 2. Tell me about the 3 LEAST helpful ways you use technology at SCHOOL and then describe WHY it is NOT helpful. You don't have to have 3, you can have more or less.

Here's an example: I have a cell phone and I keep using it during class to play Angry Birds. My teacher gets really angry about this and that's probably why my grade is not too good.

(*full sentences please*)

1.
2.
3.

Question 3. Now do the same thinking about technology use at home. Look at the list you made above. Tell me the 3 MOST helpful ways you use technology at HOME and then describe WHY it is helpful.
Here's an example: I use my smartphone to text my friends and send them pictures of my cat doing silly things. This is helpful because my friends don't live near me and I don't get to see them much after school. Then I'm not so bored at home.
(*full sentences please*)
1.
2.
3.
Question 4. Tell me about the 3 LEAST helpful ways you use technology at HOME and then describe WHY it is NOT helpful. You can have more or less than 3.
Here's an example: I like to play video games after school and sometimes I forget to do my homework. This isn't helpful because then I get bad grades.
(*full sentences please*)
1.
2.
3.

Question 4. How would you describe your social life? (*full sentences please*)
Question 5. Some people think using technology improves their social life because they can be in touch with lots of people very often. Other people feel it can get in the way of making friends because texting and email are not the same as spending time in person.
Do you think your social life is better or worse because you use technology?

Tell me some reasons why you chose that response (use details or examples please).
(*full sentences please*)
1.

2.

3
Question 6. Technology can be a **DISTRACTION** for a lot of people by taking their attention away from what they are supposed to be doing like school work, chores, even sleeping.
Is this a problem for you at SCHOOL?
Explain why you chose that response (*full sentences please*):

If technology can be a distraction for you at **SCHOOL**, describe things you do to keep it from distracting you. (*full sentences please*)

Is this a problem for you at HOME?
Explain why you chose that response (*full sentences please*):

If technology can be a distraction for you at **HOME**, describe things you do to keep it from distracting you. (*full sentences please*)

Question 7. BELOW ARE SOME STATEMENTS. Please read them and respond using full sentences.
Some students say, “I can use technology as much as I want or need to at school to help me learn. “ Does that sound like you? Explain why.
Some students say, “There are people at school who help me learn new ways to use technology to help me stay organized and to be successful.” Does that sound like you? Explain why.
Some students say “I know more about technology than my teachers, I have to show them how to use it” – what do you think about that?
Question 8. Are there things that are keeping you from using technology more to help you learn at school? If so, could you please describe what they are?
Question 9: Who helps you learn ways to use technology to help you stay organized or to learn? (Can have more than one response)

Is there anything else you want to tell me about technology and its role in your life?

APPENDIX G. PARENT RECRUITMENT EMAIL

Dear parent,
You are being contacted because your child is enrolled in the Center on Secondary Education for Students with Autism Spectrum Disorder (CSESA) research study at his/her high school.
We would like to know if your child would be interested to participate in an additional study on the use of technology by high school students with autism. The purpose of this study is to gain insight into the different ways students with autism are using technology and if they perceive its use as beneficial. Possible barriers to their use of technology will also be addressed such as access to computers at school, or school rules regarding technology use.
Students can choose to participate by email or by phone. It should take between 20-60 minutes of their time.
Students who participate will be emailed a $20 Amazon gift card upon completion of the questions.

If you are interested to have your child participate, please click on this link where you can read more about the study and give your permission. You will also be asked to provide an email address for your child so they may give their permission as well.

https://unc.az1.qualtrics.com/SE/?SID=SV_0BuGmws8rUtsEW9

Please feel free to respond to this email to ask any questions you might have about this study.
Susan Hedges
Research Assistant
CSESA

Addendum to Parental Permission for your Child to Participate in a Research Study

University of North Carolina at Chapel Hill
Parent Consent and Parental Permission for a Minor Child to Participate in a Research Study – CSESA Group

IRB Study # 13-3002
Title of Study: CSESA Project
Principal Investigators: Kara Hume and Sam Odom (University of North Carolina at Chapel Hill)
Principal Investigator Department: FPG Child Development Center
Principal Investigator Phone number: 919-843-2291
Principal Investigator Email Address: kara.hume@unc.edu
Co-Investigators: Leann Smith (University of Wisconsin at Madison), Laura Hall and Bonnie Kraemer (San Diego State University)
Funding Source and/or Sponsor: U.S. Department Of Education (DoEd)

Your child is already taking part in the CSESA study. You are receiving this addendum because we are interested in getting more information from a sub-group of teens in the CSESA study about technology. To join this part of the study is voluntary. You or your child may refuse to join.

What is the new information about the study? During this study, your child will either complete an email interview questionnaire or respond to interview questions by phone. The questions are about your child's use of technology at school and at home. If your child chooses to participate by email, an email with the questions will be sent directly to your child and he or she will need to respond to the questions in that email within one week of receipt. If your child's responses are one-word responses, or are unclear, the researcher will send a follow-up email asking for clarification. If your child chooses to participate by phone, he or she will be contacted by a researcher by phone and asked the same series of questions. The researcher will make three attempts to reach your child by phone at an agreed upon time. Both methods should take between 20 and 60 minutes. The phone interview will be recorded so the responses can be transcribed.

Will your child receive anything for being in this study? Will it cost anything? Your child will receive a $20 Amazon gift card for participating in this study. It will be emailed to your child upon completion of the interview (either by phone or by email). There are no costs associated with being in the study.

What if you have questions about this part of the study? You have the right to

ask, and have answered, any questions you may have about this research. Contact Susan Hedges by email (hedges@live.unc.edu) or phone (919-843-9078) with any questions, complaints, or concerns you may have.

What if you have questions about your child's rights as a research participant? All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns, or if you would like to obtain information or offer input, please contact the Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu.

I have read the information regarding the study. I have asked all the questions I have at this time.

