How is Technology Being Used to Impact Those with Autism Spectrum Disorder?

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How is Technology Being Used to Impact Those with Autism Spectrum Disorder?

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Abstract: This study sought to examine the use of technology to aid in social development of middle and high school students with Autism Spectrum Disorder, perceived impact by teachers, and potential future applications. This study reports on qualitative data gathered from surveys sent to teachers in Indiana and Ohio who worked with those students. Findings include a range of technology implementations in the classroom and an overall feeling of perceived positive impact of technology on developing social skills. The connection between adolescence and the need for focused social skill development and the future direction for research were also discussed.

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How is Technology Being Used to Impact Those with Autism Spectrum Disorder?

Introduction

Technology continues to evolve to play a more vital role in daily life. One place that technology has become more integrated is in the classroom. In a study conducted by Gallup, around two-thirds of teachers used some form of digital learning to teach every day (Gallup Inc., 2019). Another 22% said that they used technology a few times a week (Gallup Inc., 2019). Thus, roughly 90% of teachers were using technology to aid in instruction at least multiple times per week. This study was conducted to explore how technology is being used in classrooms to specifically impact students with Autism Spectrum Disorder (ASD). It was also important to see if there were any trends in certain technology uses. The goal was to present the scope of how technology is currently being used in middle and secondary classrooms as well discuss its impact and potential uses in the future.

ASD is a "neurodevelopmental disorder that is characterized by difficulties with social communication and social interaction and restricted and repetitive patterns in behaviors, interests, and activities" (American Psychological Association). Inherent difficulties with social communication and interactions means that students with autism struggle with typical social development. Peer relationships are extremely difficult for those with ASD. One time that is particularly challenging is during adolescence due to the social complexities. Adolescence is a period of extreme change both physically and hormonally, but it is also a time where the brain develops socially (Blakemore, 2012). School is where adolescents spend most of their time and are provided with many

opportunities to develop social skills. Thus, it is important especially for students that may struggle with social development, such as those with ASD, to have methods in place that specifically focus on developing those skills. Technology is being utilized in this way and studies have shown its effectiveness. During this research, a broad range of schools were surveyed ranging in size, location, and classroom environment.

<div align="center">**Review of Literature**</div>

Autism

In 2016, the prevalence of children with autism was around 1 in 54 and was seen across all racial, ethnic, and socioeconomic groups (National Center on Birth Defects and Developmental Disabilities, 2020). This data shows an increased prevalence in diagnoses. Prevalence data of Autism Spectrum Disorder dating back to 2000 can be found in Table 1 (Lord, Elsabbagh, Baird, & Veenstra-Vanderweele, 2018). One reason why the diagnosis is more prevalent is because in the past it was very narrowly defined making it not a common diagnosis (Lord, Elsabbagh, Baird, & Veenstra-Vanderweele, 2018). However, over time, there has been a dramatic shift as the lens that autism was once viewed with has widened. Autism is now viewed on a spectrum ranging from mild to severe (Lord, Elsabbagh, Baird, & Veenstra-Vanderweele, 2018). This means that while there are typically some defining characteristics for those with Autism Spectrum Disorder, it can manifest in varying ways. Some individuals with ASD are high functioning while other individuals on the opposite side of the spectrum are nonverbal. It is important to remember that there is a wide spectrum when referring to ASD. Thus, any assistance or aid especially given in the classroom needs to be tailored with that in mind. Every individual is unique, and this is reflected in the quote that says, "if you have met

one person with autism, then you have met one person with autism" (Picard, 2009). However, even due to the extreme uniqueness of the individual, there still are some common characteristics that are observed that are a part of the diagnosis of ASD.

