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Technology use as a support tool by secondary students with autism

Susan H Hedges, Samuel L Odom, Kara Hume and Ann Sam

Abstract

The purpose of this study was to examine how secondary students with autism spectrum disorder use technology in supportive ways. In this self-report survey study, 472 adolescents with autism spectrum disorder enrolled in high school described the forms of technology they use and purposes for which they use it. Students reported the benefits as well as barriers to technology use at school. They reported using technology in school and home settings in a variety of supportive ways such as increasing their independence, reducing their anxiety, and increasing their social opportunities. Findings suggest that practitioners may benefit from learning how to integrate technology as an instructional and support tool for their students with autism spectrum disorder. Recommendations for future research are provided.

Keywords

adolescents, autism, secondary school, self-report, support, technology

Introduction

The enthusiasm surrounding the use of new technologies (e.g. smartphones, tablets) to support children and youth with autism spectrum disorder (ASD) may be due to the affinity children with ASD exhibit for such devices. Screen-based technology use is a primary and preferred discretionary activity for the majority of adolescents with ASD (Kuo et al., 2013; Mazurek et al., 2012; Orsmond and Kuo, 2011). Kuo et al. (2013) found that 98% of the teens with ASD surveyed spent approximately 5 h per day on a computer during summer months, primarily engaged in playing video games and surfing the web. 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 h per day, respectively; Mazurek and Wenstrup, 2013). Aside from its use for entertainment, little is known about other ways adolescents with ASD are using technology.

In addition to recreation, technology support tools may also accommodate social and behavioral challenges that adolescents with autism exhibit. When well designed, technology offers consistent and clearly defined tasks and visually cued instructions that can reduce misunderstandings caused by multiple verbal instructions (Grynszpan et al., 2014) and thus promote independent functioning. These features are not only important in academics but also in the work force. Virtual environments show promise as a way to practice community-based social interactions (Bellani et al., 2011). In high schools, the complex academic environment can increase demands on organizational skills, planning skills and working memory for any student, but especially for students with ASD. Recent developments in handheld devices with tools like portable checklists and reminder alarms can help increase independence in completing tasks, transitioning, and keeping appointments (Gentry et al., 2010; Myles et al., 2007; Palmen et al., 2012). Further, 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). Technology can also ameliorate the social difficulties experienced by adolescents with ASD. Social media, email, and texting can expand opportunities for social interactions and can be far less intimidating for students

University of North Carolina at Chapel Hill, USA

Corresponding author:
Susan H Hedges, Frank Porter Graham Child Development Institute, University of North Carolina at Chapel Hill, CB 8180, Chapel Hill, NC 27599-8180, USA.
Email: hedges@live.unc.edu

with ASD who often struggle to engage in face-to-face relations (Mazurek and Wenstrup, 2013).

Although the use of technology for teaching and learning is rapidly expanding in general education classrooms, the extent to which teachers and practitioners use it as a support for children and youth with disabilities has not been substantially explored (O'Malley et al., 2013). In the early 2000s, the National Longitudinal Transition Study-2 (NLTS2, n.d.) found that 74% of students with autism, despite having computers in at least some of their classrooms, "rarely" or "never" used them for academics (Newman, 2007). NLTS2 researchers collected these data nearly 15 years ago, and the ubiquitous nature of technology has changed dramatically. A greater variety of technologies is available for use in classrooms today to support all students with disabilities. However, there are no current national studies that report on technology use in school settings.

In the general population, adolescents in particular are high adopters of technology with at least 95% of all teens online and 74% accessing the internet via mobile devices such as smartphones and tablets at least occasionally (Madden et al., 2013). Adolescents with ASD are assumed to be included in these statistics and studies have corroborated their widespread use of computers and other screen-based technology (Kuo et al., 2013; MacMullin et al., 2015; Mazurek et al., 2012) as a form of entertainment. However, little is known about their use of technology for supportive purposes.