APPENDIX I. STUDENT RECRUITMENT EMAIL

Dear student,
You are being contacted because you are already a part of the CSESA study and your parent has agreed for you to participate in a brief study on high school students' use of technology like cell phones, computers, and tablet devices.
We will get information through an interview. You can choose to participate in the interview by email or by phone. It will take approximately 20-60 minutes to complete the interview.
If you complete all the questions and use full sentence responses, you will be emailed a $20 Amazon gift card.

If you are interested to participate, please click the link below where you can read more about the study and give your permission by checking a box that says you agree. Then you can decide if you want to participate by email or by phone.

https://unc.az1.qualtrics.com/SE/?SID=SV_783yu5Nu27KYhet

If you have any questions, you can ask them by responding to this email.
Thanks!
Susan Hedges
Research Assistant
UNC

APPENDIX J. ADDENDUM TO CSESA STUDENT ASSENT

Addendum to Assent to Participate in a Research Study

University of North Carolina at Chapel Hill
Parent Consent and Parental Permission for a Minor Child to Participate in a Research Study – CSESA Group

IRB Study # 13-3002
Title of Study: CSESA Project
Principal Investigators: Kara Hume and Sam Odom (University of North Carolina at Chapel Hill)
Principal Investigator Department: FPG Child Development Center
Principal Investigator Phone number: 919-843-2291
Principal Investigator Email Address: kara.hume@unc.edu
Co-Investigators: Leann Smith (University of Wisconsin at Madison), Laura Hall and Bonnie Kraemer (San Diego State University)
Funding Source and/or Sponsor: U.S. Department Of Education (DoEd)

You are already taking part in the CSESA study. We want to get more information about technology from a small group of teens in the CSESA study. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

What is the new information about the study? During this small part of the larger study, you will complete either an email interview or a phone interview about your thoughts on using technology both at school and at home. Your participation should take between 20-60 minutes. If you choose to participate by email, you will need to respond to the questions within one week of receiving them. If you choose to respond by phone, you will have one week from the date you sign this agreement to complete the interview.

Will you receive anything for being in this study? Will it cost anything? You will receive a $20 Amazon gift card for participating in this study. It will be emailed to you upon completion of the questions either by email or phone.

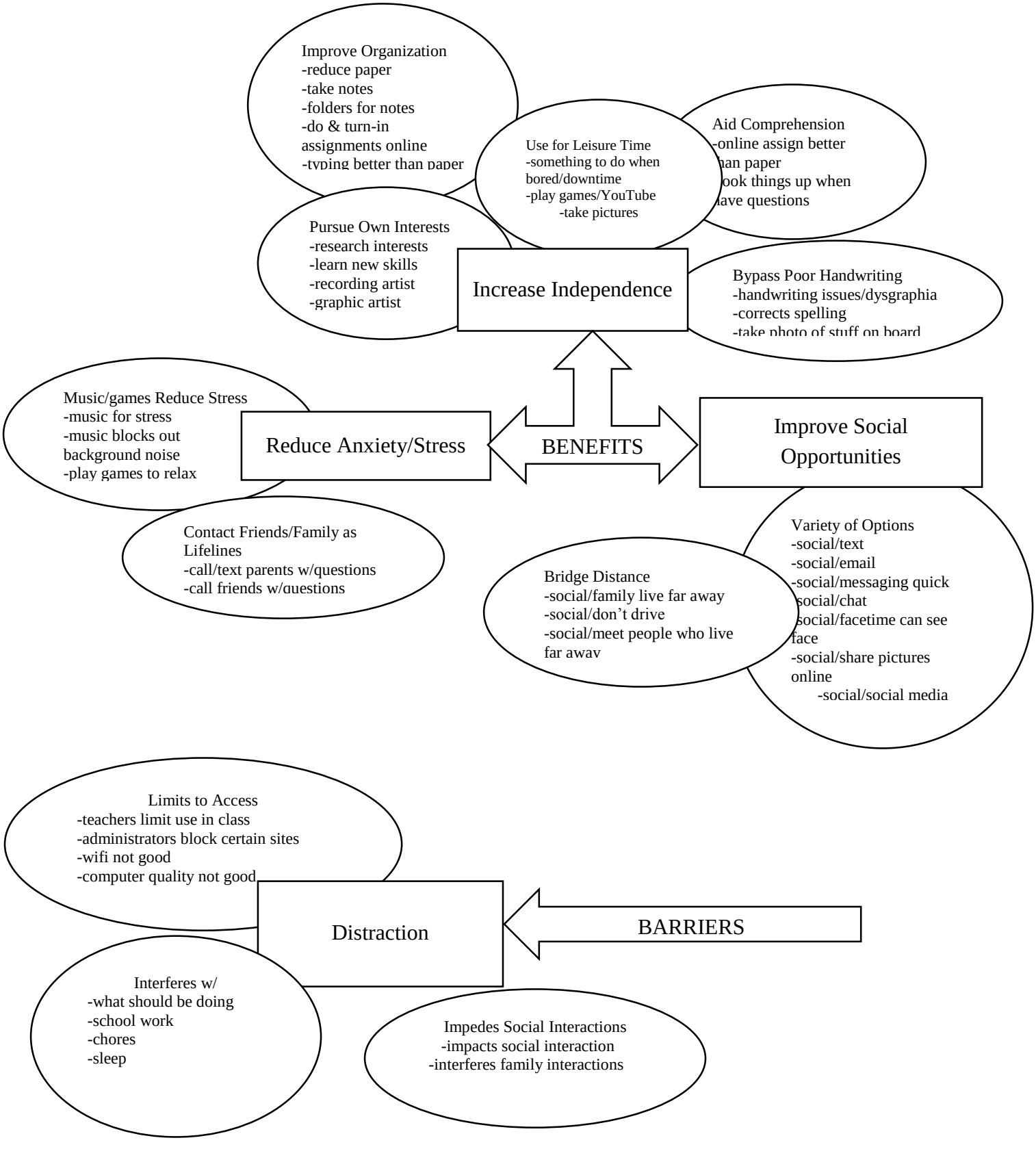
What if you have questions about this part of the study? You have the right to ask, and have answered, any questions you may have about this research. If you have questions about this part of the study, contact Susan Hedges by email (hedges@live.unc.edu) or phone (919-843-9078) with any questions, complaints, or concerns you may have.