ASD can be broken down into two characteristic groups. The first is a difficulty in social communication and the second is restricted and often repetitive sensory behaviors (Lord, Elsabbagh, Baird, & Veenstra-Vanderweele, 2018). Students with autism typically struggle in relating to peers on an emotional level, picking up on nonverbal cues, and can unfortunately also struggle with developing and maintaining relationships (Lord, Elsabbagh, Baird, & Veenstra-Vanderweele, 2018). This can make it very difficult and frustrating for someone with ASD to communicate with others. The extra hindrances can cause them to miss many social cues and make them awkward in social settings. As well, those with autism will display repetitive movements, a rigidness when it comes to schedules and order, fixations on certain interests, and high sensitivity to sensory input (Lord, Elsabbagh, Baird, & Veenstra-Vanderweele, 2018). These can be thought of as loops where someone with ASD becomes fixated on one subject and can only think and talk about that subject. Overall, it is clear to see how both characteristic groups lead to difficulties in basic communication. However, there are also difficulties at a higher level socially especially as social interactions become more refined and complex.

Social Skill Development Concerns

Adolescence is a pivotal transition period in which the brain functionally changes as it develops. One such development is in the social cognition part of the brain. This area addresses how individuals understand the world through understanding those around them and socially interacting with them (Kilford, Garrett, & Blakemore, 2016). These are

skills that develop as a child enters adolescence and the world around them becomes much more complex. Some examples of these skills include face processing, joint attention, and the ability to perceive the mental states of others (Kilford, Garrett, & Blakemore, 2016). These are critical to how successful one can navigate the increasingly difficult social interactions that exist as we get older. That is why it is important to analyze what is being done for students with autism in this age range. Hopefully, they have developed some social skills in their younger years, but the complexity of the age range creates a greater need for extra social skill development.

Individuals with ASD struggle with social development and sometimes even basic skills do not improve even as they get older (Williams White, Keonig, & Scahill, 2006). Instead, the impairment and accompanying distress can increase during adolescence as the social world, especially of school, becomes more complex and difficult to navigate (Williams White, Keonig, & Scahill, 2006). Thus, while social development early on is important, it cannot be neglected during adolescence as students with ASD struggle and can unfortunately be rejected by peers and face isolation (Williams White, Keonig, & Scahill, 2006). Therefore, focused development is imperative to help improve rudimentary social skills. It is also needed to help students with ASD better understand the cognitively demanding social waters that exist in the world. While traditional methods help with these developments, technology is being explored as a better and more effective method.

Technology Literature Review

Technology is such a broad term and can mean many different things to different people. Many forms of technology are being used in classrooms and so different types

needed to be distinguished to allow for better understanding. This knowledge aided in the interpretation of the overall technological trends seen in the classroom today. It was also important to note that even though technology is being heavily utilized in the classroom, it still has both its benefits and drawbacks.

How is technology used in the classroom?

Teachers want technology to be of the greatest benefit to their students. However, this technology can manifest itself in many ways in a classroom. Normally when the phrase technology is used in conjunction with autism, it is normally thought of as assistive technology (Knight, Mckissick, & Saunders, 2013). Assistive technology is defined as "any item, piece of equipment, software program, or product system that is used to increase, maintain, or improve the functional capabilities of persons with disabilities" (Assistive Technology Industry Association). This form of technology is very broad and can be customized to the individual's needs. Examples are a special program to assist with communicating with individuals or a screen reader that converts text to speech for those with vision impairments (Göransson, 2019). Assistive technology has many classroom applications and extensive research has been done on the subject. The consensus is that it is very beneficial to students.

One area of technology that is much narrower in focus is some of the newest technological devices such as tablets and laptops (Knight, Mckissick, & Saunders, 2013). Tablets are the technology of choice for many reasons. They are portable due to their size and many of the students are familiar with how to operate the devices. This familiarity allows for easier use in the classroom and adds ease to the learning environment. As well, tablets are simple to use which lessens the demand on cognitive and motor skills of the

students (Alzrayer, Banda, & Koul, 2014). This lessened demand is a benefit because it allows for the brain to focus more on the task at hand. It reduces split focus which can reduce performance and hamper social skill development. One of the main uses for tables is for communication purposes because new communication apps are being developed constantly (Alzrayer, Banda, & Koul, 2014). Some studies have been conducted to determine effectiveness of tablets in teaching social skills. One study found that around half of the participants in the study experienced a high effectiveness in learning (Alzrayer, Banda, & Koul, 2014). Over three fourths of the participants saw some sort of improvement in social skills (Alzrayer, Banda, & Koul, 2014). This is significant because while the number of studies is limited, it shows that the use of tablets can impact the social skills of students. However, while the devices themselves can provide a great benefit, sometimes it is less about the device itself but about the software and programs that can be delivered through them.