If one considers the affinity to certain forms of technology exhibited by many individuals with ASD (Mineo et al., 2009; Porayska-Pomsta et al., 2012; Shane and Albert, 2008), the way technology can address the defining characteristics of ASD (Grynszpan et al., 2014), and the role technology plays in 21st century education and society, prioritizing technology-based interventions and supports for adolescents with ASD should be high on the autism research agenda. The goal of this study is to provide insights to researchers, families and practitioners that may aid in the broader implementation and uptake of such supports for students with ASD. This study extends the literature by collecting first-person reports from adolescents with ASD about their everyday use of technologies (e.g. smartphones, laptops, tablets, and desktop computers)[1] in supportive ways across school and home settings. The specific research questions addressed in this study are as follows: (1) What forms of technology are high school students with ASD using? (2) For what purposes are they using technology? and (3) What are their perceptions of the benefits and barriers of that technology use?

Method

Procedures

Questionnaires were administered to 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 US Institute of Education Science (IES). The CSESA study is a randomized controlled trial of a comprehensive treatment model for high school students with ASD. The study involves two cohorts of schools and students with ASD, and the survey was administered approximately 1 year apart to each cohort. The survey was conducted in a total of 60 schools spread equally across three states (California, Wisconsin, North Carolina). All staff, parents, and adolescents consented to their participation and the study was conducted in compliance with the University of North Carolina's Institutional Review Board (IRB# 13-3002).

Development of the survey instrument. The survey instrument was developed using the tailored method of questionnaire design (Dillman et al., 2009). A draft of the questionnaire was circulated to three survey experts from the Odum Institute for Research in Social Science, University of North Carolina at Chapel Hill, who provided feedback on the survey design and implementation procedures. Three experts on educating adolescents with autism subsequently reviewed the survey and provided feedback on the appropriateness of the topics for the intended participants. Several changes to the questionnaire were made based on expert feedback. In addition, a modified version of the questionnaire was developed to increase participation of a broader range of students, in particular, for those students who needed additional supports to enhance comprehension. The adapted version included a reduced number of matched questions, some visual elements, and had increased font size. Some questions had a reduced number of answer choices.

Next, a pilot test of the questionnaire was conducted with six high school students with ASD to ensure the clarity and appropriateness of the individual questions (Fowler, 2014). The survey was revised based on the pilot test results. 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 questionnaire had 30 questions and the adapted version had 12. The questions were grouped into sections related to technology use at school, access to technology at school, opinions about technology use at school, using technology to communicate and socialize, and technology use at home. Most questions had multiple response options with the exception of the questions related to opinions about technology use. Opinions were gathered using statements to which a respondent could select "yes" or "no," for example, "Using technology to learn is hard." Separate open-ended questions were added to each section of the questionnaire to gain a broader understanding of the variety and specificity of the technologies being used by respondents.

Participants

The survey was administered to a total of 499 CSESA study student participants who were present on the day of the survey administration but 27 students did not complete the questionnaire. Based on the comments written on the blank questionnaire by the administrators, most of the participants who did not complete it did so because they did not understand the questions. Thus, a total of 472 questionnaires were completed and included in the analysis, representing a 95% respondent participation rate.

CSESA participants were recruited among all eligible students at their high schools by special education staff. Student participants met the following eligibility criteria: (1) a current primary or secondary designation of autism on their Individualized Education Program (IEP), (2) have at least 2 years remaining in high school, and (3) no uncorrected severe hearing or vision impairment. Under the Individuals with Disabilities Education Improvement Act (2004), autism is defined as:

> a developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before age three, that adversely affects a child's educational performance. Other characteristics often associated with autism are engagement in repetitive activities and stereotyped movements, resistance to environmental change or change in daily routines, and unusual responses to sensory experiences.

These criteria are consistent with diagnostic criteria set forth by the American Psychiatric Association (2013) in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Determination of eligibility in schools occurs through evaluations conducted by the local education agency or documentation of an independent diagnosis provided by the parents.

