Can Artificial Intelligence and Virtual Reality Help Improve Social Skills in Children with Autism Spectrum Disorder?

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ABSTRACT

Autism is a developmental disorder that can impede a child's communication, social interaction and behavioral skills. Children with autism may have difficulty recognizing emotional expressions and understanding social cues. Traditional therapy and educational programs for children with autism help them develop skills such as communication, emotional recognition, eye contact and social interaction. With the advancement of technology, researchers are constantly searching for new technologies to provide additional support to children with autism. Technology can improve the overall learning process for autistic children by making it more structured, interactive and personalized.

The purpose of this paper is to compare the use of artificial intelligence (AI) and virtual reality (VR) technologies for the development of social and communication skills in children with autism. The study uses a literature-based comparative case study approach to examine current technologies and their four different applications including the Floreo virtual reality platform, the Milo social robot, Proloquo2Go and other accessibility tools, and virtual reality job-interview training programs. The case studies are analyzed using the same criteria to compare how the technologies work, their social and educational outcomes, and their major limitations.

The findings show that AI and VR can provide structured and controlled environments where autistic learners can repeatedly practice communication, emotional recognition and social interaction skills. However, cost, unequal access, the need for training and privacy concerns remain important barriers. Although these technologies may not replace human interaction, they can be useful complementary tools in autism education and support.

Keywords: Autism Spectrum Disorder (ASD), Artificial Intelligence (AI), Virtual Reality (VR), Social Skills, Communication Skills, Assistive Technology, Autism Education

INTRODUCTION

Imagine having a face-to-face conversation with someone where you're unable to read the person's facial expressions. Their eyebrows rise, but you don't realize they are getting surprised; if they frown, you're carrying on the conversation without realizing that your speech might be offending them. How confusing would it be for you when you're not sure when someone "suddenly" stops talking to you or walks away from your conversation. You're not able to read people's emotions and therefore not able to make meaningful conversations or create emotional bonds that are crucial to the human experience. For many individuals with autism spectrum disorder (ASD), this is a part of everyday life. Autism Spectrum Disorder (ASD), is a neurodevelopmental condition that affects how individuals process information, communicate with others and generally experience the world around them. If we were to look at the United States alone, 1 in 36 children has been identified with ASD, making it one of the most widespread development conditions among children worldwide (CDC, 2024). As shown in Figure 1, ASD prevalence rates in the U.S. have risen steadily since 2014, while reported use of technology-based interventions in autism education has grown in parallel. This shows the growing demand for scalable support solutions.

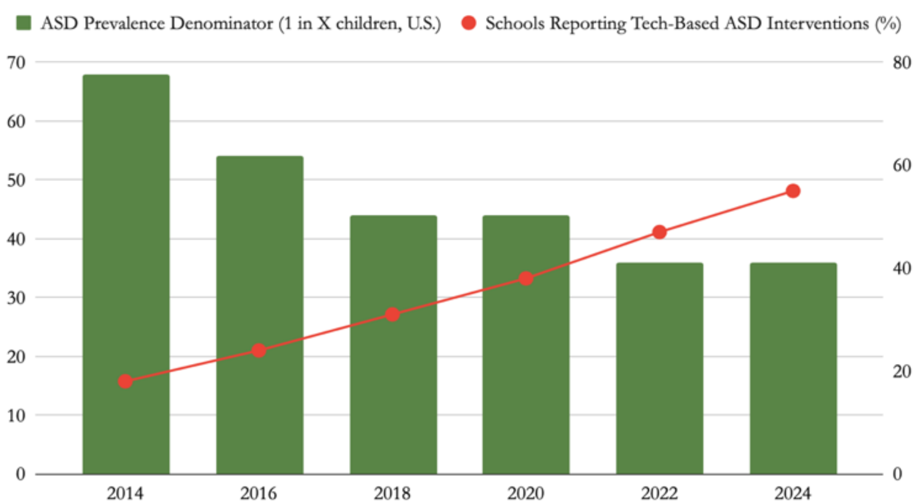

Figure 1. ASD Prevalence & Technology Adoption in Autism Education (2014–2024)

Note- A declining denominator indicates rising prevalence (e.g., 1 in 36 represents higher prevalence than 1 in 68). ASD prevalence data from CDC (2024) surveillance reports. Technology adoption figures are analytical estimates synthesized from AHRQ (2017) and educational technology surveys, representing relative trends rather than exact universal measurements.

Sources- Centers for Disease Control and Prevention (CDC, 2024); Agency for Healthcare Research and Quality (AHRQ, 2017).