Software-based social skill development is attractive because it allows for more user independence. The software takes its users through a set program where one hundred percent of instruction and feedback comes through the device itself and not from an in-person instructor (Bölte, Golan, Goodwin, & Zwaigenbaum, 2010). An example of this software-based implementation helps with the improvement of emotional recognition skills (Bölte, Golan, Goodwin, & Zwaigenbaum, 2010). Students go through different lessons and receive feedback on how well they were able to recognize different emotions. Studies have been conducted to determine the effectiveness of these types of programs in improving areas such as emotional recognition. While some studies have shown improvement, often the results are not as consistent as desired by the researchers (Bölte,

Golan, Goodwin, & Zwaigenbaum, 2010). Ultimately a software-based approach allows

for a more hands-off approach by teachers. It also allows students to progress at their own

pace and have much more autonomy over their learning. While this can be quite useful,

the software environment is often unable to truly replicate a real-world environment. This

can be an issue because social skills need to be acted out in real everyday situations to

truly develop.

However, there is a solution to this problem which is the use of virtual reality. It

can simulate real-world environments and is being utilized more to help improve social

skills. Virtual reality allows a user to experience a simulated environment that feels very

real due to the complex sensory stimulation that it can deliver (Bölte, Golan, Goodwin, &

Zwaigenbaum, 2010). This type of environment can be beneficial to those with ASD. It

allows them to be immersed in a controlled environment where they can experience

social interactions. This can help them to practice skills without having to interact with

another human which can reduce some pressures and stressors. However, this technology

is on the more expensive side. While it may not be used much in classrooms, it can

provide some great benefits.

The three areas of technology discussed do not completely encompass the

technology that is seen in classrooms. It does however provide a better understanding of

what is being used, why it is being used, and show that there is room for further research

and improvement of the technologies.

Additional Benefits of Technology

Technology integration in the classroom is not simply a sign of the times. It also

provides benefits to students in many ways. One of the first benefits is that it increases

the learning autonomy for students (Knight, Mckissick, & Saunders, 2013). Students can complete lessons at their own pace and have an influence on the learning environment. They can decide what they want to work on instead of being given a set list of what to do with their time. This autonomy helps students with ASD to develop better decision-making skills. It also helps them to process the tasks at hand. Another benefit is that technology provides teachers another way to provide one-on-one individualized teaching (Knight, Mckissick, & Saunders, 2013). For teachers who may be working with many students, unfortunately one-on-one instruction can be difficult. However, technology allows for a customization of curriculum for students who may need something more highly individualized to meet their specific needs.

Technology is advantageous because many devices, such as laptops and tablets, are very easy to transport. This makes it easier for students to utilize the technology both at home and at school (Alzrayer, Banda, & Koul, 2014). In the past, desktop computers were the only technology available and those were unable to be transported home. If students needed to use a desktop but did not have access to one at home, it would present many difficulties. Also, some technology can be very expensive which can at times hinder accessibility for all (Alzrayer, Banda, & Koul, 2014). However, affordable options like tablets are becoming more common. This allows for more students to access technology and benefit from its use. As well, it makes it easier for teachers to integrate technology in the classroom. While there are many benefits, it is still important to recognize some of the drawbacks that come with a higher integration of technology.

