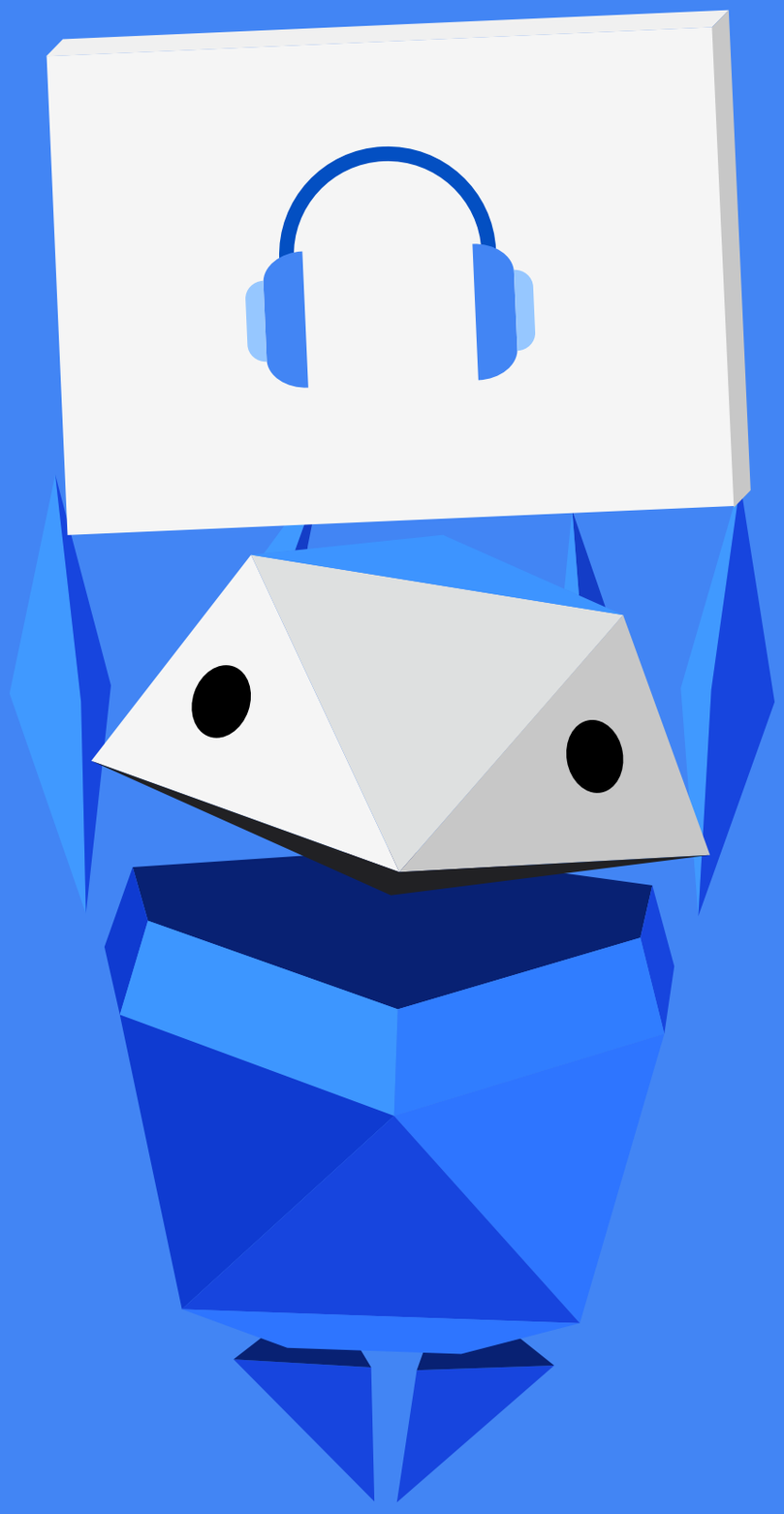


Children on the Autism Spectrum and ICT

Philippe Brunet et al.

School with Class Foundation

Be Internet Awesome

1st part of

Be Internet Awesome For All

Developing digital citizenship in children with various educational needs

Other parts of the report can be found at bia4all.eu

Authorship
Philippe Brunet et al., University of Victoria in Canada
Co-authors: Kevin Runions, Jacinta Francis, Hayley Passmore and Sarah J. Macoun

‘insights from practice’
Zyta Czechowska

Coordination
The Polish Be Internet Awesome (BIA) Team
at the School with Class Foundation

Editorial correction
David Rix

Layout and typesetting
Beata Danowska and Marta Duda, Dobry Skład

Publisher
School with Class Foundation
Śniadeckich 19, 00-654 Warsaw, Poland

szkolazklasa.org.pl
bia4all.eu

First edition, Warsaw 2023
ISBN 978-83-67621-09-0

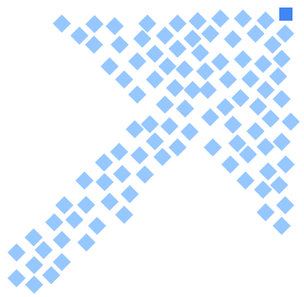
Publication created by the School with Class Foundation as part of the Be Internet Awesome program brought together by the Foundation with support from Google.org.

1 What is the Autism Spectrum?

Autism Spectrum Disorder is a neurodevelopmental disorder characterized by restricted, repetitive behaviours (RRBs) and persistent difficulties in communication and social interactions (American Psychiatric Association [APA], 2022). The autism spectrum is often associated with difficulties in language, theory-of-mind (i.e., adopting another person's perspective), attention, executive functions (i.e., cognitive processes related to daily activities and pursuing goals) and central coherence (i.e., seeing the 'big picture'). These difficulties contribute to the severity of the social and communication challenges experienced by individuals on the autism spectrum (APA, 2022; Petrina et al., 2014).

Global estimates suggest that Autism Spectrum Disorder occurs in approximately one percent of the population, with males accounting for about 80% of diagnoses (Fombonne et al., 2021; Zeidan et al., 2022). However, the diagnoses are increasing, and educators need to be equipped with the knowledge and tools to support neurodiverse students (Skafle et al., 2020; Tsiopela & Jimoyiannis, 2017). This chapter explores the common social experiences and academic needs of autistic students. Specifically, we consider the role of information and communication technologies (ICTs) in supporting neurodiverse students.

Individuals on the autism spectrum differ widely from one another due to their age, gender, the intensity of autistic traits, co-occurring conditions (e.g., the presence of mental health issues such as depression), and intelligence levels (APA, 2022; Grossard et al., 2018; Van Eylen et al., 2015). Nevertheless, all autistic individuals demonstrate social and communication challenges. Specifically, many children on the autism spectrum face difficulties initiating and maintaining conversations, sharing emotions, and playing cooperatively with their peers (APA, 2022). Furthermore, autistic children often have trouble interpreting and expressing verbal, nonverbal (e.g., gestures;) and paralinguistic (e.g., tone of voice) social cues and engaging in appropriate social and communication behaviours (e.g., waiting their turn andmaintaining eye contact; APA, 2022; Geelhand et al., 2021).