According to the World Health Organization (WHO, 2023), a defining characteristic of children with ASD is challenges with social communication, including understanding social cues, recognizing emotions, interpreting facial expressions, and maintaining eye contact. These difficulties may affect everyday interactions and children with ASD may find it difficult to participate fully in social, educational and community activities.

Many with ASD also experience sensory sensitivities which affect how they engage with others (NIMH, 2023). Everyday sounds, lights, textures, or new environments can become overwhelming, which results in an avoidance of social situations or opportunities to practice real-world communication skills. These difficulties do not translate well in classrooms or social environments, where students may struggle to understand social norms and respond appropriately to social cues. As a result, misunderstandings may occur and behaviors stemming from communication difficulties may be misinterpreted by neurotypical individuals as rude. This can contribute greatly to feelings of isolation and have a negative impact both academically and emotionally.

Early intervention is widely accepted as an effective approach for supporting children with ASD, since it can improve communication, develop social skills, support self-regulation, and enhance independence in children with autism (NIMH, 2023). Traditional therapies such as Applied Behavior Analysis (ABA) and speech therapy have also been shown to improve communication and social skills. However, they may not always provide the level of personalized and flexible engagement needed to meet the diverse learning needs of each child (Weitlauf et al., 2014).
The growing use of technology has transformed many areas of healthcare and education. More recently, artificial intelligence (AI) and virtual reality (VR) have emerged as promising tools for autism education and therapy. They offer opportunities to create personalized interactive learning experiences that can complement traditional therapies. AI can analyze user responses and adapt activities to meet each user's learning needs, allowing students to progress at their own pace.
VR, on the other hand, can immerse users in realistic environments where they can practice social interactions and communication skills. These technologies can be used hand in hand to

provide a structured learning experience that would otherwise be difficult to encounter in the real world.

Technology-based learning environments can be particularly valuable because they allow children to practice social skills in a simulated setting under controlled conditions (Diehl et al., 2012). AI and VR supported platforms can offer immediate feedback and adjust activities to meet each learner's needs, helping children build confidence in any social situation. Researchers have increasingly explored these technologies as tools that provide structured, repeatable, and personalized opportunities for social learning (Parsons, 2016).

Although interest in technology-assisted autism interventions has grown significantly, much of the existing research has looked at AI and VR as separate tools, either focusing on the effectiveness of AI-based educational applications or VR-based social training. Comparative research that combines both AI and VR within autism support programs are limited (Simões et al., 2018). As schools, therapists, and families continue adopting digital tools, understanding the combined potential of these technologies becomes all the more important. Studying how both AI and VR can work together may provide valuable insights into how these technologies can improve social learning in children with ASD while also addressing practical challenges such as cost, accessibility and real-world use.

The Central Research Question guiding this study is "Can artificial intelligence and virtual reality help improve social skills and communication in children with autism spectrum disorder?"

The Thesis Statement for this paper is Artificial intelligence and virtual reality together help children with autism develop social and communication skills through personalized and interactive learning experiences. When used alongside traditional interventions, these technologies can provide additional opportunities to practice and improve these skills. However, factors such as cost, accessibility, technology availability, and the need for supervision may affect their wider use and success in the long run.

LITERATURE REVIEW

Social and Communication Challenges in Autism

A common behavioral trait seen in most individuals with ASD is difficulty interpreting facial expressions, emotions and nonverbal social cues. As a result, individuals on the autism spectrum often tend to struggle with starting and maintaining conversation with peers, which can reduce social interactions in both the classroom and in everyday life (Kasari et al., 2011) and (Klin et al., 2003). Difficulties understanding social cues which are often interpreted naturally by neurotypical individuals, can make social interactions confusing and unpredictable for individuals with ASD, often adding to their anxiety in social situations. These challenges can become even more pronounced in situations that require frequent social interaction, like classrooms and unfamiliar environments, especially when there is an overload of sensory stimuli including large crowds, bright lights, or loud noises. Such environments can overwhelm individuals with ASD and may further restrict their social participation.

Research has shown that when children with ASD are placed in a structured and predictable learning environment, it reduces their anxiety and encourages greater engagement and participation in social interactions (National Autism Center [NAC], 2015). For this reason, structured, predictable routines, including technology-based learning are often used for children with ASD to reduce uncertainty and support social learning (NAC, 2015). People with autism, both children and adults alike, require help in developing communication and social skills, particularly those who exhibit delayed speech or are nonverbal (World Health Organization [WHO], 2023). This underscores the need and importance of communication and social skills support for individuals with autism

Artificial Intelligence in Autism Support

Many classrooms, therapy sessions and special education institutions use a number of artificial intelligence-based tools to support students with autism. These tools are of immense help to autistic students to build social and emotional skills and improve their overall communication with neurotypical individuals. Unlike older, traditional methods, AI can finetune and adjust activities and lessons based on each individual student's needs, responses and progress. This not only makes the whole learning experience personalized but also very engaging.