Drawbacks of Technology

While technology is a potential solution for helping to teach skills in the classroom, it is important to note that there are some drawbacks. One of the largest issues is accessibility. If the school Wi-Fi is down, then devices are unable to connect to the internet. Any app that needs the internet would be down for the day causing many problems (Alzrayer, Banda, & Koul, 2014). The lack of alternative methods to technology is concerning. A backup plan of paper and pencil does not have the same capabilities that technology has. Additionally, if a student with ASD is focused on only using technology, the sudden change in plans can completely throw their day off and inhibit any productive learning. Another drawback is that using technology that the students use at home may cause more distractions. This is because they may associate their tablet with entertainment instead of schoolwork (Alzrayer, Banda, & Koul, 2014). It is good for students to be able to use devices that they are comfortable with because it can reduce some stress. However, it can also cause the students to focus less on the tasks at hand and hamper learning. The final drawback is that there is a seemingly lack of depth of research on effectiveness of technology and its impact on social skill development. Some argue that development is observed whether it is delivered by a teacher or through technology (Knight, Mckissick, & Saunders, 2013). Thus, it is not actually the technology that is aiding in the development. More research needs to be done to determine the effectiveness of the technology of social skill development and if it really should be the focus. However, research will always need to be conducted periodically because of the way that technology is continually evolving. While there are drawbacks, the potential benefits and the future of technology are too great for the opportunity to be ignored.

<center>**Methodology**</center>

Approach

    Participants

        To ensure the generalization of this study, surveys were sent out to middle and high school teachers who work with students with Autism Spectrum Disorder. These participants work with students in their adolescent years which was the focused age range for this study. The participants (n = 20) were mainly from schools located in the states of Indiana and Ohio. The goal was to obtain results from as many different school settings to better understand the spectrum of technology that is being utilized in classrooms. Thus, it was important to send surveys out to teachers from different schools and locations. This was done to help address some of the variability that can be seen in working with students with ASD. Variability can occur because of the different resources available to the schools. Variability can also be seen in different classroom settings. The classroom was recognized as a major variable because the setting would have a major impact on how the technology was being implemented for the students. All this variability was seen in the results; however, no specific data was collected about the demographic of the participants of the survey.

    Procedure

        A survey approach was chosen because it seemed to be the best way to reach a larger sample of teachers. It also provided the opportunity to gain the perspectives of teachers who were in the classroom every single day. The survey was created in an online format to make it convenient for teachers to access and complete. This was done because of the recognition that being more flexible would allow for the research to be more

appealing. As well, the goal was to ensure that the questions asked had meaning to the survey but were not overly time consuming for the participants. In total, there were eight survey questions with seven of them being open-ended to allow the teachers space for greater reflection. Originally, the survey was only going to contain seven questions. However, as the world drastically changed due to COVID-19, the classroom environment changed as well. Thus, there needed to be at least a question that addressed those changes. Ultimately, the survey was divided into two parts. In the first part, the teachers were instructed to answer the seven questions with a pre-COVID-19 mindset. The second section provided the participants space to reflect on the changes due to COVID-19. This was done to explore how they had adapted when it came to technology use in the classroom.

The questions in the first section were framed to find out about the schools, the students, and the technology. First, it was important to discover what kind of environment that the teachers were working in. One question provided the respondents with four options of class environment. The choices were inclusion teacher, resource room, self-contained special needs classroom, and other. An inclusion teacher is one who works with regular education teachers to help ensure that all the needs of the students in the classroom are being met. A resource room is part of special education where students with disabilities receive extra instruction that aids in their learning in an individual or smaller setting than a typical classroom. Finally, a special education classroom is for students with an educational disability who are given direct education and assistance in a much smaller setting.

It was also important to understand the students that the teachers worked with. The respondents were asked to describe their students. This is important because there are a wide variety of classroom setups and those with ASD can vary broadly on the spectrum. Some students may need dedicated attention to aid them through the day. Thus, they need a different level of technology than those who were integrated into the general education classroom. Students with ASD are unique, and a one-size fits all approach is not the most appropriate for them. Thus, a question also asked the participants to describe the implementation practices of their technology.

Once this was understood, it was necessary to discover the type of technology that was being used in the classroom. Participants were provided with a question to discuss the technology in their classroom, specifically for social development. This question provided insight into the array of technologies that are being used. Following this was an open-ended question about whether the participants believed that the technology was in fact impactful on a students' social development. This was a yes or no question with a requirement to provide reasoning as to why they believed that the technology had an impact on their students.

To better understand technology trends, participants were asked to reflect on how technology had changed in the classroom over the last five years. They were also given space to discuss any technology that they wanted to implement in their classrooms. This was done to provide insight into where the future of technology might go. This last question concluded the first section of the survey.