The demographic characteristics of the survey participants are reported in Table 1. The sample was primarily male (87%), white (67%), and non-Hispanic (79%). Parental income was distributed across income levels, with upper income families representing the largest percentage. The majority of participating schools were located in suburban (45%) and urban (40%) areas, and only 15% were in rural areas. The majority of participants (77%) were without intellectual disability (as determined by IQ scores > 70 on the Leiter3) and the majority (60%) were on a track to graduate with a regular education diploma type. All participants were between the ages of 14 and 21.

Table 1. Participant Characteristics.

Characteristics	
Gender ($N = 472$)	Male 87% (409)
Mean age (in years) ($N = 469$)	16.8 (*SD* 1.4)
Race ($N = 439$)	
White	67% (296)
African American	14% (62)
American Indian/Alaskan Native	3% (14)
Asian	4% (17)
Multiracial	7%(32)
Other	4 (18)
Ethnicity ($N = 450$)	
Non-Hispanic	79 (356)
Income ($N = 370$)	
Low[a]	23 (84)
Medium[b]	29 (107)
High[c]	48 (179)
IQ ($N = 443$)	
>70	77 (342)
Diploma track ($N = 471$)	
Standard	60 (282)

[a]Low = US$0–39k.
[b]Medium = US$40–99k.
[c]High = US$100k and above.

Data collection

CSESA assessors administered the survey in paper form as they collected assessment data for the CSESA project (Cohort 1, May 2015, and Cohort 2, May 2016). 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.

Instructions were provided to the assessors to help them increase the accuracy of participant responses. Assessors had the ability to interact freely with the participants to develop rapport (Dillman et al., 2009) and were encouraged to read the survey questions aloud to participants to enhance comprehension and help prevent students from rushing through the survey. Assessors were permitted to write in the responses if dictated by the student. 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 CSESA team members. The survey took participants approximately 15 min to complete.

Data analysis. Descriptive analysis was used to profile the personal and demographic characteristics of the sample and provide the frequency of use, and opinions of the benefits and barriers to technology use. Researchers entered the data into Qualtrics (2015) Research Suite to prepare for analysis. Fifty percent of the data was verified with less than 0.5% of errors of the total number of items and corrections were made. Descriptive analyses were completed

Table 2. 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	54	41	5
To type things up	45	46	9
To make presentations (e.g. PowerPoint)	21	59	20
To turn in assignments	33	43	23
To work with other students (e.g. Google docs)	18	48	33

$N = 358$.

using STATA, version 14 (2015) data analysis and statistical software. Frequency tables were generated for all questions. Text data from the open-ended questions were uploaded into NVivo 11 software and coded into broad categories.

The number of respondents varied for some questions due to the different versions of the surveys. All 472 participants responded to the 12 matched questions. In all, 358 participants completed the full survey version (30 questions) and 114 completed the modified version only (12 questions). Unless an "*N*" is noted, it can be assumed that all percentages refer to the total *N* of 472.

Table 3. Frequency of using technology to stay organized.

Using technology to stay organized	Everyday M-F (%)	Some days (%)	Never (%)
As a calendar	20	44	36
As a planner	13	33	54
As an alarm	29	25	45
As a timer	17	40	42
As a camera	18	47	35
As a video/sound recorder	13	32	54
To take notes	22	38	39

$N = 358$.

Results

Forms of technology used

The majority of survey respondents (98%) said they used technology at school. Many of them (86%) also reported bringing their own technology with them. The most common forms of technology students reported bringing to school included the following: smartphone (57%), tablet (26%), game device (22%), laptop (23%), and cell phone without Internet (17%). While at school, survey respondents reported primarily using desktop computers (79%), laptops (63%), smartphones (50%), interactive whiteboards (41%), and tablet devices (41%).

Purposes of technology use

At school. During a typical week, respondents reported using technology to complete assignments at least some days if not every day to look things up on the Internet (95%), to type things up (91%), to make presentations (80%), to turn in assignments (76%), and to work with other students (66%) (see Table 2).