What if you have questions about your rights as a research participant? All research on human volunteers is reviewed by a committee that works to protect your

rights and welfare. If you have questions or concerns, or if you would like to obtain information or offer input, please contact the Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu.

I have read the information provided above. I have asked all the questions I have at this time.

APPENDIX K. DIAGRAM OF QUALITATIVE CODES



REFERENCES

Aagaard, J. (2015). Drawn to distraction: A qualitative study of off-task use of educational technology. *Computers & Education, 87*, 90-97.

Aakash, T., Fiore, V., Fischer, B. (2015). Cyber-slacking in the classroom: Potential for digital distraction in the new age. Computers & Education, 87, 90-97. doi: 10.1016/j.compedu.2014.11.009

Allen, K. D., Burke, R. V., Howard, M. R., Wallace, D. P., & Bowen, S. L. (2012). Use of audio cuing to expand employment opportunities for adolescents with autism spectrum disorders and intellectual disabilities. *Journal of Autism and Developmental Disabilities, 42,* 2410-2419. doi: 10.1007/s10803-012-1519-7

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Asperger, H. (1991). Die autistischen psychopathen imkindesalter. In U. Frith (Ed, & Trans.), Autism and Asperger syndrome (pp. 37-92). New York: Cambridge University Press. (Original work published in 1944)

Ayres, K., Mechling, L. & Sansosti, F. (2013). The use of mobile technologies to assist with life skills/independence of students with moderate/severe intellectual disability and/or autism spectrum disorders: Considerations for the future of school psychology. *Psychology in the Schools, 50*(3), 259-271. doi: 10.1002/pits.21673

Bagatell, N. (2010). From cure to community: Transforming notions of autism. *Journal of the Society for Psychological Anthropology*, *38(*1), 33-55. doi: 10.1111/j/1548-1352.2009.0108-.x

Baio, J. (2014). Prevalence of autism spectrum disorder among children aged 8 years: Autism and developmental disabilities monitoring network, 11 sites, United States, 2010, *63*, 1-21. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6302a1.htm?s_cid=ss6302a1_

Baranek, G. T., Little, L. M., Diane Parham, L., Ausderau, K. K., & Sabatos-DeVito, M. G. (2014). Sensory features in autism spectrum disorders. *Handbook of Autism and Pervasive Developmental Disorders, Fourth Edition*. doi: 10.1002/9781118911389.hautc16

Baron-Cohen, S. (1995). Mindblindness: An essay on autism and theory of mind. Boston: MIT Press/Bradford Books.

Bellani M., Fornasari L., Chittaro L., Brambilla P. (2011). Virtual reality in autism: state of the art. *Epidemiology and Psychiatric Sciences, 20*, 235-238. doi: 10.1017/S2045796011000448

Benford, P., & Standen, P. J. (2011). The use of email-facilitated interviewing with higher functioning autistic people participating in a grounded theory study. *International Journal of Social Research Methodology, 14*(5), 353-368. doi:10.1080/13645579.2010.534654

Benford, P. (2008). *The use of internet-based communication by people with autism* (Doctoral thesis, University of Nottingham, Nottingham, UK). Retrieved from http://etheses.nottingham.ac.uk/661/1/thesis_post_viva_version_2.pdf

Bennett, K. D., Ramasamy, R., & Honsberger, T. (2013). Further examination of covert audio coaching on improving employment skills among secondary students with autism. *Journal of Behavioral Education, 22,* 103-119. doi: 10.1007/s 10864-013-9168-2

Bereznak, S., Ayres, K. M., Mechling, L. C., & Alexander, J. L. (2012). Video self-prompting and mobile technology to increase daily living and vocational independence for students with autism spectrum disorders. *Journal of Developmental and Physical Disabilities, 24,* 269-285. doi: 10.1007/s10882-012-9270-8

Bhat, A., Landa, R., & Galloway, J. (2011). Current Perspectives on Motor Functioning in Infants, Children, and Adults with Autism Spectrum Disorders. *Physical Therapy, 91*(7), 1116-1129. doi: 10.2522/ptj.20100294

Blume, H. (1997). Connections: Autistics are communicating in cyberspace. New York Times, Retried from http://www.nytimes.com/1997/06/30/business/autistics-freed-from-face-to-face-encounters-are-communicating-in-cyberspace.html

Blumberg, S. J., Bramlett, M. D., Kogan, M. D., Schieve, L. A., Jones, J. R., & Lu, M. C. (2013). Changes in prevalence of parent-reported autism spectrum disorder in school-aged U.S. children: 2007 to 2011-2012. *National Health Statistics Report*, (65), 1-12.

Bondy, A., & Frost, L. (1994). The picture exchange communication system. *Focus on Autistic Behavior, 9,* 1–19.

Bolte, S. (2014). The power of words: Is qualitative research as important as quantitative research in the study of autism? *Autism, 18*(2), 67-68. doi: 10.1177/1362361313517367

Bolte, S., Golan, O., Goodwin, M. & Zwigenbaum, L. (2010). What can innovative technologies do for autism spectrum disorders? *Autism, 14,* 155-159. doi: 10.1177/1362361310365028

Bottema-Beutel, K., Mullins, T. S., Harvey, M.N., Gustafson, J. R., & Carter, E. W. (2015). Avoiding the "brick wall of awkward": Perspectives of youth with autism spectrum

disorder on social-focused intervention practices. *Autism*, doi: 10.1177/1362361315574888

Brantlinger, E., Jimenez, R., Klingner, J., Pugach, M., & Richardson, V. (2005). Qualitative studies in special education. *Exceptional Children, 71,* 195-207.

Burgstahler, S. (2003). The role of technology in preparing youth with disabilities for postsecondary education and employment. Journal of Special Education Technology, 18(4),7-19.