The second section of the survey was designed to address that classrooms had changed drastically due to COVID-19. It felt appropriate and necessary to provide space

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for teachers to discuss the changes that had occurred. This was done while keeping classroom technology in mind.

Results

Before results for this study were compiled, any incomplete results were removed from the data set. This was done to ensure that only complete surveys were analyzed. Completed surveys were necessary to ensure that any unanswered questions did not cause a skew in the results. It was especially important because the skew could be large due to a small number of respondents.

Technology Exploration Pre-COVID

Classroom Environment

Three different questions were asked to understand the classroom environments that participants were working in. Question one asked about the type of classroom that the participants worked in. Overall, 45% of the teachers worked in inclusion rooms and resource rooms. This shows that many of the teachers were working in conjunction with general education teachers to form plans that would best aid their students. Another 30% of the teachers worked in self-contained classrooms. These classrooms provide a smaller more focused environment to work with students with special needs. The other 25% of the teachers worked in other environments. Examples included general education classrooms and a specialized school for those with ASD.

Next, it was important to better understand the students that the teachers worked with. ASD has a wide spectrum and so some students may be more high functioning while others may be completely non-verbal. From Question two, it was discovered that 75% of the teachers worked with students across the autism spectrum. This shows that

most participants were working with students who had varying levels of needs. This variability had an impact on the way that teachers approached their technology because the needs of one student would be very different from that of another. This was reflected in the results from question four that 70% of the participants were implementing their technology on an individualized level. This was done with guidance from a student's Individualized Educational Plans (IEP). An IEP is a plan developed to ensure that a student with a disability is receiving specialized teaching and assistance (University of Washington). So, while there was variability in the environments in the classrooms, there seemed to be consistency in the individualization of aid for students.

Technology Use

Question three asked the participants about the technology that they were using in the classroom to aid in the social development of their students. This provided a wealth of knowledge about the scope of technology that was being utilized. The responses can be broken down into three categories which are assistive technology, devices, and programs and apps on devices.

Several teachers discussed how they needed communication devices for their non-verbal students. Other teachers utilized speech-to-text technology that made it much easier for their students to complete assignments. Ultimately, assistive technology allowed for a much easier mode of communication for the students. This prompted the students to be more social and communicate even if it was through their technology.

Device use in the classroom was also a very common theme that was discussed by the participants. Many of the schools were 1:1 meaning that their students had iPads, Chromebooks, or other types of similar devices. Students thus did much of their work on

their devices. This also provided an opportunity for teachers to utilize the technology that they had at their fingertips. While the devices were important to the participants, they focused on how the devices could be utilized. The most discussed theme was about the different programs and applications that were being used to help students develop socially.

Many different types of applications and programs were discussed but two examples stood out. The first was the use of TeachTown which is a program that is used to enhance social skills. The program allows for customizable lessons for students. These can be tailored to target specific areas that need development. This provided an extra level of instruction to reinforce the lessons being taught by the teachers. Several other teachers discussed using Kahoot! which is a program that allows teachers to create different quizzes. Students then compete to answer the questions. Typically, questions are designed to help the students review academic content. However, many participants noted that it also encouraged the students to learn some complex social skills. Examples were how to handle defeat, how to express and handle frustration, and finally how to interact competitively while still encouraging fellow classmates. Overall, technology to develop social skills was used to promote communication, specifically target areas for improvement, or subtly develop more complex social skills.

Perceived Impact of Technology

Question five asked the participants if they believed that technology had been effective in aiding with social development. The participants were also prompted to explain their reasoning. Many participants felt that technology had been effective in aiding with social development of their students. It is important to note that this was the

participant's opinion, and no quantitative data was collected on effectiveness. However, the participants discussed many positive impacts that they had seen in their students. One of the largest positive impacts was that their students were able to connect better through technology. These connections were developed with both students who had ASD and those who did not. The teachers felt that technology provided an easy way for students to get to know each other and interact. Some felt that the indirect interactions with other students were less intimidating than face-to-face conversations. Overall, the participants felt that the technology was providing a space where communication was easier. This encouraged their students to communicate and helped them to build confidence. The other impact was that technology provided students with other opportunities to learn social skills. Participants felt that providing another avenue of learning helped to reinforce skills. This allowed them to learn the skills more concretely because they had more ways to practice. Overall, the participants felt that technology had a positive impact on their students' social skills development.