Study participants reported using technology less often for purposes of organization. They indicated they used technology to stay organized at school at least some days if not every day in the following ways (from the full survey $N = 358$): as a camera (65%), a calendar (64%), to take notes (60%), as a timer (57%), an alarm (54%), as a planner (46%), and as a video or sound recorder (45%). See Table 3 for the frequency of use.

An open-ended question was included to encourage students to share other ways they use technology at school not listed in the questionnaire. A total of 112 students wrote in their comments, which are grouped into the following categories: complete assignments, learn, organization, leisure, stress reduction/focus, and communication. Samples of their responses are in Table 4.

At home. Students were asked additional questions about technology use at home, including for entertainment. Respondents indicated that "watching YouTube and other online videos" was the most popular use of technology at home (90%). The next most frequent uses were "looking things up on the internet" (87%) and "playing video games" (81%). Forty-seven percent of students said they use some form of technology to wake up in the morning.

In the full survey ($N = 358$), students indicated they use technology to support their learning by checking class or school websites (61%), turning in assignments (59%), keeping track of homework assignments (54%), for reminders, calendar, planner (47%), communicating with teachers (38%), and collaborating with other students (38%).

An open-ended question was included in this survey section to find out about specific apps and software students might be using at home "besides for playing games."

Table 4. Other ways students use technology at school.

Category/no. cited	Examples of other technology purposes
Complete assignments/37	Edmodo for my biology assignments/iPads work extremely well as writing tools when using a keyboard/math textbook is an ebook/read articles for current event assignments/use a computer at school to look up some important history documents/Khan Academy for math help
Learn/26	You can do web activities to make yourself smarter/composing music/watch useful videos/coding and programming/"Cahoot" and educational game on phone/I use quizlet to study for tests/I use photoshop to help me be more of a digital artist
Organization/15	Infinite Campus to check grades/Google Classroom to turn in assignments/set reminders for yourself so you're prepared for important events/record class to go over later/I use my phone to remind me to do things like finish a project or turn in work/ phone to take pictures of assignments
Leisure/14	To read in spare time/I look up songs I'm interested in learning/show pictures/ listen to music/I've been typing up a song I wrote/writing a story
Stress Reduction-Focus/13	Look at wallpaper to distress/to unwind at school I watch YouTube/I play music to stay focused/I listen to music on my iPad to keep me motivated/I use my phone to listen to music because it helps me stay on track during work times/use [iPod] during passing times b/c the hallways are way too loud
Communication/7	Emailing my mom/talk to other people in my group when we're apart/ask parents and teachers for assistance/prefer to email teachers when I have questions/I get email about clubs at school/email from teachers re: assignments

Table 5. Applications or software used at home.

Category/no. cited	Examples of other apps and software
Organization/51	The Homework app/Task app/cozi calendar family calendar/Moodle for geography and astronomy assignments/Medisafe app for med reminders/Period Tracker app to track menstruation
Music/28	Spotify/Pandora/iTunes/MusicTube/ditty (to make songs)/Soundcloud
Educational/23	Solar system app/presidents app/software for reading books/software for learning languages/ iTunesU/Biologypop
Art/17	Adobe Photoshop/Visual Studio/draw and paint tool/photo editor app/art studio/autodesk sketch book
Relaxation/16	White noise app to help sleep/fan sound to help sleep/healing rhythms biofeedback/Modus/anime shows to de-stress/tap titan app to relieve anger

A total of 157 respondents wrote in specific products they used and these were sorted into categories. The following categories had the most citations: organization, music, educational, art, and relaxation. Samples of student responses are in Table 5.

Technology use for social communication. The majority of survey respondents (92%) reported using technology to communicate and to socialize at home or at school. The most common tools they used included the phone (81%), text (69%), email (60%), Facebook (47%), and video calls (41%). Roughly, 60% of survey respondents are active on social media using a variety of tools in addition to Facebook such as Instagram, Snapchat, Twitter, Kik, Vine, Tumblr, Steam, Google+, WhatsApp, and a variety of interactive game-related outlets.