Estimates suggest that Autism Spectrum occurs in approximately 1% of the population and the diagnoses are increasing.

School Experiences of Children and Adolescents with ASD

Children and adolescents on the autism spectrum often have unique school experiences and needs influenced partly by their traits (Adams et al., 2020; Rowley et al., 2012). For example, the social complexities associated with frequently changing classrooms and instructors throughout the day may be especially stressful for autistic students (Aubineau & Blicharska, 2020). Moreover, behavioural differences related to the autism spectrum (e.g., atypical interests and behaviours) can elicit negative responses from peers and challenge positive peer relationships (Adams et al., 2020; Rowley et al., 2012). In fact, many autistic students report experiencing negative peer interactions (e.g., teasing or bullying) and increased rates of social isolation compared to non-autistic children (Dillon et al., 2016; Rowley et al., 2012). Crucially, negative peer interactions contribute to feelings of loneliness and present an increased risk of anxiety, depression, academic underachievement (i.e., poor grades), school refusal, and poor quality of life among young people on the autism spectrum (Adams et al., 2020; Bellini et al., 2007; Dechsling et al., 2021; Rowley et al., 2012; Skafle et al., 2020).

The social complexities associated with frequently changing classrooms and instructors throughout the day may be especially stressful for autistic students.

Social & Communication Challenges

Socialization and communication often present obstacles for autistic individuals seeking to establish and maintain friendships (APA, 2022). Specifically, challenges with forming friendships may be partially attributable to the fact that many individuals on the autism spectrum struggle to (i) initiate social interactions and play, (ii) respond to other's social attempts, and (iii) interpret and express social cues (Jellema et al., 2009; Mendelson et al., 2016; Rowley et al., 2012). Furthermore, autistic individuals often have different interests and play preferences than non-autistic people (Dominguez et al., 2006). Research shows that individuals on the autism spectrum and with associated social-communication difficulties tend to have fewer meaningful friendships than their non-autistic peers (Adams et al., 2020; Rowley et al., 2012). Students and teachers report that only about 50% of students on the autism spectrum have at least one close friend (Rowley et al., 2012). In addition, 40% of autistic students report feeling excluded and rejected at school (Rowley et al., 2012). Moreover, friendships tend to feel less secure, intimate and supportive for those on the autism spectrum (Macoun et al., 2021).

Social & Communication Difficulties in Individuals on the Autism Spectrum

- → initiating social interactions and play
- → responding to other's social attempts
- → interpreting and expressing social cues

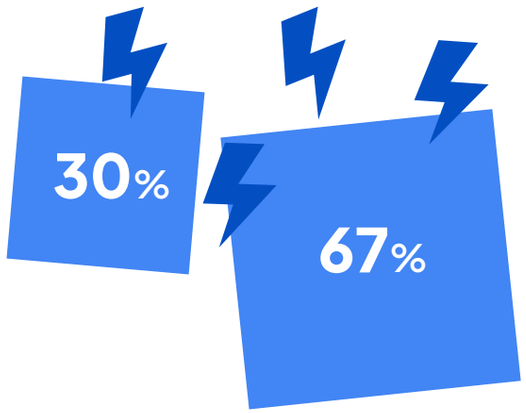
As many as **50**% students on the autism spectrum do not have close friends

As a result, autistic individuals tend to have fewer mutually satisfying relationships and smaller social support networks (Macoun et al., 2021). Crucially, these persistent social difficulties lead to a heightened risk of mental health problems in adulthood (Moss et al., 2015).

Despite the social and communication challenges discussed above, many individuals on the autism spectrum crave friendship and social interaction (White et al., 2006; 2009). Indeed, stronger social support networks have been shown to improve self-worth and mental health and reduce feelings of loneliness among autistic individuals (Bauminger et al., 2003; Mazurek & Kanne, 2010). In light of this and the fact that engaging with friends helps to develop social skills, educators may wish to facilitate friendships and reduce social discomfort for students on the autism spectrum (Rowley et al., 2012). Therefore, to promote social bonds, educators may wish to monitor social interactions and provide social skills training for autistic students.

In addition to difficulties with forming friendships, research indicates that students on the autism spectrum are 2.4 times more likely to be the target of bullying than non-autistic children, with a prevalence of 67% (Park et al., 2020), compared to the overall childhood/adolescent prevalence estimates of bullying, which are approximately 30% (Modecki et al., 2014). In fact, autistic students who demonstrate pronounced social and communication difficulties are especially vulnerable to bullying (Park et al., 2020). Specifically, those with more severe social problems tend to display a higher intensity of autistic traits overall and, as a result, are more visible targets for bullying (Holfeld et al., 2019). For example, autistic children and adolescents are often singled out for their uncommon interests and behaviours or for their difficulties reading non-verbal behaviour (e.g., gestures and facial expressions) and interpreting language (Rowley et al., 2012).

Interestingly, some research suggests that students with minor social difficulties are more likely to be bullied than those with severe social difficulties (Rowley et al., 2012). However, despite experiencing increased bullying, students with minor social difficulties have more mutual friendships than those with severe social difficulties (Rowley et al., 2012). These findings could be explained by the fact that students with less severe difficulties may engage in more social activities and, thus, be more exposed to bullying. In contrast, students with significant social difficulties tend to isolate themselves (Rowley et al., 2012).



Students on the autism spectrum are **2.4 times more** likely to be the target of bullying than non-autistic children

Educational Support for Autistic Young People

Educators can play a crucial role in reducing bullying among students on the autism spectrum, especially in inclusive school settings where these students are in constant contact with non-autistic peers (Beckman et al., 2020; Park et al., 2020). Specifically, educators can reduce the likelihood of bullying by promoting neurodiversity awareness among students (e.g., by providing lessons on the strengths and needs of individuals on the autism spectrum), closely supervising students on the autism spectrum and firmly disciplining all acts of bullying (Park et al., 2020). These initiatives are especially important considering that bullying among autistic individuals can carry long-term psychological, social and health consequences (Beckman et al., 2020; Park et al., 2020; Wolke & Lereya, 2015).