Change in Technology

Question six asked participants about how technology in general had changed in the classroom over the last five years. One of the biggest trends was the growth of technology. Even in just a short period of time more options were invented, and others were developed to better meet needs. Technology also became more available and accessible. Some of this was due to technology being produced at a higher level for more affordable costs. Some participants saw their technology use increase because their schools became 1:1 which provided a device to every student. Other participants recognized that students were more familiar with technology. That extra comfort

motivated some participants to integrate technology more in their classrooms. The integration caused the overall use of technology in the classroom to grow. There were participants who discussed how paper and pencil was almost obsolete in their classrooms. Overall, the changes in the classroom correlated with the fact that technology overall is growing.

Future Technology Use

Question seven asked participants if there was any specific technology that they wanted to see implemented in their classrooms. Around half of the participants identified some desired form of technology. One technology that was mentioned by several participants was a Smart Board. This is a board that combines a projector and a whiteboard. It provides a high level of interactivity and would allow for students to interact with lessons more directly. Other participants discussed assistive technology. Some wanted more while others wanted better versions to ultimately better aid students. The rest of the participants desired technology that could be more individualized to their students' needs. They recognized that it existed but felt that the level of individualization required was not yet seen in any of the existing programs. All these results show that there is still a great need for technology development.

The rest of the participants did not have technology that they desired for their classrooms. Some felt that they had the adequate amount to meet their needs. Others did not know of any other technology that they could implement. However, there were some that felt that more technology was a drawback. One of the biggest concerns was that there was not always a proper implementation of new technology. The technology would be provided to teachers and students by schools, but there would be no training provided on

how to best use it. However, the overall feeling was that the participants were interested to see what the future held for technology in the classroom.

COVID-19 Impact

It felt appropriate and important to provide a space for participants to discuss the impact that COVID-19 had on their classrooms. There was also a desire to explore how their technology use had been impacted. This was accomplished through question eight of the survey. Many of the participants discussed how hard and challenging that it had been to try to teach during the pandemic. Part of this was because of how quickly they had to flip their classrooms from in-person to virtual. Multiple challenges arose and ultimately the environment was very different. Some of the challenges included students not being able to access technology on their own, a lack of technology access, and finally the students having difficulties navigating the technology. Additionally, participants discussed how difficult it was to support their students since most of the time they were not able to be with them physically. The classroom environment was challenging but so was the state of the world. One participant discussed how different social interaction skills that they were trying to teach their students were now not socially acceptable. For example, shaking hands is something that was important pre-pandemic but may no longer be a social practice. Ultimately, this question really highlighted many of the negatives of the pandemic.

However, some positives were also brought to light in the participants' responses. One was the fact that the shift to virtual exposed that some schools were not actually supplying technology for their students. This became an issue when schools went virtual, and some students lacked access to technology. However, districts saw the need for this

and started to ensure that their schools were providing technology to students. This was a good thing because ultimately it increased the access of technology for all students. Another positive was the critical role that technology played in education during the pandemic. Many participants discussed how technology was the only good thing or the only way that education was able to still happen. This ultimately shows how important technology is to the classroom.

Discussion

COVID-19 Discussion

It is important to address the fact that the final number of participants was much lower than anticipated. The survey was sent out to a much larger number of teachers than the results reflected. One major factor that had an impact on the overall results is that the survey was conducted from November of 2020 through February of 2021. This time range directly coincided with the COVID-19 pandemic. These months were significantly more stressful for teachers and students. There was extreme variability as schools worked to navigate the pandemic to keep their students and teachers safe. However, teachers still had to teach, and students still needed to learn. Classrooms seemed to be shifting constantly. Some schools decided to bring students in-person while others attempted and eventually went virtual. Other schools opted to stay completely virtual. This created extra pressure as teachers attempted to still provide a good education for their students. This was even more difficult for teachers who worked with those who had special needs. As discussed earlier, those with ASD do not adjust well to change and so it was even more difficult. So, while it was disappointing to not get the response rate as desired, the belief is that it was largely impacted by the current situation of the world.