Canadian Association for Occupational Therapy. (2012). *CAOT position statement on assistive technology and occupational therapy.* Ottawa, Ontario, Canada: Author. Retrieved from https://www.caot.ca/default.asp?pageid=4184

Capo, B. & Orellana, A. (2011). Web 2.0 Technologies for classroom instruction: High school teachers' perceptions and adoption factors. *Quarterly Review of Distance Education, 12*(4), 235-253.

Carter, E., Boehm, T., Biggs, E., Annandale, N., Taylor, C., Loock, A., & Liu, R. (2015). Known for my strengths: Positive traits of transition-age youth with intellectual disability and/or autism. *Research and Practice for Persons with Severe Disabilities*, 1-19. doi: 10.1177/1540796915592158

Centers for Disease Control and Prevention (CDC) (2014). Prevalence of autism spectrum disorder among children aged 8 years-Autism and developmental disabilities monitoring network, 11 sites, United States, 2010. MMWR Surveillance Summaries, 63(2), 1–21.CDC 2015 http://www.cdc.gov/ncbddd/developmentaldisabilities/features/birthdefects-dd-keyfindings.html

Cihak, D., Fahrenkrog, C., Ayres, K. M., & Smith, C. (2009). The use of video modeling via a video iPod and a system of least prompts to improve transitional behaviors for students with autism spectrum disorders in the general education classroom. *Journal of Positive Behavior Interventions*, 12(2), 103–115. doi: 10.1177/1098300709332346.

Clark, B. G., Magill-Evans, J. E., & Koning, C. J. (2015). Youth with autism spectrum disorders: Self- and proxy-reported quality of life and adaptive functioning. *Focus on Autism and Other Developmental Disabilities, 30(1),* 57-64. doi: 0.1177/1088357614522289

Cosden, M., Koegel, L., Koegel, R., Greenwell, A., & Klein, E. (2006). Strength-based assessment for children with autism spectrum disorders. *Research & Practice for Persons with Severe Disabilities, 31*(2), 134-143.

Courchesne, V., Meilleur, A., Lord, M., Dawson, M., & Soulieres, I. (2015). Autistic children at risk of being underestimated: School-based pilot study of strength-informed assessment. *Molecular Autism.* doi: 10.1186/s13229-015-0006-3

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

Creswell, J.W., Plano Clark, V., Gutmann, M., & Hanson, W. (2003). Advanced mixed methods designs. In A. Tashakkori & C. Teddlie (Eds.), Handbook of mixed method research in the social and behavioral sciences (pp. 209-240). Thousand Oaks, CA: Sage.

Creswell. J.W. (2015) *A concise introduction to mixed methods research*. Los Angeles, CA: Sage.

CSESA Technology Working Group. (2013). *Definition of technology for adolescents with Autism Spectrum Disorders.* Chapel Hill, NC: Center on Secondary Education for Students with Autism Spectrum Disorder.

Damiano, C., Mazefsky, White, S., & Dichter, G. (2014). *Journal of Clinical Child & Adolescent Psychology, 43*(5), 828-843. doi:10.1080/15374416.2014.945214

Daniel, L.S. & Billingsley, B. S. (2010). What boys with an autism spectrum disorder say about establishing and maintaining friendships. *Focus on Autism and Other Developmental Disabilities, 25(4),* 220–229. doi: 10.1177/1088357610378290

DiGennaro Reed FD, Hyman SR and Hirst JM (2011) Applications of technology to teach social skills to children with autism. *Research in Autism Spectrum Disorders,* 5(3): 1003-1010. doi:10.1016/j.rasd2-011-01-022

Dillman, D.A., Smyth, J.D., & Christian, L.M. (2009). *Internet, mail, and mixed-mode surveys: The tailored design method.* New Jersey: John Wiley & Sons, Inc.

Domings, Y., Crevecoeur, Y. & Ralabate, P. Universal design for learning: Meeting the needs of learners with autism spectrum disorders. In K. Boser, M. Goodwin, & S. Wayland (Eds.), Technology tools for students with autism (pp. 21-42).

Elsabbagh, M., Yusuf, A., Prasanna, S., Shikako-Thomas, K, Ruff, C., & Fehlings, M. (2014). Community engagement and knowledge translation: Progress and challenges in autism research. Autism, 18, 771-781. doi: 10.1177/1362361314546561

Engelhardt, C. & Mazurek, M. (2014). Video game access, parental rules, and problem behavior: A study of boys with autism spectrum disorder. *Autism, 18*(5), 529-537. doi: 10. 1177/1362361313482053

Erdődi, L., Lajiness-O'Neill, & Schmitt, T. (2013). Learning curve analyses in neurodevelopmental disorders: are children with autism spectrum disorder truly visual learners? *Journal of autism and developmental disorders 43*(4), 880-890. doi: 10.1007/s10803-012-1630-9

Faja, S., Aylward, E., Bernier, R., & Dawson, G. (2008). Becoming a face expert: A computerized face-training program for high-functioning individuals with autism spectrum disorders. *Developmental Neuropsychology*, *33*, 1-24. doi: 10.1080/87565640701729573

Feeley, C., Deka, D., Lubin, A. & McGackin, M. (2015). *Detour to the right places: A study with recommendations for addressing the transportation needs and barriers of adults on the autism spectrum in New Jersey*. New Jersey: Rutgers.

Fletcher-Watson, S. (2014). A targeted review of computer-assisted learning for people with autism spectrum disorder: Toward a consistent methodology. *Review of Research in Autism and Developmental Disorders, 1*, 87-101. doi: 10.1007/s40489-013-0003-4

Fletcher-Watson, S., & Durkin, K. (2015). Uses of new technologies by young people with neurodevelopmental disorders: Motivations, processes and cognition. In J. Van Herwegen, D. Riby, (Eds.), *Neurodevelopmental disorders: Research challenges and solutions* (pp. 243-267). New York, NY, US: Psychology Press.