Educators can also play a vital role in the social development of children on the autism spectrum. For example, educators can teach and practice important social skills through role-playing scenarios. That said, studies examining educational interventions targeting social skills for autistic students often yield inconsistent results (Ostryn & Mincic, 2022). In this regard, information and communication technologies (ICTs) are interesting tools to supplement traditional educational practices. ICTs encompass various tools providing digital access to information and socialization opportunities (Macoun et al., 2021). For example, ICTs include computers, smartphones, tablets, video game consoles and many programs and applications accessed through these devices (e.g., video-conferencing tools, social media applications and internet search engines). Researchers and practitioners are increasingly leveraging ICTs with the aim of improving social and emotional skills among autistic children. For example, robotics, virtual reality devices and computer-based interventions show early promise for improving social and emotional skills (Dechsling et al., 2021; Grossard et al., 2018; Ramdoss et al., 2012). Furthermore, certain home-delivered ICT interventions allow parents to get involved in their children's education (Heath et al., 2015).

Ways to Support Autistic Youth in a School Setting

- → promoting neurodiversity awareness among students (e.g. lessons on the strengths and needs of individuals on the autism spectrum)
- → closely supervising students on the autism spectrum and firmly disciplining all acts of bullying
- → teaching and practicing important social skills through role-playing scenarios

Leveraging ICTs to Support the Development of Social Skills in Students on the Autism Spectrum

If your students have difficulties expressing their emotions, defining social relations and rules, establishing positive relationships with peers and fitting into the social environment, you should bear in mind that modern technologies offer increasingly interesting solutions to support the development of autistic students.

Tablets play an integral part during my in-class lessons, where they are used to shape specific skills and plan a child's activities during social skills training.

'Autimo' and 'Expressions for Autism' are examples of two interesting **applications** that you can successfully use with your students.

Moreover, you can source engaging student exercises from **platforms** such as:

- → Learningapps
- → Word Wall
- → Bamboozle
- → Educandy
- → Avatar Maker

Zyta Czechowska – Therapist and Special Education Teacher, Be Internet Awesome Trainer

ICTs are also playing an increasingly important role in the classroom. Educational ICTs include smart whiteboards, computers and tablets with or without internet access (Area-Moreira et al., 2016). Specifically, students can use personal computers with internet access for research, problem-solving, writing and communication (Area-Moreira et al., 2016). In special education classrooms, ICTs are most commonly used to deliver web-based instructions and applied games (i.e., educational games; Liu et al., 2013). Notably, students and teachers report that learning is easier, more enjoyable and more effective in classrooms equipped with ICTs (Liu et al., 2013). Moreover, school-delivered computer-assisted interventions can be used to teach autistic students social problem-solving and social skills (Sansosti et al., 2015). Indeed, ICTs may be socially appealing to individuals on the autism spectrum, given that they often find face-to-face interactions difficult and anxiety-provoking (Macoun et al., 2021).

2 Students on the Autism Spectrum and the Internet

Outside the classroom, social networking sites, blogs and instant messaging services offer a promising communication bridge between autistic and non-autistic individuals. Indeed, ICTs eliminate nonverbal and paralinguistic cues such as facial expressions and tone of voice and provide a structured format for communication (Burke et al., 2010). Children on the autism spectrum who use social networking sites report improved relationships (Mazurek et al., 2012). However, autistic individuals around the globe primarily use the internet for non-social purposes, such as playing single-player games and watching television (Mazurek et al., 2012; Ntalindwa et al., 2019). As a matter of fact, many individuals on the autism spectrum report disliking social media sites (e.g., Facebook) and experience them as confusing and boring (Bahiss et al., 2010). It appears that autistic individuals prefer communicating with others when pursuing common goals or performing activities (Bahiss et al., 2010). In light of this, educators using ICTs to provide social support to students on the autism spectrum must account for their students' motivation levels. For example, students may prefer ICTs that are packaged or 'disguised' as video games (Macoun et al., 2021).

Autistic individuals around the globe primarily use the internet for non-social purposes, such as playing single-player games and watching television. As a matter of fact, many individuals on the autism spectrum report disliking social media sites and experience them as confusing and boring.

3 Risks and Opportunities

Beyond the current application of smart whiteboards, computers and tablets for instruction delivery, educators might consider leveraging ICTs to support social skills among students on the autism spectrum. However, educators using ICTs to promote socialization should be mindful of the risks and opportunities associated with these technologies, especially when working with students with complex learning needs and unique abilities. Indeed, despite the promise of ICTs to support social skills, autistic students might be negatively impacted by certain properties of technology.

Specific Risks

Expanding beyond the current application of ICTs to promote social skills among students on the autism spectrum does carrysome risks. Despite the importance of motivating students, increasing the rewarding properties of ICTs may be a ‘double-edged sword’ given the risk of problematic technology use (MacMullin et al., 2016). Problematic technology use can be defined as use that either (i) persists despite intentions to stop, (ii) leads to frequent and intrusive thoughts related to technology, or (iii) causes personal or interpersonal conflict (MacMullin et al., 2016).

As a group, individuals on the autism spectrum are especially vulnerable to problematic technology use, such as compulsive video game use (Craig et al., 2021). Thus, further introducing technology into the lives of students on the autism spectrum may have negative consequences. Some educators are concerned that technology could interfere with other aspects of learning (Bauer, Kenton, 2005). For example, teachers may find it challenging to shift autistic students away from ICTs to other learning activities. Hence, educators must balance motivating their students with teaching them how to limit their internet use. This balance can be facilitated through the active mediation of technology, which has been discussed below.

Furthermore, the benefits of ICTs for individuals on the autism spectrum may not translate to real-world social interactions and may even hinder the development of adaptive compensatory behaviours (i.e., limiting the development of strategies to overcome social challenges; Grossard et al., 2018; Macoun et al., 2021). Specifically, an overreliance on ICTs for socialization may impede social development by limiting real-life interactions (Macoun et al., 2021; Ong et al., 2011). For example, over-reliance on ICTs can limit the time autistic children spendwith friends and in healthy activities such as exercise and reading (Macoun et al., 2021). Crucially, overuse of ICTs is related to academic underachievement, poor social engagement, behavioural issues and health issues among individuals on the autism spectrum (Mazurek et al., 2012).

Moreover, autistic individuals may be particularly vulnerable to cyberbullying (i.e., online bullying; Iglesias et al., 2019). Some studies report that up to 41% of children on the autism spectrum who are online experience cyberbullying (Beckman et al., 2020). These rates are much higher than the estimates of cyberbullying among the general adolescent population (about 15%; Modecki et al., 2014). It appears that certain properties of ICTs may increase the risk and impact of cyberbullying for autistic individuals. For one, individuals on the autism spectrum may display social and communication difficulties in online mediums, making them visible targets for cyberbullying (Macoun et al., 2021). For instance, text-based messages transmitted via ICTs are more likely to be misinterpreted and perceived as aggressive than real-life communications (Runions et al., 2013). This threat is augmented by the fact that some autistic individuals report feeling confused about how to use ICTs, thus making them more likely to disclose private information online (Benford & Standen, 2009). Second, the anonymous nature of many ICT interactions may appeal to bullies, increasing the prevalence of cyberbullying in general. Third, despite the absence of physical violence, cyberbullying is severely distressing due to the permanence of messages and potentially large audiences (Runions et al., 2013).