Another field that deserves special mention is AI based social robotics. Social robotics programs are designed to help students develop emotional recognition skills by teaching them how to identify and respond to facial expressions and emotions through real time interactive feedback (Pennisi et al., 2016). A well-known example is Milo Robot by RoboKind which uses AI to provide very structured social and emotional learning lessons. These lessons are highly interactive and engage autistic students to better understand social concepts and participate enthusiastically in the learning process (RoboKind, 2024).

AI can also help nonverbal and minimally verbal students communicate more independently through Augmentative and Alternative Communication (AAC) tools. Studies have shown that AAC technologies can help autistic students develop more expressive language while also improving their communication and social participation skills (Ganz, 2015). For example, Proloquo2Go uses predictive technology in classroom settings, to recommend words and phrases, helping autistic students express their thoughts easily and independently (Assistiveware, 2024). AI powered tools like captions, voice commands and reading support features provide further support to students with ASD by reducing communication barriers.

Together, these systems highlight the fact that AI has the potential to help autistic individuals with supportive and customized learning environments which provide personalized feedback and model social behaviors. However, factors such as cost, access to technology, and the possibility of becoming too dependent on devices remain important concerns for schools and families.

Virtual Reality in Autism

While artificial intelligence can customize learning to an individual's specific needs, virtual reality goes a step further by helping students with autism practice social interactions in safe, realistic and above all controlled environments. VR can recreate everyday school experiences like entering a classroom, walking through hallways, or even interacting with classmates. VR provides a safe space where children with ASD can practice social skills, make mistakes, and learn from them without the anxiety causing pressure and uncertainty which are so typical of the real world (Bellani et al., 2011). This makes the learning experience less overwhelming and more manageable for autistic students.

Existing studies show that when autistic individuals regularly and repeatedly practice in a virtual environment, there is a noticeable improvement in their social and communication skills. For example, a study by Kandalaft et al. (2013) found that VR-based social training helped participants improve their understanding of emotions, social situations, and conversation skills. Many persons with ASD benefit from routine and repetition and VR ensures that interactions in the same social situations can be practiced multiple times under predictable and controlled conditions. This can help students become more familiar with social interactions and build confidence in an unhurried and non-stressful manner. Similarly, Didehbani et al. (2016) found that the benefits of VR training extended beyond childhood and were very useful in workplace settings as well. The study found that VR training reduced anxiety and stress in autistic individuals by making them better understand workplace expectations and social norms. It gave them an opportunity to practice social interactions and workplace behaviors well in advance thus supporting their independence in the long run.

Today, VR-based learning tools are being used in schools, therapy centers, and hospitals to help autistic students develop important social and life skills. One such example is the Floreo platform which is very popular in the United States. It includes lifelike lessons on eye contact, emotional recognition, and routine social interactions in a community (Floreo Inc., 2024). However, these benefits are accompanied by certain challenges. The cost of equipment can be high and access to VR headsets is limited. Additionally, the need for staff with specialized training can create further barriers for some schools and families to implement these programs.

Combining AI and VR Technologies

Both Artificial Intelligence and Virtual Reality offer meaningful support for learners with autism on their own, but what happens when they are used together? By using a combination of AI and VR, researchers can create learning activities that are tailored to each learner's individual strengths, challenges and progress, at a level that neither can fully achieve on their own (Zhao et al., 2018; Lorenzo et al., 2016).

AI systems can track a student's behavior, emotional responses, and progress during VR lessons, and adjust the difficulty level or make changes to the pace of the activity in real time to offer the right level of support. The level of personalization is especially useful for students with ASD as no two individuals experience social, communication and behavioral challenges in exactly the same way. For example, if the system finds that a student is struggling with maintaining eye contact or initiating a conversation, it can immediately address the problem and provide support like simplifying the dialogue, slowing down the pace or providing more visual cues. Thus, students develop their social skills gradually without getting overwhelmed. These gains are likely due to the balance of VR's structure and AI's flexibility. While VR provides predictable, lifelike practice activities, AI provides support tailored to each learner's individual needs.

These combined systems are already being used in therapy programs and classrooms to provide personalized support to students with ASD and help them recognize emotions and develop conversation and other social skills (Lorenzo et al., 2016).