Fogg, B. J., Lee, E., & Marshall, J. (2002). Interactive technology and persuasion. In J. Dillard & M. Pfau (Eds.), *The persuasion handbook: Developments in theory and practices*. Thousand Oaks, CA: Sage. Retrieved from http://knowledge.sagepub.com/view/hdbk_persuasion/n34.xml

Foster, N. E., Ouimet, T., Tryfon, A., Doyle-Thomas, K., Anagnostou, E., & Hyde, K. L. (2016). Effects of Age and Attention on Auditory Global–Local Processing in Children with Autism Spectrum Disorder. *Journal of autism and developmental disorders*, 1-14. doi: 10.1007/s10803-015-2684-2

Fowler, F. (2014). *Survey research methods*. Thousand Oaks, CA: Sage.

Frith, U., & Happé, F. (1994). Autism: Beyond "theory of mind." *Cognition*, *50*(1), 115–132.

Gentry, T., Wallace, J., Kvarfordt, C., & Lynch, K. B. (2010). Personal digital assistants as cognitive aids to high school students with autism: Results of a community-based trial. *Journal of Vocational Rehabilitation, 32*, 101-107. doi: 10.3233/JVR-2010-0499

Gerhardt, P. F., & Lainer, I. (2011). Addressing the needs of adolescents and adults with autism: A crisis on the horizon. *Journal of Contemporary Psychotherapy*, *41*(1), 37-45. doi: 10.1007/s10879-010-9160-2

Gersten, R., Fuchs, L. S., Compton, D., Coyne, M., Greenwood, C., & Innocenti, M. S. (2005). Quality indicators for group experimental and quasi-experimental research in special education. *Exceptional Children, 71,* 149-164. doi: 10.1177/001440290507100202

Gillespie-Lynch, K., Kapp, S.K., Shane-Simpson, C., Smith, D.S. & Hutman, T. (2014). Intersections between the autism spectrum and the internet: Perceived benefits and preferred functions of computer-mediated communication. *Intellectual and Developmental Disabilities, 52(6),* 456-469. doi: 10.1352/1934-9556-52.6.456

Golan, O., & Baron-Cohen, S. (2006). Systemizing empathy: Teaching adults with Asperger syndrome or high-functioning autism to recognize complex emotions using interactive multimedia. *Development and Psychopathology, 18,* 591-617. doi: 10.1017/S0954579406060305

Grandin, T. (1995). *Thinking in pictures and other reports from my life with autism.* New York: Vintage Books.

Groves, R. (1989). *Survey costs and survey errors*. New York: Wiley.

Grynszpan, O., Weiss, P.L., Perez-Diaz, F., Gal, E. (2014). Innovative technology based interventions for Autism Spectrum Disorders: A meta-analysis. *Autism, 18(4), 346-361.* doi: 10.1177/1362361313476767.

Haigh, S., Heeger, D., Dinstein, I, Minshew, N. & Behrmann, M. (2015). Cortical variability in the sensory-evoked response in autism. *Journal of Autism and Developmental Disorders, 45,* 1176-1190. doi: 10.1007/s10803-014-2276-6

Hall, T. E., Meyer, A., & Rose, D. H. (2012). *Universal Design for Learning in the Classroom: Practical Applications. What Works for Special-Needs Learners Series*.New York: Guilford Publications.

Happe, F.G.E. (1993). Communicative competence and theory of mind in autism: A test of relevance theory. *Cognition, 48,* 101-119.

Hare, D., Gracey, C., & Wood, C. (2015). Anxiety in high-functioning autism: A pilot study of experience sampling using a mobile platform. *Autism.* doi: 10.1177/1362361315604817

Heijst, B. & Geurts, H. (2015). Quality of life in autism across the lifespan: A meta-analysis. *Autism, 19(*2), 158-167. doi: 10.1177/1362361313517053

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71,* 165-179. doi: 10.1177/001440290507100203

Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult Outcome for Children with Autism. *Journal of Child Psychology and Psychiatry, 45*(2), 212-229.

Hume, K., Boyd, B., Hamm, J. & Kucharczyk, S. (2014). Supporting independence in adolescents on the autism spectrum. *Remedial and Special Education, 35*(2), 80-90. doi: 10.1177/0741932513514617

Humphrey, N., & Symes, W. (2010). Perceptions of social support and experience of bullying among pupils with autism spectrum disorders in mainstream secondary schools. *European Journal of Special Needs Education, 25*, 77-91.

Individuals with Disabilities Education Improvement Act of 2004. 108-446, 118 Stat. 2647 (2004).

Ingersoll, B. & Wainer, A. (2013). Initial efficacy of project ImPACT: A parent-mediated social communication intervention for young children with ASD. *Journal of Autism and Developmental Disorders, 43,* 2943–2952. doi: 10.1007/s10803-013-1840-9

Ivankova, N., Creswell, J. & Stick, S. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods, 18(*1), 3-20. doi: 10.1177/1525822x05282260

Kagohara, D. M., van der Meer, L., Achmadi, D., Green, V. A., O'Reilly, M. F., Mulloy, A., ... Sigafoos, J. (2010). Behavioral intervention promotes successful use of an iPod-based communication device by an adolescent with autism. *Clinical Case Studies, 9*, 328-338. doi: 10.1177/1534650110379633

Kaldy, Z., Giserman, I, Carter, A, & Blaser, E. (2013). The mechanisms underlying the ASD advantage in visual search. *Journal of Autism and Developmental Disabilities*. doi: 10.1007/s10803-013-1957-x

Kalyva, E. (2010). Multirater congruence on the social skills assessment of children with Asperger syndrome: Self, mother, father, and teacher ratings. *Journal of Autism and Developmental Disorders, 40*, 1202–1208. doi: 10.1007/s10803-010-0978-y

Keintz, J., Goodwin, M.S., Hayes, G., & Abowd, G. (2014). Interactive Technologies for Autism. In *Synthesis Lectures on Assistive, Rehabilitative, and Health-Preserving Technologies.* (Vol.2, Issue 2, pp. 1-177). Morgan & Claypool. doi: 10.2200/s00533ed1v01y201309arh004

King, A. M., Thomeczek, M., Voreis, G., & Scott, V. (2014). iPad (R) use in children and young adults with Autism Spectrum Disorder: An observational study. *Child Language Teaching and Therapy, 30*(2), 159–173. doi: 10.1177/0265659013510922