In short, the misuse and overuse of ICTs, their potential failure to generalize to real-world scenarios, and the high rates of cyberbullying represent serious risks for students on the autism spectrum. Crucially, cyberbullying, perceived social risks, and uncertainties about how to properly use ICTs lead to an increased risk of mental health challenges among autistic individuals (e.g., anxiety, depression, and lower self-esteem; Iglesias et al., 2019; Macoun et al., 2021). Nevertheless, these technologies may be promising tools to support students on the autism spectrum when properly implemented.

Key Risks

- → problematic technology use (e.g. compulsive video game use)
- → threats resulting from autistic people being especially vulnerable to cyberbullying
- → difficulties in shifting autistic students away from ICTs to other learning activities
- → challenges to translate skills developed with use of ICT to real-world social interactions
- → overreliance on ICTs for socialization may impede social development by limiting real-life interactions

Specific Opportunities

Despite the risks, ICTs offer numerous potential benefits for social development in students on the autism spectrum. For example, ICTs can increase the accessibility of interventions and reach autistic individuals living in rural and remote communities (Parsons et al., 2019). ICTs can also bring together individuals with common interests, thus strengthening one's social network and promoting the positive effects related to social support (Macoun et al., 2021). For instance, research shows that social connection enhances self-esteem, well-being and happiness and reduces loneliness and mental health challenges among autistic individuals (Macoun et al., 2021). Furthermore, ICTs may offer additional social benefits, such as strengthening existing friendships and increasing social engagement (Macoun et al., 2021). Crucially, these social benefits may help reduce the negative effects related to social communication challenges common with the autism spectrum.

Four aspects unique to online communication may be especially beneficial for individuals on the autism spectrum (Macoun et al., 2021; Runions et al., 2013):

- First, ICTs may help with **communication between autistic and non-autistic individuals** by eliminating nonverbal cues such as body language, facial expressions, and voice inflections (Macoun et al., 2021). Moreover, emoticons (e.g., a smiley face) provide clear emotional cues that can be valuable in guiding emotional understanding and self-expression, especially given the proliferation of online guides to interpreting emoticons (e.g., emojipedia.org). Indeed, individuals on the autism spectrum report feeling less stressed during online communication than in real-life conversations (van der Aa et al., 2016).

- Second, **the normal delay between messages in online conversations matches the communication preferences of autistic individuals** (Macoun et al., 2021). ICTs make turn-taking during conversation easier and allow individuals on the autism spectrum to take their time before responding to messages.

- Third, though **the permanence of messages** in ICTs poses a risk, **it may also provide benefits by providing autistic individuals with the opportunity to review and learn** from prior social interactions or seek real-time guidance (Macoun et al., 2021).

- Finally, ICTs offer opportunities to **practice group conversations** (Macoun et al., 2021). Take, for example, a discussion in the comments section of your favourite social media platform. Although large online audiences can present a risk of cyberbullying, these group interactions may help individuals on the autism spectrum feel that they are part of a community. Moreover, successfully engaging in large group discussions via ICTs may increase feelings of self-efficacy in autistic individuals.

Notably, when used for social purposes, ICTs may promote the inclusion of students on the autism spectrum into the broader school community (Hersh et al., 2020). For example, higher education courses frequently utilize online discussion forums, which could help translate the benefits of ICTs into tangible academic and social gains for autistic students. Furthermore, for elementary and high school students on the autism spectrum, ICTs can provide continuity between the school and home environments and promote the involvement of parents or caregivers (Heath et al., 2015).

In the classroom, computer-assisted instruction (CAI) appears to be a promising method for teaching certain academic skills to students on the autism spectrum (Pennington, 2010). For example, computers and digital programs (i.e., ICTs) reduce potentially confusing social interactions and allow autistic students to focus on the relevant material (Pennington, 2010). Indeed, ICTs can promote social understanding among students on the autism spectrum by highlighting, repeating and slowing down important social cues (e.g., through video modelling; Pennington, 2010). Additionally, ICTs allow educators to pre-record instructions, which can be captioned, paused, replayed and slowed down for students struggling with understanding. ICTs also allow educators to supplement instructions with relevant audio-visual materials, which is crucial when working with autistic individuals (Pennington, 2010). Students on the autism spectrum report that instructions with audio-visual support are more reinforcing and motivating than traditional methods (Pennington, 2010). These students also exhibit lower rates of inappropriate behaviour when receiving CAI compared to conventional instruction methods.

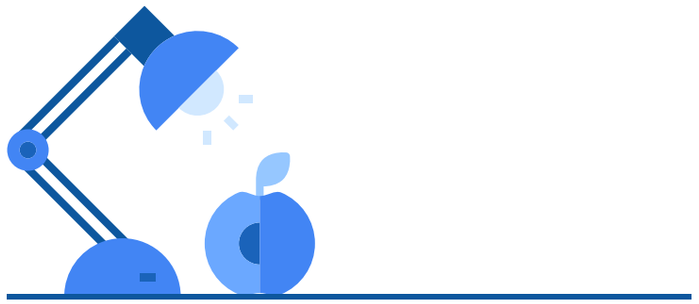
ICTs allow educators to pre-record instructions, which can be captioned, paused, replayed and slowed down for students struggling with understanding.

Students on the autism spectrum report that instructions with audio-visual support are more reinforcing and motivating than traditional methods.

In short, for autistic students, CAI and associated software appear more effective, efficient and engaging than traditional instructional methods (Pennington, 2010). Nevertheless, the current weight of evidence is insufficient to coin ICTs and CAI as evidence-based practice (Pennington, 2010; Ramdoss et al., 2012). More research needs to be done to understand the specific risks and benefits associated with ICT use among students on the autism spectrum.

4 Recommendations

Given their unique strengths and needs, a personalized approach to education and intervention is essential for students on the autism spectrum. Educators should be aware of the benefits and risks specific to the autistic population and to each individual on the autism spectrum. The school setting provides students with unique opportunities to develop social skills, expand social networks and build communication skills. Educators can support autistic students by facilitating collaborative play and friendships and by reducing social discomfort. Moreover, educators are tasked with reducing bullying, especially among students on the autism spectrum, given that they are particularly vulnerable. With this in mind, four practical applications to guide the use of ICTs among autistic students have been offered below (Macoun et al., 2021).



Given their unique strengths and needs, a personalized approach to education and intervention is essential for students on the autism spectrum.