Despite these benefits, there are barriers to wider adoption, including high equipment costs and the need for trained staff (Parsons, 2016). Educators and families have also raised concerns that overreliance on technology could reduce direct human interaction. As shown in Figure 2, AI tools and VR systems differ across several key dimensions of autism intervention, with AI excelling in personalization and communication support, and VR excelling in immersion and social scenario realism.

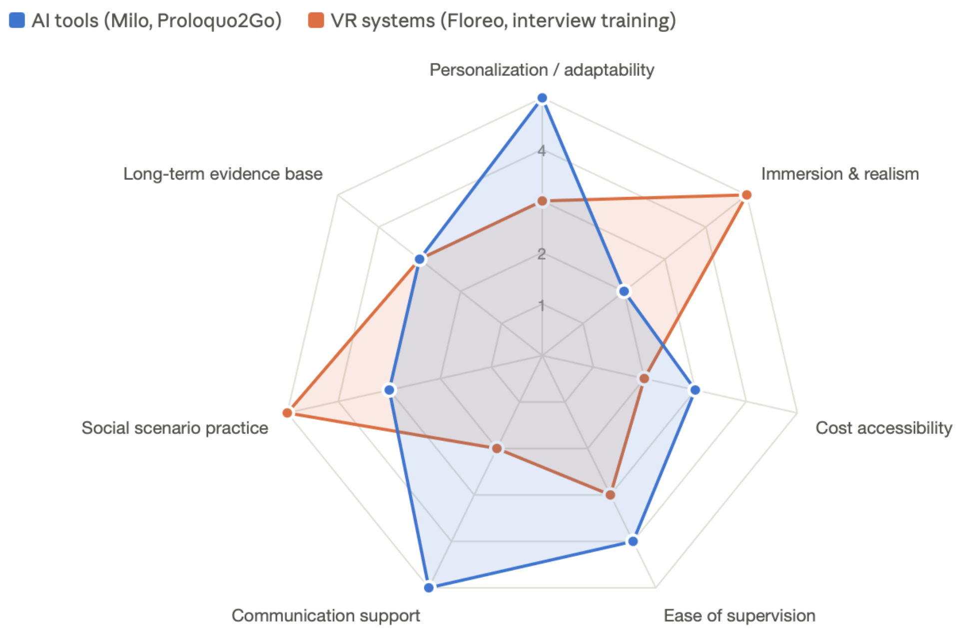

Figure 2. Comparison of AI Tools vs. VR Systems in Autism Intervention (2014–2024)
Note- Scores are analytical estimates derived from comparative findings in the literature review rather than standardized measurements; they represent the relative strengths of each technology type on a 1–5 scale, where 5 indicates the strongest performance on a given dimension and 1 indicates the weakest. AI tools show stronger performance in personalization and communication support, while VR systems show stronger performance in immersion and social scenario realism.
Sources- Pennisi et al. (2016); Ganz (2015); Floreo Inc. (2024); Lorenzo et al. (2016); Parsons (2016); Zhao et al. (2018).

METHODOLOGY

This study uses a qualitative literature-based comparative case study methodology to examine how artificial intelligence (AI) and virtual reality (VR) technologies are used to support social skills development in children with autism spectrum disorder (ASD). The research mainly focuses on published academic studies, educational reports, therapy programs, and existing technology-based interventions related to autism education and communication support.

A literature review was conducted using sources from Google Scholar, PubMed, SpringerLink, ResearchGate, and educational technology journals. The selected studies mainly focused on AI learning tools, virtual reality therapy systems, communication technologies, and social-skills training programs designed for children with autism. Sources published within the last 10 years were prioritized to ensure that the technologies discussed in this paper are recent and relevant.

The study also uses a comparative case study approach to examine different examples of AI and VR technologies currently used in educational and therapeutic settings. The selected case studies include the Floreo VR platform, Milo Robot by RoboKind, Google accessibility tools, and VR interview training simulations. These case studies were chosen because they represent different approaches to improving communication, emotional understanding, and social interaction skills in children with ASD.

Each case study was analyzed using similar categories, including the purpose of the technology, how it supports social learning, benefits, limitations, and real-world outcomes. This study does not involve direct experimentation or participant testing. Instead, it compares findings from existing studies and programs to identify common patterns, advantages, and challenges associated with AI and VR-based autism interventions.