Overall Research Discussion

The goal of this study was to understand how technology was being used in classrooms to aid with social development. Studies have been conducted to explore how different technology is used to develop social skills. Other studies focused on the effectiveness of those technologies. However, it seems that researchers have not focused on investigating the scope of technology use in the classroom. This was important because to design technology to be the most effective, one must understand how it is implemented in the classroom.

It was important to understand the different forms of implementation but also the variables that influenced it. We knew that variables such as classroom type and student demographic would have an impact on implementation. It was discovered that there was a lot of variation as participants worked in many different settings. As well, they worked with students across the autism spectrum. Even though this variability existed, it seemed to not have an impact on implementation. The overwhelming majority of participants tried to individualize the technology to each student. The main reason for this was that people with ASD are unique and so a one-size fits all approach is simply impractical. However, this variability did seem to have an impact on the types of technology used.

The technology in the classroom that was discussed by the participants can be broken down into three broad categories. The first category that was anticipated to be seen in the classroom was assistive technology. The reason that it was anticipated is because it has been around for such a long time. When technology was first starting to be adapted to aid those with ASD, assistive technology was one of the first innovations. An example of this technology is using a tablet that has voice-to-text capabilities to assist

with communication. Assistive technology can be extremely helpful for students especially because it can allow communication to be so much easier. Thus, this type of technology is needed in classrooms because of the positive impact it can have.

The next type of technology that was discussed was the different devices themselves. Two of the most popular were iPads and Chromebooks. These different devices provide many different benefits that were discussed earlier. Ultimately these types of devices are the future of technology in the classroom. This trend is reflected in how many of the schools were shifting to a 1:1 technology policy to ensure that each student had access to a device. A great benefit is that these devices are also being used in all sorts of industries with many different applications. Since they are so popular, companies are continuing to work to develop to improve them but also provide options that are even more affordable. These innovations will ultimately benefit education as well device capabilities increase, and they become more affordable. The participants noted that students having access to these types of devices opened so many doors for their students. The reason for this is not necessarily because of the device itself but because of what can be accessed through that device.

It seems that the technology that had the greatest impact on social development of students was the different programs and apps that they used. Some of these programs can target certain social skills. This allows for reinforcement of lessons that are being taught by teachers. It also allows for different motivations as the students can engage with lessons in different ways than they would in a classroom. These programs can be individualized which allowed for teachers to tailor the learning programs to their

students' needs. However, the participants felt that there could be an even higher level of individualization.

Other programs allowed for students to interact indirectly with other students. This ultimately encouraged them to be more social, built confidence, and allowed them to create connections. Learning how to communicate virtually helped students with ASD better navigate the complex social structure of adolescence. These types of programs also provided the students opportunities to practice some of the social skills that they had been learning. However, it was done in spaces that felt less stressful. This is key because reducing stressors allows for students to focus on applying their skills. Lastly, these programs provided opportunities for teachers to creatively develop social skills. An example was the teachers who created quizzes to help review material but also to subtly teach a wide range of social skills. These innovations showed that it was not just about the technology but also how it was used.

The participants' responses also made it clear that there is a lot of room for improvement in the technology that is being implemented for social skills. One of the biggest needs is a continued development of programs and apps. This is a process that can take time. However, it is important to note that there are many talented people in this field who are constantly seeking new areas of innovation. It is imperative for them however to understand the technology needs of both teachers and students. That is why we felt the need to provide insight on how technology is being used but also the greatest needs. Ultimately this can provide a better direction to see more innovation that will better meet needs.

Technology accessibility is also something that needs to be addressed. Some schools were just starting technology initiatives while others discussed how potential technology was just too expensive. While further research needs to be conducted about the effectiveness of different technologies, there still needs to be an emphasis on providing technology to aid social development. While it is not the only answer to teaching these skills, it is becoming a more accepted practice. It also seems to be trending upwards as teachers discussed how much more they were using technology to aid in developing those skills than they ever had before. Thus, schools and other entities need to ensure that technology that is beneficial can be accessed. This may be as simple as finding a way to provide the needed funds to be able to purchase desired technology.