- First, educators may wish to leverage the benefits of ICTs to **promote the development of social skills among students on the autism spectrum**. Since autistic students typically use ICTs for individual activities, educators need to devise creative ways to use these tools for social purposes (Mazurek et al., 2012). For example, multiplayer educational games may motivate students and be socially conducive.

- Second, given the unique strengths and needs of individuals on the autism spectrum, members of this population should be **educated on the specific opportunities and risks associated with ICT use**. For example, autistic students should be aware of the dangers of problematic technology use and understand how over-reliance on ICTs can negatively impact real-world relationships. When monitoring ICT use among children on the autism spectrum, educators might consider how long and for what purpose these technologies are being used (Livingstone & Blum-Ross, 2020). As with parents, teachers may wish to use *active mediation* rather than *restrictive mediation*. The active mediation of ICT use is achieved through open communication and negotiation with the child, whereas restrictive mediation places concrete limits on usage. Indeed, active mediation is associated with lower online risks without significantly restricting the opportunities for children to develop greater digital skills. That said, restrictive mediation may be important for children with low self-regulatory capacity (i.e., children who show a low ability to control their behaviour; Lee, 2013).

- Third, given the elevated risk of cyberbullying for individuals on the autism spectrum, in addition to the practices listed above, educators might wish to supplement ICT use with **instructions to guide appropriate online behaviour**.

- Finally, owing to social and communication difficulties, educators might offer **to facilitate online communication and review past interactions with autistic students**. This practice may help students apply newly acquired social skills to their everyday lives and increase confidence during online interactions.

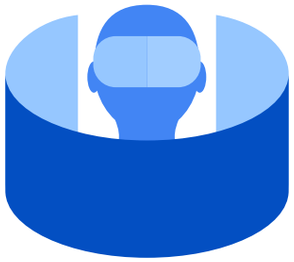
In light of these recommendations, school administrations must provide continuing education and training opportunities for educators supporting children on the autism spectrum. Indeed, studies highlight a pressing need for improved training and neurodiversity awareness among education professionals (Fleury & Kemper, 2022; Van Der Steen et al., 2020). Specifically, educators should be aware of the risks and opportunities of ICTs for autistic individuals and feel confident using these technologies when appropriate. Furthermore, educators frequently identify a lack of resources and time as the most significant barriers to implementing new interventions for children on the autism spectrum (Barry et al., 2020). Thus, administrators can support the efforts of special education teachers by providing adequate financial and human resources dedicated to implementing new interventions (e.g., supplying the necessary funds to acquire new tools like mobile tablets). Finally, researchers often seek to involve school personnel in studies evaluating interventions for school-aged children (including research with ICTs). Special-education teachers may therefore take the opportunity to get involved in research and advocate for the needs of autistic students. Specifically, feedback from special-education teachers can shape future iterations of software products to address the needs of those on the autism spectrum.

Summary of Recommendations

- → Educators may wish to use ICTs to promote the **development of social skills** among students on the autism spectrum.
- → Teachers may consider educating autistic students on the specific **opportunities and risks associated with ICT use**.
- → Educators may consider the **active mediation of ICT** use rather than restrictive mediation.
- → Educators can supplement ICTs with instructions to **guide appropriate online** behaviour and reduce cyberbullying risks for students on the autism spectrum.
- → Educators may offer to support students during online communications and **review past online interactions**.
- → **Administrators can support the efforts of special-education teachers** by providing continuing education opportunities and adequate financial and human resources.
- → Educators may wish to **participate in research regarding ICTs** and other interventions for students on the autism spectrum.

5 Emerging Issues – New Trends

New interventions tailored to the unique needs of students on the autism spectrum are a pressing concern for educators and clinicians. Although ICTs appear promising to supplement and support learning, more research must be done to understand the risks and benefits associated with ICT use among neurodiverse students. Due to the time spent in this environment, frequent peer interactions, and abundant opportunities to learn problem-solving strategies, the school setting presents a unique environment to develop social skills. Therefore, integrating new technologies into the school setting may be especially beneficial for children on the autism spectrum. For example, applied games, virtual reality, and robotics appear promising for training social skills such as imitation, attention and emotion production and recognition among autistic individuals (Grossard et al., 2018). One study evaluated the efficacy of a tablet-delivered intervention targeting language and social skills among children on the autism spectrum (Parsons et al., 2019). Results suggested that the participants demonstrated improved language and social skills following the intervention. Notably, these improvements were still present 12 months after the intervention (Parsons et al., 2019; 2020).



Applied games, virtual reality, and robotics appear promising for training social skills such as imitation, attention and emotion production and recognition among autistic individuals.

Moreover, virtual environments can provide a unique opportunity to mimic real-life situations while eliminating physical risks (Boucenna et al., 2014; Grossard et al., 2018). For example, virtual reality (VR) devices can immerse participants in life-like environments through advanced auditory and visual simulation (Dechsling et al., 2021). Other devices, such as augmented reality (AR) glasses, can supplement real-world experiences with superimposed images or sounds (Dechsling et al., 2021). Research demonstrates that VR and AR technologies can effectively teach social skills to individuals on the autism spectrum. In particular, virtual environments can help train emotion recognition (i.e., interpreting another's emotions), expression (i.e., displaying appropriate emotions for the situation), imitation (i.e., responding to another's emotions with congruent emotions) and joint attention (i.e., focusing on the same object as another person) among autistic individuals (Boucenna et al., 2014; Grossard et al., 2018). However, it is worth noting that sensory sensitivities and related anxiety concerns may make immersive VR experiences stressful for some individuals on the autism spectrum (McCleery et al., 2020). Nevertheless, many autistic participants report high levels of motivation and satisfaction with these interventions (Dechsling et al., 2021).

Forward-thinking educators and administrators may ask how these interventions could be integrated into the curriculum to support students on the autism spectrum. However, more research is necessary before drawing conclusions regarding the efficacy of ICTs among autistic students. Questions about which types of ICTs are most appealing, practical and effective for individuals on the autism spectrum remain unanswered. Future research should investigate the impact of differences in the intensity of autistic traits, gender and age on the risks and opportunities relating to ICTs (Macoun et al., 2021). For example, research should examine the effects of age on problematic ICT use among individuals on the autism spectrum (Macoun et al., 2021). Furthermore, research should measure the prevalence of cyberbullying in autistic adults, given that the current studies have excluded this age group (Macoun et al., 2021). Finally, considering that individuals on the autism spectrum are attracted to video games, future research should investigate the potential social benefits and risks associated with multiplayer games (Macoun et al., 2021).

Research demonstrates that VR and AR technologies can effectively teach social skills to individuals on the autism spectrum. In particular, virtual environments can help train emotion recognition, expression, imitation and joint attention among autistic individuals.