Kirby, A., Dickie, V. & Baranek, G. (2015). Sensory experiences of children with autism spectrum disorder: In their own words. *Autism, 19(3),* 316-326. doi: 10.1177/1362361314520756

Knight V., McKissick B.R. & Saunders, A. (2013). A review of technology-based interventions to teach academic skills to students with autism spectrum disorder. *Journal of Autism and Developmental Disorders 43*(11): 2628-2648. doi: 10.1007/s1083-013-1814-y

Kratochwill, T. R., Hitchcock, J. H., Horner, R. H., Levin, J. R., Odom, S. L., Rindskoff, D. M., Shadish, W. R. (2013). Single-case intervention research design standards. *Remedial and Special Education, 34,* 26-38. doi: 1 0.1177/0741932512452794

Kraushaar, J. & Novak, D. (2010). Examining the effects of student multitasking with laptops during the lecture. *Journal of Information Systems Education, 21*(2), 241-251.

Kuo, M., Orsmond, G., Coster, W. & Cohn, E. (2013). Media use among adolescents with autism spectrum disorder, *Autism, 18*(8), 914-923. doi: 10.1177/1362361313497832

Leigh J.P. and J. Du (2015). Brief report: Forecasting the economic burden of autism in 2015 and 2025 in the United States. *Journal of Autism Developmental Disorders, 45*(12), 4135-4139. doi: 10.1007/s10803-015-2521-7

Leitner, Y. (2014). The Co-Occurrence of Autism and Attention Deficit Hyperactivity Disorder in Children – What Do We Know? *Frontiers in Human Neuroscience, 8,* 268. http://doi.org/10.3389/fnhum.2014.00268

Lenhart, A., Smith, A.., Anderson, M., Duggan, M. & Perrin, A. (2015). *Teens, technology and friendships.* Retrieved from Pew Research Center website: http://www.pewinternet.org/2015/08/06/teens-technology-and-friendships/

Lenhart, A. (2007). *Cyberbullying and online teens*. Retrieved from Pew Research Center website: http://www.pewinternet.org/2007/06/27/cyberbullying/

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

Locke, J., Ishijima, E. H. & Kasari, C. (2010). Loneliness, friendship quality and the social networks of adolescents with high-functioning autism in an inclusive school setting. Journal of research in Special Educational Needs, 10, 74-81. doi: 10.1111/j.1471-3802.2010.01148.x

MacMullin, J.A., Lunsky, W., & Weiss, J.A. (2015). Plugged in: Electronics use in youth and young adults with autism spectrum disorder. *Autism.* doi: 0:1177/1362362361314566047

Madden, M., Lenhart, A., Duggan, M., Cortesi, S., & Gasser, U. (2013). *Teens and technology 2013.* Washington, DC: Pew Research Center's Internet & American Life Project. Retrieved from http://www.pewinternet.org/Reports/2013/Teens-and-Tech.aspx

Mayes, S. D., & Calhoun, S. L. (2007). Learning, Attention, Writing, and Processing Speed in Typical Children and Children with ADHD, Autism, Anxiety, Depression, and Oppositional-Defiant Disorder. *Child Neuropsychology*, *13*(6), 469-493. doi: 10.1080/09297040601112773

Muyingi, H. (2014). Factors contributing to technology-enabled distractions in the classroom: a case study of students at the Polytechnic of Namibia. *NAWA Journal of Communication, 8*(1), 1-17.

Mazurek, M. & Engelhardt, C. (2013). Video game use and problem behaviors in boys with autism spectrum disorders. *Research in Autism Spectrum Disorders, 7,* 316-324. doi: 10.1016/j.rasd.2012.09.008

Mazurek, M.O., Shattuck, P. T., Wagner, M., & Cooper, B. P. (2012). Prevalence and correlates of screen-based media use among youths with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 42,* 1757-1767. doi: 10.1007/s10803-011-1413-8

Mazurek, M. & Wenstrup, C. (2013). Television, videogame and social media use among children with ASD and typically developing siblings. *Journal of Autism and Developmental Disorders,* doi: 10.1007/s10803-012-1659-9

Mechling, L. C. (2011). Review of twenty-first century portable electronic devices for persons with moderate intellectual disabilities and autism spectrum disorders. *Education and Training in Autism and Developmental Disabilities, 46,* 479-498.

Mechling, L. C., Gast, D. L., & Cronin, B. A. (2006). The effects of presenting high-preference items, paired with choice, via computer-based video programming on task completion of students with autism. *Focus on Autism and Other Developmental Disabilities, 21*(1), 7-13.

Merriam, S.B. (1998). *Qualitative research and case study applications in education*, San Francisco, CA: Jossey-Bass.

Milton, D., Mills, R., & Pellicano, E. (2014). Ethics and autism: Where is the autistic voice? *Journal of Autism and Developmental Disorders, 44*(10), 2650-2651. doi: 10.1007/s10803-012-1739-x

Mineo, B., Ziegler, W., Gill, S. & Salkin, D. (2009). Engagement with electronic screen media among students with autism spectrum disorders. *Journal of Autism and Developmental Disorders 39*(1): 172-187. doi:10.1016/j.compedu.2012.11.006

Morse (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing Research, 40,* 120-123.

Myles, B. S., Ferguson, H., & Hagiwara, T. (2007). Using a personal digital assistant to improve the recording of homework assignments by an adolescent with Asperger syndrome. *Focus on Autism and Other Developmental Disabilities*, *22*(2), 96-99.

Napoli, E., Wong, S., Hertz-Picciotto, I., & Giulivi, C. (2014). Deficits in bioenergetics and impaired immune response in granulocytes from children with autism. *Pediatrics, 133*(5), E1405-E1410. doi:10.1542/peds.2013-1545

National Longitudinal Transition Study-2 (NLTS2) (n.d.). Retrieved on May 17, 2013 from http://www.nlts2/org/fact-sheets/index.html

National Professional Development Center on ASD. (2013). Evidence-based practice briefs. Retrieved from http://autismpdc.fpg.unc.edu/

Newman, L. (April 2007). *Facts from NLTS2: Secondary school experiences of students with autism*. Menlo Park, CA: SRI International. Retrieved from http://ies.ed.gov/pubsearch/pubsinfo.asp?pubid=NCSER20073005

NVivo for Mac [qualitative data analysis software]; QSR International Pty Ltd. Version 10, 2014.