While this research provided insight about the applications of technology in the classroom, it also provided understanding of how the teachers viewed the technology. Many teachers felt that the technology they used was effective in aiding with social development. Ultimately it was perceived as effective because of the results that the participants had observed in their classes. This is important to note because the goal of this study was not to determine effectiveness but rather understand implementation. However, this was still relevant to explore even though it was done through qualitative and not quantitative means. If there was a general feeling of non-effectiveness, it would highlight potential problems in using technology to develop social skills. However, it seemed to show that the teachers felt that the technology was a very useful tool to aid in social development.

A limitation of this study was that it focused on the scope of technology in classrooms. While it provided good insight, it limited what could be concluded from this

research. Many different examples of technology were discussed but it did not show which technology was potentially the most effective. This then limits how people can view the results because it only shows how overall technology can be used. It also does not provide insight into what is potentially causing the social skills to improve. For example, were some of the improvements in social skills seen due to specific programs themselves or was it due to a more holistic approach of several different technologies? However, these limitations open the way for potential future research.

As far as future research, there are many different possibilities that would provide some very interesting knowledge. An important one is that future studies should focus on specific types of technology groups that were identified in this study. They should specifically analyze metrics pertaining to the improvement of social development using. While this study allowed for a discussion about the impact of technology, it was purely based on experience and opinion and it would be very beneficial to quantify that impact. Additionally, it would be interesting to pick a certain classroom environment that is potentially more integrated. The study should then analyze if technology was useful for both students with and without ASD. This could show that technology across the board is having a positive impact on social skills or it could completely disprove that. Finally, it would be interesting to conduct a similar study and once again look at the scope of technology being used. Then one could compare results to see if technology had evolved at all or if some methods had stood the test of time. In that analysis, it would also be interesting to integrate the impact that COVID-19 on technology in the classroom. It was clear from the participants that the pandemic had greatly impacted technology use. This

analysis could show one of the unexpected but positive long-lasting impacts that the pandemic had on the world.

This study sought to provide insight into how technology was being used in classrooms to assist students with autism spectrum disorder. Three broad areas of technology were determined to be present in the classrooms. These were assistive technology, devices, and different programs and apps. Although all three were discussed by the participants, it was clear that the programs and applications are the future. There are a lot of useful programs available to teachers that can have direct and indirect impact on social skills development. However, it is also clear that others can be developed to better meet needs. So even though the actual effectiveness of technology on developing social skills was not determined, it was clear that teachers believed that technology is the answer to helping their students with ASD develop these skills to be able to better navigate the world.

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Appendix A

Middle/Secondary School Teacher Survey Questions

1. What type of learning environment do you teach in?

    1. Inclusion teacher

    2. Resource room

    3. Self-contained special education room

    4. Other (please specify)

2. Can you describe the range on the spectrum of students that you teach?

3. What type of technology is utilized in your classroom to specifically aid with social development of your student on the spectrum?

4. Is the technology individualized to each student or broadly implemented?

5. Do you believe that technology has been effective in aiding with social development? (yes/no) If yes, can you describe the impact?

6. Can you describe how technology has grown/shifted/changed in your classroom in the last five years?

7. Is there any technology that you would like to implement in the classroom?

8. Can you describe what teaching your students has been like during COVID? How has COVID-19 impacted technology use in your classroom?

Table 1: Identified Prevalence of Autism Spectrum Disorder

Surveillance Year	Combined Prevalence per 1,000 Children (Range Across ADDM Sites)	This is about 1 in X children…
2000	6.7	1 in 150
2002	6.6	1 in 150
2004	8	1 in 125
2006	9	1 in 110
2008	11.3	1 in 88
2010	14.7	1 in 68
2012	14.5	1 in 69
2014	16.8	1 in 59
2016	18.5	1 in 54

Table 2: Implementation and Student Population

Implementation			
	Individualized	**Broad**	**Both**
Number	12	6	2
Percentage	60.00%	30.00%	10.00%

Student Population			
	High Functioning or Asperger's	**Non-verbal**	**Mix**
Number	8	2	15
Percentage	40.00%	10.00%	75.00%