6 Lessons from Emergency Remote Education

The global COVID-19 pandemic created a pressing need for the remote education of all students, including those on the autism spectrum. Some students enjoyed remote learning, while others did not (Reicher, 2020). However, remote learning appears to be beneficial for autistic children and adolescents (Reicher, 2020). Specifically, remote education appears to reduce the social and sensory demands placed on young people on the autism spectrum (e.g., fewer unplanned social interactions and fewer distractions such as loud noises or odd smells) and limit the instances of bullying directed at neurodiverse students (Hill et al., 2021; Reicher, 2020). This online medium could therefore reduce the need for autistic children to camouflage (i.e., attempt to hide) their symptoms (Gillespie-Lynch et al., 2014). Furthermore, remote education may be less stressful than traditional school environments, given that individuals on the autism spectrum often experience stress associated with new settings and routine disruptions (Corbett et al., 2009). Moreover, research has demonstrated that remote education effectively meets the learning objectives of neurodiverse students (Aloizou et al., 2021). However, further research should examine the long-term social and academic consequences of remote learning in autistic children. This final point is especially important considering that, as discussed above, schools are an essential environment for developing and practising social skills (Kasari et al., 2011). Nevertheless, this emergency transition to remote education highlighted three key lessons for educators supporting children on the autism spectrum. Autistic children:

- learn best in the presence of nurturing social interactions (e.g., at home with family)
- benefit from more flexibility (e.g., the freedom to establish routines),
- prefer environments with fewer sensory demands (e.g., a room with few visual or auditory distractions; Hill et al., 2021).

Finally, the COVID-19 pandemic also highlighted the digital divide between low- middle- and high-income countries (Kumm et al., 2022). Numerous individuals on the autism spectrum live in low- to middle-income countries, limiting their access to technology (Kumm et al., 2022). Moreover, even within high-income countries, the digital divide affects disadvantaged families. In light of this, affordable, accessible and culturally appropriate ICTs offer a promising avenue for bridging the digital divide and supporting autistic individuals with a low socio-economic status (Kumm et al., 2022).

7 Further Reading

[Information & Communication Technologies Use by Children & Youth with Autism Spectrum Disorder: Promise and Perils (Macoun i in., 2021)]

This review of the scientific literature presents some important insights regarding the amount, type and reasons for ICT use among individuals on the autism spectrum. This article also discusses the benefits and risks of ICT use for autistic individuals. Finally, this review presents recommendations for future research and a framework to evaluate the benefits and risks of ICTs for individuals on the autism spectrum.

[Cyber-Aggression and Victimisation and Social Information Processing: Integrating the Medium and the Message (Runions i in., 2013)]

This article applies the social information processing theory to evaluate the potential impact of the inherent properties of ICTs on cyberbullying. This analysis highlights five features of ICTs that influence social information processing and, in turn, cyberbullying. Namely, the limited social cues, permanence of messages, lack of privacy measures, large audiences and continuous access afforded by ICTs can all influence cyberbullying. The authors also provide recommendations for future research.

References

Adams, R. E., Taylor, J. L., & Bishop, S. L. (2020). Brief report: ASD-related behavior problems and negative peer experiences among adolescents with ASD in general education settings. *Journal of Autism and Developmental Disorders, 50*(12), 4548–4552. https://doi.org/10.1007/s10803-020-04508-1

Aloizou, V., Chasiotou, T., Retalis, S., Daviotis, T., & Koulouvaris, P. (2021). Remote learning for children with special education needs in the era of COVID-19: Beyond teleconferencing sessions. *Educational Media International, 58*(2), 181–201. https://doi.org/10.1080/09523987.2021.1930477

American Psychiatric Association (2022). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425787

Area-Moreira, M., Hernández-Rivero, V., & Sosa-Alonso, J.-J. (2016). Models of educational integration of ICTs in the classroom. *Comunicar, 24*(47), 79–87. https://doi.org/10.3916/c47-2016-08

Aubineau, M., Blicharska, T. (2020). High-functioning autistic students speak about their experience of inclusion in mainstream secondary schools. *School Mental Health,* 12, 537–555. https://doi.org/10.1007/s12310-020-09364-z

Bahiss, K., Cunningham, S. J., & Smith, T. (2010). Investigating the usability of social networking sites for teenagers with autism. In *Proceedings of the 11th International Conference of the NZ Chapter of the ACM Special Interest Group on Human-Computer Interaction* (pp. 5–8). https://doi.org/10.1145/1832838.1832840

Bauminger, N., Shulman, C., & Agam, G. (2003). Peer interaction and loneliness in high-functioning children with autism. *Journal of autism and developmental disorders, 33*(5), 489–507. https://doi.org/10.1023/a:1025827427901

Bauer, J., & Kenton, J. (2005). Toward technology integration in the schools: Why it isn't happening. *Journal of Technology and Teacher Education, 13*(4), 519–547. Retrieved from: https://link.gale.com/apps/doc/A138483291/AONE?u=subd78095&sid=bookmark-AONE&xid=495dac1b

Barry, L., Holloway, J., & McMahon, J. (2020). A scoping review of the barriers and facilitators to the implementation of interventions in autism education. *Research in Autism Spectrum Disorders, 78*, 101617. https://doi.org/10.1016/j.rasd.2020.101617

Beckman, L., Hellström, L., & Kobyletzki, L. (2020). Cyberbullying among children with neurodevelopmental disorders: A systematic review. *Scandinavian Journal of Psychology, 61*(1), 54–67. https://doi.org/10.1111/sjop.12525

Bellini, S., Peters, J. K., Benner, L., & Hopf, A. (2007). A meta-analysis of school-based social skills interventions for children with autism spectrum disorders. *Remedial and Special Education, 28*(3), 153–162. https://doi.org/10.1177/07419325070280030401

Benford, P., & Standen, P. (2009). The internet: A comfortable communication medium for people with Asperger syndrome (AS) and high functioning autism (HFA)? *Journal of Assistive Technologies 3*(2), pp. 44–53. https://doi.org/10.1108/17549450200900015

Boucenna, S., Narzisi, A., Tilmont, E., Muratori, F., Pioggia, G., Cohen, D., & Chetouani, M. (2014). Interactive technologies for autistic children: A review. *Cognitive Computation, 6*(4), 722–740. https://doi.org/10.1007/s12559-014-9276-x

Burke, M., Kraut, R., & Williams, D. (2010). Social use of computer-mediated communication by adults on the autism spectrum. In *Proceedings of the 2010 ACM conference on Computer supported cooperative work* (pp. 425–434). https://doi.org/10.1145/1718918.1718991

Corbett, B. A., Schupp, C. W., Levine, S., & Mendoza, S. (2009). Comparing cortisol, stress, and sensory sensitivity in children with autism. *Autism Research, 2*(1), 39–49. https://doi.org/10.1002/aur.64