Odom, S., Thompson, J., Hedges, S., Boyd, B., Dykstra, J., Duda, M., Szidon, K., Smith, L., & Bord, A. (2015). Technology-aided interventions and instruction for adolescents with autism spectrum disorder. *Journal of Autism and Developmental Disabilities. 45*(12), *3805-3819.* doi: 10.1007/s10803-014-2320-6

O'Malley, P., Lewis, M., Donehower, C. (2013, April). Using tablet computers as instructional tools to increase task completion by students with autism. American Educational Research Association, San Francisco, CA.

Orsmond, G.I. & Kuo, H. (2011). The daily lives of adolescents with an autism spectrum disorder: Discretionary time use and activity partners. *Autism 15*(5): 579-599. doi: 10.1177/1362361310386503

Orsmond, G. I., Shattuck, P. T., Cooper, B. P., Sterzing, P. R., & Anderson, K. A. (2013). Social participation among young adults with an autism spectrum disorder. *Journal of autism and developmental disorders*, *43*(11), 2710-2719. doi: 10.1007/s10803-013-1833-8

Palmen, A., Didden, R. & Verhoeven, L. (2012). A personal digital assistant for improving independent transitioning in adolescents with high-functioning autism spectrum

disorder. *Developmental Neurohabilitation, 15(6),* 401-413. doi: 10.3109/17518423.2012.701240

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health Services Research, 34(5),* 1189-1208.

Pellicano, L. (2014). A future made together: New directions in the ethics of autism research. *Journal of Research in Special Educational Needs, 14(*3), 200-204. doi: 10.1111/1471-3802.12070_5

Pennington, R. C. (2010). Computer-assisted instruction for teaching academic skills to students with autism spectrum disorders: A review of literature. *Focus on Autism and Other Developmental Disabilities, 25*(4), 239-248.

Pierce, N., O'Reilly, M., Sorrells, A., Fragale, C., White, P., Aguilar, J., & Cole, H. (2014). Ethnicity reporting practices for empirical research in three autism-related journals. *Journal of Autism and Developmental Disorders, 44*, 1507-1519. doi: 10.1007/s10803-014-2041-x

Ploog, B. O., Scharf, A., Nelson, D., & Brooks, P. J. (2013). Use of computer-assisted technologies (CAT) to enhance social, communicative, and language development in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 43*(2), 301-322. doi: 10.1007/s10803-012-1571-3

Porayska-Pomsta, K., Frauenberger, C., Pain, H., Rajendran, G., Smith, T., Menzies, R., ... Lemon, O. (2012). Developing technology for autism: An interdisciplinary approach. *Personal and Ubiquitous Computing, 16,* 117-127. doi: 10.1007/s00779-011-0384-2

Qualtrics (2015) Provo, Utah, Retrieved from http://www.qualtrics.com

Quill, K.A. (1997). Instructional considerations for young children with autism: The rationale for visually cued instruction. Journal of Autism and Developmental Disorders, 27(4), 697-714.

Ramdoss, S., Lang, R., Mulloy, A., Franco, J., O'Reilly, M., Didden, R., & Lancioni, G. (2011). Use of computer-based interventions to teach communication skills to children with autism spectrum disorders: A systematic review. Journal of Behavioral Education, 20(1), 55-76. doi: 10.1007/s10864-010-9112-7.

Ramdoss, S., Machalicek, W., Rispoli, M., Mulloy, A., Lang, R., & O'Reilly, M. (2012). Computer-based interventions to improve social and emotional skills in individuals with autism spectrum disorders: A systematic review. Developmental neurorehabilitation, 15(2), 119-135. doi:10.3109/17518423.2011.651655

Ramdoss, S., Mulloy, A., Lang, R., O'Reilly, M., Sigafoos, J., Lancioni, G., Didden, R., & El Zein, F. (2011). Use of computer-based interventions to improve literacy skills in

students with autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders, 5,* 1306-1318. doi:10.1016/j.rasd.2011.03.004

Ravizza, S., Hambrick, D., & Fenn, K. (2014). Non-academic internet use in the classroom is negatively related to classroom learning regardless of intellectual ability. Computers & Education, 78, 109-114. doi: 10.1016/j.compedu.2014.05.007

Richter, S., & Test, D. (2011). Effects of multimedia social stories on knowledge of adult outcomes and opportunities among transition-aged youth with significant cognitive disabilities. *Education and Training in Autism and Developmental Disabilities, 46,* 410-424.

Robertson, A. & Simmons, D. (2015). The sensory experiences of adults with autism spectrum disorder: A qualitative analysis. *Perception, 44*(5), 569-86. doi: 10.1068/p7833

Sabella, L., & Hart, J. (2014). Are There Benefits of Online Learning for Students with High-Functioning Autism Spectrum Disorders. *The Exceptional Parent*, *44*(4), 48-50.

Samson, F., Mottron, L., Soulières, I., & Zeffiro, T. A. (2012). Enhanced visual functioning in autism: An ALE meta-analysis. *Human Brain Mapping*, *33*(7), 1553-1581.

Samson, P. (2010). Deliberate engagement of laptops in large lecture classes to improve attentiveness and engagement, *Computers in Education, 20* (2), 27–38.

Sana, F., Weston, T., & Cepeda, N. (2013). Laptop multitasking hinders classroom learning for both users and nearby peers. Computers & Education, doi:10.1016/j.compedu.2012.10.003

Savin-Baden, M. & Major, C. (2013). *Qualitative research. The essential guide to theory and practice.* London, UK: Routledge.