Benefits and barriers of technology use

Students reported technology use at school was beneficial in a variety of ways. They acknowledged that technology makes learning easier (87%) and fun (85%) and they like having their phone at school so that they can contact a parent (66%). In the full survey ($N = 358$), respondents indicated that they use technology during lunch or breaks to relax (84%) or to play with friends (49%). When asked the reasons why they use technology to communicate or socialize, respondents indicated to talk to friends (81%) and family members (74%), to keep up with what's going on (55%), to make new friends (47%), find people with their same interests (47%), to avoid talking to people face-to-face (32%), and to communicate with teachers (36%).

Barriers to technology use at school were not as clearly defined. The biggest barrier to supportive technology use at school was related to the distracting nature of technology. A little more than half of the students (58%; $N = 358$) felt that technology use can be distracting at school. Forty-four percent of all respondents indicated they were not permitted to use technology in all classes. Only 11% percent of respondents indicated their school did not provide technology and 11% of respondents to the full survey ($N = 358$) indicated that they did not have Wi-Fi access at

school. Another form of access is knowing how to use the technology. Roughly, one-third of all respondents indicated that using technology to learn was hard and 30% percent indicated they did not have people at school to help them learn to use technology.

Discussion

High school students with ASD were surveyed to gain insights into the forms of technology they use, how they use it in their everyday lives in supportive ways especially at school and also at home, and their perceptions of the benefits and possible barriers to its use. 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 and Wenstrup, 2013). Information was lacking on the ways youth with ASD use technology to support learning, and independent functioning. Additionally, updated studies on the forms of technology used in schools were lacking. The results of this study revealed that respondents are using a variety of forms of technology in a wide variety of ways across settings including to help support learning, stay organized, communicate, increase social opportunities, and to reduce stress.

Results indicate that much has changed since the NLTS2 survey, which found that students with ASD "rarely" or "never" used computers in their classrooms (Newman, 2007). Today, many students with ASD not only use their schools' computers but also use their own mobile devices, especially smartphones but also tablets and laptops, to support learning and independence throughout the school day. One distinct advantage of internet-capable mobile devices is that they can fulfill a range of functions in one compact device from organizational support, communication, social interaction, to entertainment. Further, the adolescents in this study are using technology in ways similar to typical adolescents as reported in the 2015 Pew Research Center's survey of teens, technology, and friendship (Lenhart et al., 2015). Similar to typical teens, students with ASD use technology, especially handheld technology, to increase their social opportunities by engaging in a variety of social media outlets. They are also using their handheld technology to reduce their anxiety by listening to music and using calming apps. This study reveals that technology, by reducing the need for face-to-face synchronous interactions both for supporting learning and for social interactions, may be helping to reduce some of the differences between adolescents with and without ASD and thus reduce their need for special services. It will be important for future research to examine the impact of technology use by adolescents with ASD not only on their success in school and increased independence but also on their feelings of social connectedness and other aspects of quality of life.

Benefits of technology use

The three primary findings from this descriptive study are the wide variety of ways adolescents with ASD are using technology to (1) increase their independence, (2) enhance their social opportunities, and (3) relieve their anxiety and stress. Clearly, all of these areas can be challenging for individuals with ASD.

Technology use to increase independence. Independence can be challenging for individuals with ASD, with this challenge going across the range of 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). Difficulties with independence for individuals with ASD can manifest in many ways including the areas of self-management, self-advocacy, and even initiating simple but necessary activities such as doing homework and waking up in the morning. Participants in this study indicated that using technology helped them address areas of need resulting in increased independence. For example, using calendars and alarms to help with organization, word processing 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 or to pursue their own interests including publishing their art, music, and writing, and making their own choices about what to do at times when they have no structured activities planned.

Technology use to facilitate social opportunities. 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. The variety of different options for socializing (e.g. text, video calls, twitter) makes it easy for teens to keep up with what is going on with their peers. These newer methods of social interaction are less intimidating (Gillespie-Lynch et al., 2014) and might also be used to improve communication with teachers and employers to help support success in adulthood (Benford and Standen, 2011).