Craig, F., Tenuta, F., Andrea De Giacomo, Trabacca, A., & Costabile, A. (2021). A systematic review of problematic video-game use in people with autism spectrum disorders. Research in Autism Spectrum Disorders *82*, 101726–101726. https://doi.org/10.1016/j.rasd.2021.101726

Dechsling, A., Orm, S., Kalandadze, T., Sütterlin, S., Øien, R. A., Shic, F., & Nordahl-Hansen, A. (2021). Virtual and augmented reality in social skills interventions for individuals with autism spectrum disorder: A scoping review. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-021-05338-5

Dillon, G. V., Underwood, J. D. M., & Freemantle, L. J. (2016). Autism and the UK secondary school experience. *Focus on Autism and Other Developmental Disabilities, 31*(3), 221–230. https://doi.org/10.1177/1088357614539833

Dominguez, A., Ziviani, J., & Rodger, S. (2006). Play behaviours and play object preferences of young children with autistic disorder in a clinical play environment. *Autism, 10*(1), 53–69. https://doi.org/10.1177/1362361306062010

Fleury, V. P., & Kemper, T. (2022). An examination of education professionals' beliefs about causes of autism and their perceptions of practices. *Focus on Autism and Other Developmental Disabilities, 37*(3), 189–198. https://doi.org/10.1177/10883576211073685

Fombonne, E., MacFarlane, H., & Salem, A. C. (2021). Epidemiological surveys of ASD: Advances and remaining challenges. *Journal of autism and developmental disorders, 51*(12), 4271–4290. https://doi.org/10.1007/s10803-021-05005-9

Geelhand, P., Papastamou, F., Deliens, G., & Kissine, M. (2021). Judgments of spoken discourse and impression formation of neurotypical and autistic adults. *Research in Autism Spectrum Disorders, 82*, 101742. https://doi.org/10.1016/j.rasd.2021.101742

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. https://doi.org/10.1352/1934-9556-52.6.456

Grossard, C., Palestra, G., Xavier, J., Chetouani, M., Grynszpan, O., & Cohen, D. (2018). ICT and autism care: State of the art. *Current Opinion in Psychiatry, 31*(6), 474–483. https://doi.org/10.1097/YCO.0000000000000455

Heath, D., Maghrabi, R., & Carr, N. (2015). Implications of information and communication technologies (ICT) for school-home communication. *Journal of Information Technology Education: Research, 14*, 363–396. Retrieved from: http://www.jite.org/documents/Vol14/JITEv14ResearchP363-395Heath1876.pdf

Hersh, Leporini, B., & Buzzi, M. (2020). ICT to support inclusive education: Introduction to the special thematic session. In *Computers Helping People with Special Needs* (pp. 123–128). Springer International Publishing. https://doi.org/10.1007/978-3-030-58805-2_15

Hill, C., Keville, S., & Ludlow, A. K. (2021). Inclusivity for children with autism spectrum disorders: Parent's reflections of the school learning environment versus home learning during COVID-19. *International Journal of Developmental Disabilities, 1*–9. https://doi.org/10.1080/20473869.2021.1975253

Holfeld, B., Stoesz, B., & Montgomery, J. (2019). Traditional and cyberbullying and victimization among youth with autism spectrum disorder: An investigation of the frequency, characteristics, and psychosocial correlates. *Journal on Developmental Disabilities, 24*(2), 61–76. Retrieved from: https://oadd.org/wp-content/uploads/2019/12/41028-JoDD-24-2-v11f-61-76-Holfeld-et-al.pdf

Iglesias O., Sanchez L. E., Rodriguez M. A. (2019) Do young people with Asperger's syndrome or intellectual disability use social media and are they cyberbullied or cyberbullies in the same way as their peers? *Psicothema, 31*(1), 30–37.

Jellema, T., Lorteije, J., van Rijn, S., van t' Wout, M., de Haan, E., van Engeland, H., & Kemner, C. (2009). Involuntary interpretation of social cues is compromised in autism spectrum disorders. *Autism Research, 2*(4), 192–204. https://doi.org/10.1002/aur.83

Kasari, C., Rotheram-Fuller, E., Locke, J., & Gulsrud, A. (2011). Making the connection: Randomized controlled trial of social skills at school for children with autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 53*(4), 431–439. https://doi.org/10.1111/j.1469-7610.2011.02493.x

Kumm, A. J., Viljoen, M., & de Vries, P. J. (2022). The digital divide in technologies for autism: Feasibility considerations for low- and middle-income countries. *Journal of Autism and Developmental Disorders, 52*(5), 2300–2313. https://doi.org/10.1007/s10803-021-05084-8

Lee, S. J. (2013). Parental restrictive mediation of children's internet use: Effective for what and for whom? *New Media and Society, 15*(4), 466–481. https://doi.org/10.1177/1461444812452412

Liu, G., Wu, N., & Chen, Y. (2013). Identifying emerging trends for implementing learning technology in special education: A state-of-the-art review of selected articles published in 2008–2012. *Research in Developmental Disabilities, 34*(10), 3618–3628. https://doi.org/10.1016/j.ridd.2013.07.007

Livingstone, S., & Blum-Ross, A. (2020). *Parenting for a digital future: How hopes and fears about technology shape children's lives*. Oxford University Press: USA.

MacMullin, J. A., Lunsky, Y., & Weiss, J. A. (2016). Plugged in: Electronics use in youth and young adults with autism spectrum disorder. *Autism, 20*(1), 45–54. https://doi.org/10.1177/1362361314566047

Macoun, S. J., Bedir, B., Runions, K., Barker, L. E., Halliday, D., & Lewis, J. (2021). Information and communication technologies use by children and youth with autism spectrum disorder: Promise and perils. *Journal of Psychiatry and Behavioral Sciences, 4*(1), 1–11.