RESULTS

Floreo Virtual Reality Therapy Platform

Background

Floreo is a virtual reality therapy and learning tool made for learners with ASD. It uses mobile VR headsets to give students safe and guided practice with their social and communication skills. The platform was created to help students who benefit from predictable, structured ways of learning. Floreo's curriculum includes eye contact, following directions, emotional awareness, and navigating everyday places like stores, airports, and crosswalks (Floreo Inc., 2024). Schools and therapy centers can use Floreo to integrate VR sessions into their existing programs, especially for those students who need extra support with social situations. Therapists and teachers stay involved throughout each session, using an app to monitor the child and adjust the lesson based on the areas where the student is struggling and needs additional support.

In 2019, a pilot study tested the Floreo platform at Celebrate the Children, a private special education school in New Jersey. The study included 12 autistic students aged between 9 to 16 years who were evaluated over a five-week period. The students completed 14 sessions using Floreo's Joint Attention Module, which specifically focused on skills such as eye contact and initiating and responding to social interactions. The study showed encouraging results, with students completing 97.6% of the VR sessions they started. An interesting feature of the study was that researchers actually recorded students' social behaviors before and after the 5-week study period. 75% of the 12 students showed an increase in total number of social interactions, 58% showed improvement in eye contact while 42% initiated more interactions socially (Ravindran et al., 2019).

Overall, Floreo was built to give learners with autism a calm, repeatable space to practice skills that can often feel overwhelming in the real world.

Technology and System Design

Floreo works through a VR headset used by the learner paired with a tablet app for the therapist, teacher, or any other caregiver the child is working with. The headset shows simple, controlled social scenarios, like greeting someone, identifying emotions, or practicing everyday community safety skills. To provide the appropriate level of support, the supervising adult can pause, repeat, or slow down the lesson based on how the student is doing (Floreo Inc., 2024). Floreo focuses on predictable visuals, clear prompts, and step by step activities. This structured format makes learning easier as it may reduce sensory overload and keeps the student focused. Research on similar VR systems shows that repeated practice in virtual environments can help autism learners feel more confident and much less anxious when facing real-life social situations (Parsons, 2016).

Social and Educational Outcomes

Studies on VR-based autism interventions show improvements in eye contact, emotional recognition, and willingness to participate in social tasks (Kandalaft et al., 2013). One of the main advantages of Floreo is that students can practice these social skills repeatedly in a calm and predictable setting before trying them in real-life social situations (Floreo Inc., 2024). Many learners display more confidence when practicing skills like greetings, identifying feelings, or responding to simple social cues, as they can practice and become comfortable at their own pace (Parsons, 2016).

As observed in the pilot study in New Jersey, more than 97% of the VR-based activities that were started were completed, suggesting that Floreo's lessons were generally well tolerated and that students were able to remain involved long enough to complete them (Ravindran et al., 2019).

The controlled VR setting also helps reduce distractions, which makes it easier for students to stay on task (Parsons, 2016). Floreo's lessons allow students to practice everyday situations like visiting stores or airports, helping them to develop familiarity before facing these situations in the real world (Floreo Inc., 2024).

Limitations and Challenges

Unfortunately, there are some limitations to Floreo, the cost being one of the biggest challenges. VR headsets, tablets, other equipment can be expensive for lower-income schools and smaller therapy programs (Parsons, 2016). Even though Floreo uses mobile VR, there are ongoing subscription costs which can add up over time. The platform also requires adult supervision during the sessions, which can be difficult in schools or therapy centers with limited staff. Some students may also struggle with wearing a headset due to sensory sensitivities. Although the New Jersey pilot study found that the Floreo technology was generally well tolerated, the study was limited to just 12 students, making it difficult to generalize the findings to all autistic learners (Ravindran et al., 2019)

Another challenge is that long-term research on VR therapy for autism is still limited. While the early results are definitely encouraging, more studies are needed to really understand how well VR skills are retained over time and applied successfully in everyday life (Parsons, 2016).

Milo Robot by RoboKind

Background

Milo Robot is a humanoid robot the size of a child created by RoboKind to support learners with ASD in special settings including schools and therapy centers. The robot teaches social and emotional skills through predictable and scripted lessons. Social robots like Milo were designed to provide consistent, predictable and non-judgmental interactions, which many children with autism may find easier to understand than complex, unpredictable and often overwhelming human interactions (Pennisi et al., 2016; Scassellati et al., 2012). Milo's lessons focus on skills such as facial expression and emotional recognition, conversational skills, and understanding basic social rules (RoboKind, 2024). Rather than getting autistic students to immediately practice these skills with another human, Milo gives them a chance to first practice these skills in a structured and predictable environment. The robot can also repeat the same lesson multiple times without frustration and change in tone, helping students develop a sense of familiarity and comfort (Pennisi et al., 2016).