Shane, H. C., & Albert, P. D. (2008). Electronic screen media for persons with autism spectrum disorders: Results of a survey. *Journal of Autism and Developmental Disorders, 38,* 1499-1508. doi: 10.1007/s10803-007-0527-5

Shane, H. C., Laubscher, E. H., Schlosser, R. W., Flynn, S., Sorce, J. F., & Abramson, J. (2012). Applying technology to visually supported language and communication in individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42,* 1228-1235. doi: 10.1007/s10803-011-1304-z

Shattuck, P. T., Narendorf, S. C., Cooper, B., Sterzing, P. R., Wagner, M., & Taylor, J. L. (2012). Postsecondary education and employment among youth with an autism spectrum disorder. *Pediatrics, 12,* 1042-1049. doi:10.1542/peds.2011-2864

Sikora, D., Vora, P., Coury, D., & Rosenberg, D. (2012). Attention-deficit/hyperactivity disorder symptoms, adaptive functioning, and quality of life in children with autism spectrum disorder. Pediatrics, 130(2), S91-97. doi: 10.1542/peds.2012-0900G

Silver, M., & Oakes, P. (2001). Evaluation of a new computer intervention to teach people with autism or Asperger syndrome to recognize and predict emotions in others. *Autism, 5*, 299-316. doi: 10.1177/1362361301005003007

Sreckovic, M. A., Brunsting, N. C., & Able, H. (2014). Victimization of students with autism spectrum disorder: A review of prevalence and risk factors. Research in Autism Spectrum Disorders, 8(9), 1155-1172.

STATA (version 14). Statacorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StatCorp LP.

Stephenson, K. G., Quintin, E. M., & South, M. (2015). Age-related differences in response to music-evoked emotion among children and adolescents with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, doi: 10.1007/s10803-015-2624-1

Strickland, D. C., Coles, C. D., & Southern, L. B. (2013). Jobtips: A transition to employment program for individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*. Advance online publication. doi: 10.1007/s10803-013-1800-4

Tavernor, L., Barron, E., Rodgers, J., & McConachie, H. (2013). Finding out what matters: Validity of quality of life measurement in young people with ASD. *Child: Care, Health & Development, 39*(4), 592-601. doi:10.1111/j.1365-2214.2012.01377.x

Taylor, B. A., Hughes, C. E., Richard, E., Hoch, H., & Coello, A. R. (2004). Teaching teenagers with autism to seek assistance when lost. *Journal of Applied Behavior Analysis, 37*, 79-82. doi:10.1901/jaba.2004.37-79

Test, D., Smith, L., & Carter, E. (2014). Equipping youth with autism spectrum disorders for adulthood: Promoting rigor, relevance, and relationships. *Remedial & Special Education, 35*(2), 80-90.

Thompson, B., Diamond, K., McWilliam, R., Snyder P. & Snyder, S. (2005). Evaluating the quality of evidence from correlational research for evidence-based practice. *Exceptional Children, 71(2),* 181-194.

Tourangeau, R., Rips, L., & Rasinski, K. (2000). *The psychology of survey response*. Cambridge, UK: Cambridge University Press.

Trainor, A. (2011). Commentary: Using mixed methods to transform special education research. *Learning Disability Quarterly, 34(3),* 219-221. doi: 10.1177/0731948711417560

Trembath, D.,Vivanti, G., Iacono, T., & Dissanayake, C. (2015). Accurate or assumed: Visual learning in children with ASD. *Journal of Autism and Developmental Disorders, 45*(10), 3276-3287. doi: 10.1007/s10803-015-2488-4

Trimmel, M. & Bachmann, J. (2004), Cognitive, social, motivational and health aspects of students in laptop classrooms. *Journal of Computer Assisted Learning, 20,* 151-158.

Van Laarhoven, T., Kraus, E., Karpman, K., Nizzi, R., & Valentino, J. (2010). A comparison of picture and video prompts to teach daily living skills to individuals with autism. *Focus on Autism and Other Developmental Disabilities, 25,* 195-208. doi: 10.1177/1088357610380412

Vries, M., & Geurts, H. (2015). Influence of autism traits and executive functioning on quality of life in children with an autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 45(9), 2734-2743. doi: 10.1007/s10803-015-2438-1

Wainer, A. L., & Ingersoll, B. R. (2011). The use of innovative computer technology for teaching social communication to individuals with autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*(1), 96-107. doi:10.1016/j.rasd.2010.08.002.

Wei, X., Yu, J., Shattuck, P., McCracken, M., & Blackorby, J. (2013). Science, Technology, Engineering, and Mathematics (STEM) participation among college students with an autism spectrum disorder. *Journal of Autism and Developmental Disorders, 43,* 1539-1546.

Wentz, E., Nyden, A. & Krevers, B. (2012). Development of an internet-based support and coaching model for adolescents and young adults with ADHD and autism spectrum disorders: A pilot study. *European Child & Adolescent Psychiatry, 21*(11), 611-622. doi: 10.1007/s00787-012-0297-2

White, S., Mazefsky, C., Dichter, G., Chiu, P., Richey, J., & Ollendick, T. (2014). Social-cognitive, physiological, and neural mechanisms underlying emotion regulation impairments: understanding anxiety in autism spectrum disorder. *International Journal of Developmental Neuroscience, 39,* 22-36. doi:10.1016/j.ijdevneu.2014.05.012

Winter-Messiers, M. (2007). From tarantulas to toilet brushes: Understanding the special interest areas of children and youth with asperger syndrome. Remedial and Special Education, 28(3), 140-152.

Wong, C., Odom, S. L., Hume, K. A., Cox, A., Fettig, A., Kucharczyk, S., Brock, M., Plavnick, J., Fleury, V., & Schultz, T. (2014). *Evidence-based practices in autism spectrum disorders (1990-2011).* Chapel Hill, NC: National Professional Development Center on Autism Spectrum Disorders.

Zamora, I., Williams, M., Higareda, M., Wheeler, B., & Levitt, P. (2016). Brief reports: Recruitment and retention of minority children for autism research, *Journal of Autism and Developmental Disorders, 46*(2), 698-703. doi: 10.1007/s10803-015-2603-6