Technology to reduce anxiety and stress. Anxiety is a common comorbid condition in adolescents with ASD (White et al., 2014). It can have a profound impact on the individual's ability to function and can lead to problematic behavior (Stephenson et al., 2016). In this study, respondents reported using technology to help them "relax" and "de-stress" by listening to music or by playing games

while at school. Having the ability to contact their parents on their cell phone during the school day, which many respondents indicated they liked, may be helping to deal with anxious moments and should be investigated further. In fact, Hare et al. (2015) found for adults with autism that using a handheld device that prompted individuals to report their feelings at different intervals resulted in improved moods and less anxious thinking in authentic situational contexts. Similarly, having pre-recorded messages by family or friends might be another way to help de-escalate a stressful situation. 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 and Simmons, 2015). Some of this study's participants wrote in response to an open-ended question how they found listening to music (using ear buds or headphones) while at school to be calming.

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 is the excessive use of technology at the expense of other activities (Mazurek and Engelhardt, 2013; Mazurek and Wenstrup, 2013; MacMullin et al., 2015).

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. Respondents reported few barriers; the most predominant was related to the distracting nature of technology.

In the classroom, technology distraction is now known as *cyber slacking* (Aakash et al., 2015). Even though the majority of respondents in this study have access to technology tools, there were times throughout the day in which they were not permitted to use them. The reason for these restrictions is most likely due to the belief by teachers that some technology can be a distraction from prescribed activities. For the students in this study, the perceived distractive nature of technology by school staff was reducing the opportunities for it to be used in supportive ways.

As more students have access to technology in the classroom, more research is being done to examine its impact on learning (Aagaard, 2015; Aakash et al., 2015; Ravizza et al., 2014). Past research found that having access to technology in the classroom improves learning outcomes (Samson, 2010; Trimmel and Bachmann, 2004), while studies that are more recent are finding the negative effects outweigh the benefits (Kraushaar and Novak, 2010; Sana et al., 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) as they will likely have unlimited access to it in their future post-secondary and employment settings.

Recommendations for practice

The use of technology has the potential to support positive post-school academic and career outcomes for students with ASD (Bolte et al., 2010; Odom et al., 2015). Specifically, a recent comprehensive review of the literature by Wong et al. (2014) found sufficient empirical support to classify Technology-Aided Instruction and Intervention (TAII) as an evidence-based practice. However, to be meaningful for student outcomes, teachers will need to provide students with access to technology and facilitate the use of technology in ways that contribute to 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 a variety of supportive ways. However, the finding that some teachers are banning technology use in their classrooms 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 and 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 posited that teachers might interpret these restrictions as threatening to their job security, thus reducing their willingness to provide access in the classroom (Capo and Orellana, 2011).

Directions for future research

The goal of this study was to provide insights to researchers from the users of the technology themselves to help focus research agendas. While the perceptions of students about their technology use as a support tool is important, it will 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. Future studies should examine the associations of technology use across settings with demographic characteristics to look

for differences. Additionally, it will be important to examine the perception of technology as distracting and how this affects the willingness of teachers to use technology supports with their students with ASD. If this is truly a barrier, it needs to be addressed as technology access and use in schools is only likely to increase and technology skills will most likely be essential for future work placements of individuals with ASD.

Limitations

There are two primary limitations to this study. First, the findings are based on self-report and student perceptions of the benefits of technology use were not confirmed by their teachers or parents. 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 from their parents, in both directions, on several scales (Clark et al., 2015). Similarly, Kalyva (2010) found that individuals with ASD reported their social skill abilities more favorably than their parents did. Including the individual's perspective is important to researchers because it can vary from that of the caregiver or practitioner and affect how interventions and supports are designed and implemented (Pellicano, 2014). Thus, 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 with ASD 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 United States (Zamora et al., 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.

Conclusion

Contrary to previous research, this study revealed that high school students with ASD use 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 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.

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Note

1. 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" (Center on Secondary Education for Students with ASD (CSESA) Technology Group, 2013).

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