Technology and Learning Features

Developed by RoboKind, Milo is approximately two feet tall and uses facial expressions, gestures, speech, and a screen on its chest (RoboKind, 2024). Its child-like appearance and predictable responses were incorporated so that students with autism feel comfortable and less intimidated while learning with Milo.

Milo uses AI-supported interactions alongside facial animations and structured lessons. The robot shows clear facial expressions and body language while explaining emotions giving students a chance to connect different facial expressions with the emotions they represent (Pennisi et al., 2016). For learners who benefit from routine, lessons can be repeated and follow the same pattern each time. Milo also guides students through practicing conversations and turn-taking activities (RoboKind, 2024) The robot can adjust its pace based on student responses, and teachers can track progress through a connected device and offer additional support when needed (RoboKind, 2024). The predictable design can reduce the complexity of human interaction and may help students stay focused (Pennisi et al., 2016). Milo’s lessons can easily be incorporated into classroom routines and therapy sessions which makes it a useful tool for students who benefit from consistent, step-by-step instruction.

Educational Outcomes

Research shows that when working with robots, students with autism are often more engaged and show fewer avoidance behaviors compared to human interactions (Pennisi et al., 2016). For example, in 2019, researchers at the Callier Center for Communication Disorders at the University of Texas at Dallas studied how children with autism responded to Milo compared with a human therapist. The study included nine children between the ages of 5 and 14, including both minimally verbal children as well as those who could speak fluently. The sessions were recorded and researchers measured how much time the children remained engaged with Milo and with the human therapist. The results showed that the children with fluent speech engaged with Milo around 87.5% of the time compared to only about 2–3% with the human therapist (RoboKind, n.d.). Among minimally verbal children, engagement with Milo was 67.81%, compared with 2.37% with the therapist. The results showed that Milo was able to maintain high engagement levels with the children in this study.

Another Milo-specific study was conducted in Macao and published in 2021. Researchers from the University of Saint Joseph worked with the Macao Science Center and Macao Autism Association to understand whether Milo could be of use with autistic children in Macao. The study involved 4 children between the ages of 6 and 12. The children participated in activities involving emotional recognition, greetings, conversations and other basic social skills. All four students were able to understand and complete the exercises while parents also reported an improvement in their children's understanding of emotions (Teixeira & Lai, 2021). Overall, these outcomes suggest that the Milo robot can be a useful learning tool for children with autism, but it should be used to support rather than replace interactions with teachers and therapists. However, the results were mixed and we will discuss the challenges in the next segment.

Limitations and Challenges

The main limitation is the high cost. Robotic systems are expensive, and many schools and therapy centers may not be able to afford the hardware or training required to use them. The robot also works best in structured environments with well-established routines and trained staff, which may not be available in all classrooms (Pennisi et al., 2016).

The Macau study had its own specific limitations. Some of the older and higher functioning students found the lessons to be too simple and boring. Additionally, there was a language barrier as Milo communicated in English while the children spoke Cantonese. Children were also unfamiliar with some social situations used in the lessons due to cultural differences (Teixeira & Lai, 2021). These findings suggest that the usefulness of the Milo robot might vary due to differences in age, ability, language, and cultural background (Teixeira & Lai, 2021).

Additionally, there is a lack of long-term research. Early results are promising, but longer studies are needed to understand whether skills learnt from Milo are successfully retained and applied in the real world in the long run (Pennisi et al., 2016; Scassellati et al., 2012). There is also the risk of over-reliance on robotic instruction, at the cost of human interaction.

Proloquo2Go and AI-Supported Accessibility Tools

Background

Proloquo2Go is an augmentative and alternative communication (AAC) app which has been designed to support people who have difficulty using speech to communicate. This includes autistic learners who are either nonspeaking or minimally verbal. The app lets students communicate using symbols, buttons, and voice output on a tablet or phone (Assistiveware, 2024). It is a portable communication system that can be customized to each student's specific needs. Users can select symbols and words to create a message, which the app can then speak aloud.

Besides dedicated AAC apps such as Proloquo2Go, there are other broader accessibility tools developed by companies such as Google that can provide additional support. Google's accessibility tools include features like Live Caption, Voice Access, and text-to-speech that make digital information easier to access in different ways (Google LLC, 2024). Live Caption converts speech and other audio into written captions, Voice Access allows users to control compatible devices through spoken commands, and text-to-speech can read digital content aloud (Google LLC, 2024). Although Google's tools were not developed specifically for autism support, they can be very useful for autistic students with specific communication and accessibility needs.