Mazurek, M. O., & Kanne, S. M. (2010). Friendship and internalizing symptoms among children and adolescents with ASD. *Journal of Autism and Developmental Disorders, 40*(12), 1512–1520. https://doi.org/10.1007/s10803-010-1014-y

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*(8), 1757–1767. https://doi.org/10.1007/s10803-011-1413-8

McCleery, J. P., Zitter, A., Solórzano, R., Turnacioglu, S., Miller, J. S., Ravindran, V., & Parish-Morris, J. (2020). Safety and feasibility of an immersive virtual reality intervention program for teaching police interaction skills to adolescents and adults with autism. *Autism Research, 13*(8), 1418–1424. https://doi.org/10.1002/aur.2352

Mendelson, J. L., Gates, J. A., & Lerner, M. D. (2016). Friendship in school-age boys with autism spectrum disorders: A meta-analytic summary and developmental, process-based model. *Psychological Bulletin, 142*(6), 601–622. https://doi.org/10.1037/bul0000041

Modecki, K. L., Minchin, J., Harbaugh, A. G., Guerra, N. G., & Runions, K. C. (2014). Bullying prevalence across contexts: A meta-analysis measuring cyber and traditional bullying. *Journal of Adolescent Health, 55*(5), 602–611. https://doi.org/10.1016/j.jadohealth.2014.06.007

Moss, P., Howlin, P., Savage, S., Bolton, P., & Rutter, M. (2015). Self and informant reports of mental health difficulties among adults with autism findings from a long-term follow-up study. *Autism, 19*(7), 832–841. https://doi.org/10.1177/1362361315585916

Ntalindwa, T., Soron, T. R., Nduwingoma, M., Karangwa, E., & White, R. (2019). The use of information communication technologies among children with autism spectrum disorders: Descriptive qualitative study. *JMIR Pediatrics and Parenting, 2*(2), e12176. https://doi.org/10.2196/12176

Ong, C. S., Chang, S. C., & Wang, C. C. (2011). Comparative loneliness of users versus nonusers of online chatting. *Cyberpsychology, Behavior, and Social Networking, 14*(1–2), 35–40. https://doi.org/10.1089/cyber.2009.0321

Ostryn, C., & Mincic, M. S. (2022). A literature review of social communication interventions for individuals with autism spectrum disorder in general education settings. *Current Developmental Disorders Reports, 9*(2), 19–36. https://doi.org/10.1007/s40474-022-00247-3

Park, I., Gong, J., Lyons, G. L., Hirota, T., Takahashi, M., Kim, B., Lee, S., Kim, Y. S., Lee, J., & Leventhal, B. L. (2020). Prevalence of and factors associated with school bullying in students with autism spectrum disorder: A cross-cultural meta-analysis. *Yonsei Medical Journal, 61*(11), 909. https://doi.org/10.3349/ymj.2020.61.11.909

Parsons, D., Cordier, R., Lee, H., Falkmer, T., & Vaz, S. (2019). A randomised controlled trial of an information communication technology delivered intervention for children with autism spectrum disorder living in regional Australia. *Journal of Autism and Developmental Disorders, 49*(2), 569–581. https://doi.org/10.1007/s10803-018-3734-3

Parsons, D., Vaz, S., Lee, H., Robinson, C., & Cordier, R. (2020). A twelve-month follow-up of an information communication technology delivered intervention for children with autism spectrum disorder living in regional Australia. *Research in Developmental Disabilities, 106*, 12. https://doi.org/10.1016/j.ridd.2020.103743

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. https://doi.org/10.1177/1088357610378291

Petrina, N., Carter, M., & Stephenson, J. (2014). The nature of friendship in children with autism spectrum disorders: A systematic review. *Research in Autism Spectrum Disorders*, 8(2), 111–126. https://doi.org/10.1016/j.rasd.2013.10.016

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. https://doi.org/10.3109/17518423.2011.651655

Reicher, D. (2020). Debate: Remote learning during COVID-19 for children with high functioning autism spectrum disorder. *Child and Adolescent Mental Health, 25*(4), 263–264. https://doi.org/10.1111/camh.12425

Rowley, E., Chandler, S., Baird, G., Simonoff, E., Pickles, A., Loucas, T., & Charman, T. (2012). The experience of friendship, victimization and bullying in children with an autism spectrum disorder: Associations with child characteristics and school placement. *Research in Autism Spectrum Disorders, 6*(3), 1126–1134. https://doi.org/10.1016/j.rasd.2012.03.004

Runions, K., Shapka, J. D., Dooley, J., & Modecki, K. (2013). Cyber-aggression and victimization and social information processing: Integrating the medium and the message. *Psychology of Violence, 3*(1), 9–26. https://doi.org/10.1037/a0030511

Sansosti, F. J., Doolan, M. L., Remaklus, B., Krupko, A., & Sansosti, J. M. (2015). Computer-assisted interventions for students with autism spectrum disorders within school-based contexts: A quantitative meta-analysis of single-subject research. *Review Journal of Autism and Developmental Disorders, 2*(2), 128–140. https://doi.org/10.1007/s40489-014-0042-5

Skafle, I., Nordahl-Hansen, A., & Øien, R. A. (2020). Short report: Social perception of high school students with ASD in Norway. *Journal of Autism and Developmental Disorders, 50*(2), 670–675. https://doi.org/10.1007/s10803-019-04281-w

Tsiopela, D., & Jimoyiannis, A. (2017). Pre-vocational skills laboratory: Designing interventions to improve employment skills for students with autism spectrum disorders. *Universal Access in the Information Society*, 16, 609–627. https://doi.org/10.1007/s10209-016-0488-6

van der Aa, C., Pollmann, M. M. H., Plaat, A., & van der Gaag, R. J. (2016). Computer-mediated communication in adults with high-functioning autism spectrum disorders and controls. *Research in Autism Spectrum Disorders, 23*, 15–27. https://doi.org/10.1016/j.rasd.2015.11.007

Van Der Steen, S., Geveke, C. H., Steenbakkers, A. T., & Steenbeek, H. W. (2020). Teaching students with autism spectrum disorders: What are the needs of educational professionals? *Teaching and Teacher Education, 90*, 103036. https://doi.org/10.1016/j.tate.2020.103036

Van Eylen, L., Boets, B., Steyaert, J., Wagemans, J., & Noens, I. (2015). Executive functioning in autism spectrum disorders: Influence of task and sample characteristics and relation to symptom severity. *European Child & Adolescent Psychiatry, 24*(11), 1399–1417. https://doi.org/10.1007/s00787-015-0689-1

White, S. W., Oswald, D., Ollendick, T., & Scahill, L. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Clinical Psychology Review, 29*(3), 216–229. https://doi.org/10.1016/j.cpr.2009.01.003

White, S. W., Keonig, K., & Scahill, L. (2006). Social skills development in children with autism spectrum disorders: A review of the intervention research. *Journal of Autism and Developmental Disorders, 37*(10), 1858–1868. https://doi.org/10.1007/s10803-006-0320-x

Wolke, D., & Lereya, S. T. (2015). Long-term effects of bullying. *Archives of Disease in Childhood, 100*(9), 879–885. https://doi.org/10.1136/archdischild-2014-306667

Zeidan, J., Fombonne, E., Scorah, J., Ibrahim, A., Durkin, M. S., Saxena, S., Yusuf, A., Shih, A., & Elsabbagh, M. (2022). Global prevalence of autism: A systematic review update. *Autism Research, 15*(5), 778–790. https://doi.org/10.1002/aur.2696