Overall, both Proloquo2Go and the other technologies discussed above can support different sides of communication. Proloquo2Go helps students express themselves while Google's tools can help them better access incoming information.

Technology and Communication Features

Proloquo2Go works through customizable symbol boards, adjustable vocabulary sets, and voice output. Tapping icons or words allows users to create messages which the app then speaks. This helps nonverbal or minimally verbal students to get their message across and communicate more clearly (AssistiveWare, 2024). The layout can be changed depending on individual needs and abilities like motor skills, reading level and sensory needs. The vocabulary can also be adjusted as the user's communication skills improve (AssistiveWare, 2024). This flexibility is important because autistic students often have very different communication abilities and may require different levels of support.

Google's tools, on the other hand, use technologies such as automatic speech recognition and voice control to improve accessibility. Live Caption automatically converts audio into written captions, Voice Access allows a user to control a device hands-free, and text-to-speech reads content aloud (Google LLC, 2024). These features can help students who have difficulties processing spoken information, reading written text, or using fine motor tasks. Teachers, therapists, or parents may personalize settings so the tools match each student's communication style and needs.

Educational and Social Outcomes

AAC tools like Proloquo2Go have been linked to improved unprompted communication, reduction in challenging behaviors and better participation in classroom activities for some autistic individuals (Ganz, 2015). In 2019, Collette et al. studied four children with ASD to understand whether Proloquo2Go could help them become more independent in performing classroom activities. A comparison was made between the amount of assistance the children needed when using Proloquo2Go, other technologies such as PECS and a SMARTBoard, and no technology at all. Researchers found that the children required less assistance when using Proloquo2Go than when no technology was used. However, the amount of support needed was similar to PECS and the SMARTBoard (Collette et al., 2019). This suggests that Proloquo2Go can help some students participate more independently in classroom activities.

Another study by King et al. (2014) involved three autistic children between the ages of three and five who were either nonverbal or had limited communication. The children were taught to use Proloquo2Go on an iPad to request items they wanted. Although the three children progressed to different levels, all three learned to make requests using the app. Interestingly, their spoken requests also increased compared with their levels before the study (King et al., 2014). This shows how Proloquo2Go can give students another way to get their message across when they have difficulty expressing themselves through speech.

Unlike Proloquo2Go, Google's accessibility tools have limited research on their impact on social and educational outcomes specifically for autistic students.

Limitations and Challenges

One major issue is access. Tools like Proloquo2Go rely heavily on devices, updated software, and in some cases, stable internet, which not all students or schools have access to (Ganz, 2015). Unequal access to technology remains a big barrier, especially in low-income communities. Training can also be a challenge since students need to be taught how to use the system, and teachers, parents and therapists need to also understand how to support them effectively (Ganz, 2015).

Another limitation is that outcomes can vary between students. The King et al. (2014) and Collette et al. (2019) studies involved only small groups of three and four children respectively, making it difficult to generalize their findings to all autistic children (Ganz, 2015). There is also limited research on whether AAC skills transfer to real-world conversations without ongoing support and whether Google's accessibility tools improve outcomes specifically for autistic students

VR Job Interview Training for Autistic Adolescents and Young Adults

Background

VR job interview training programs were created to help teens with autism prepare for real world job interviews and communication in the workplace. Interviews can be stressful for anyone, but for those with autism, the fast pacing, unpredictable questions, and the pressure of being evaluated can make the process even more intimidating. VR programs give students a safe and controlled space to practice these situations repeatedly without the pressure of a real interviewer watching and judging them (Smith et al., 2021).

One example is Virtual Interview Training for Transition Age Youth, an adapted version of Virtual Reality Job Interview Training (VR-JIT), which has been used in high-school special education and pre-employment programs. Here a virtual hiring manager helps students practice interview skills, allowing them to respond to questions, become comfortable with and familiarize themselves with the interview process before actually facing a real employer. The program breaks the interview process into smaller, repeatable steps, allowing students to repeatedly practice answering questions and other interview behaviors like eye contact and body language and gradually build confidence (Smith et al., 2021).

In 2021, a study was conducted involving 71 autistic youth. In the study, 48 of the 71 participants received the virtual interview training in addition to their usual school-based employment services while the remaining 23 received only the usual services without the virtual training (Smith et al., 2021).

Another program, JobTIPS, was developed specifically to help autistic adolescents with job interviews. It combined online teaching with virtual interview practice to help students understand and practice appropriate interview behavior (Strickland et al., 2013).

Technology and Simulation Design

VR interview programs simulate virtual office spaces with digital interviewers who ask students standardized questions without the pressure of an actual interview. Students respond verbally, and the system gives feedback on tone, pacing, clarity, and eye contact (Strickland et al., 2013). Specifically, In VR-JIT, users interact with a virtual hiring manager and respond to different interview questions. The program can change the difficulty level of the interview and provides feedback so that users can learn from their mistakes and practice again (Smith et al., 2021). The main advantage is repeatability so students can practice the same type of questions multiple times without anyone getting annoyed. This allows students to develop familiarity with the process in a low-pressure setting.

JobTIPS combines online instruction with virtual interview practice. Students learn about appropriate interview behavior in theory online and then practice these skills with a virtual interviewer (Strickland et al., 2013).

Educational and Behavioral Outcomes

Research into VR interview training shows that it can improve interview performance. Strickland et al. (2013) studied 22 autistic youth aged 16 to 19 years. The participants who received JobTIPS training were found to be better at verbally responding to interview questions than those who did not receive the training (Strickland et al., 2013). Improvements were most noticeable in areas such as responding appropriately to interview questions and presenting a professional appearance (Strickland et al., 2013).

Smith et al. (2021) studied VR job interview training among autistic youth and collected anxiety scores both before and after VR practice. They found that participants who received the training experienced lower anxiety levels. The training focused on different parts of the interview process, including how participants responded to questions and their nonverbal behavior. Overall, those who received the VR training showed better interview skills than those who received only their usual school-based employment services (Smith et al., 2021).

Limitations and Challenges

The biggest barrier is access. Many schools don't have access to VR technology, specialized equipment or trained staff to run interview simulations (Strickland et al., 2013). The technology can be expensive, and most transition programs have limited budgets. Some students may also require a higher level of support from teachers or trainers.

Another drawback is that the studies involved relatively small groups of participants who cannot be considered to represent all autistic adolescents and youth (Strickland et al., 2013; Smith et al., 2021). Most importantly, practicing with a virtual interviewer does not guarantee success in the real world. More long-term research with diverse groups of autistic youth is needed to determine whether the interview skills learned through VR are retained and effective across different students. VR training should therefore be an additional support rather than a replacement for human interaction, coaching and real-world practice (Smith et al., 2021).

Some students also need individualized support to understand feedback or apply skills outside the VR environment. Without extra coaching, it can be hard to transfer VR practice into real interviews. Teachers need training too, which takes time and resources. Another issue is that VR interview programs are still developing, and long-term research is limited. It's known that they can help with confidence and anxiety, but it's not as well known about the skills holding up months or years later. The potential may be huge, but access and support remain major obstacles. The technology is promising, but like most things in autism education, it works best when paired with real human guidance and patience.

Cross-Case Comparison

Table 1 provides a cross-case comparison of the four technology programs on key dimensions, highlighting differences in focus area, primary benefit, main limitation, and intervention setting.

Technology	Focus Area	Key Benefit	Primary Limitation	Setting	Outcome Evidence
Floreo VR Platform	Social interaction & eye contact	Immersive, therapist-guided VR practice	High device and licensing cost	Schools & therapy clinics	75% of students showed increased social interactions; 58% improved eye contact
Milo Robot (RoboKind)	Emotional recognition & social learning	Consistent, non-judgmental AI-driven lesson delivery	Hardware expense; requires structured environment	Special education classrooms & therapy centers	Higher engagement with Milo vs. human therapist (up to 87.5%); improved emotion understanding

Proloquo2 Go / Google Tools	Communication support for nonverbal/minimally verbal students	Greater independence & classroom participation	Internet/device dependency; unequal access	Classrooms & home	Reduced need for assistance vs. no technology; increased spoken and AAC-based requests
VR Interview Training	Workplace readiness & interview communication	Reduced interview anxiety; repeatable low-pressure practice	Limited availability; requires trained staff	Transition & career-readiness programs	Lower anxiety scores; improved verbal responses and professional presentation

Table 1. Cross-Case Comparison of AI & VR Technologies
Note. Outcome evidence reflects findings reported in the cited studies for each program. Limitations summarize challenges most consistently identified across the case studies. Setting indicates the primary environment in which each technology is deployed.
Sources. Floreo Inc. (2024); Ravindran et al. (2019); Pennisi et al. (2016); Callier Center for Communication Disorders (2019); Teixeira & Lai (2021); AssistiveWare (2024); Collette et al. (2019); King et al. (2014); Smith et al. (2021); Strickland et al. (2013).

DISCUSSION

The four case studies reveal many common benefits and limitations in the use of AI and VR technologies for autistic learners. Figure 3 summarizes these similarities and differences across the four case studies.

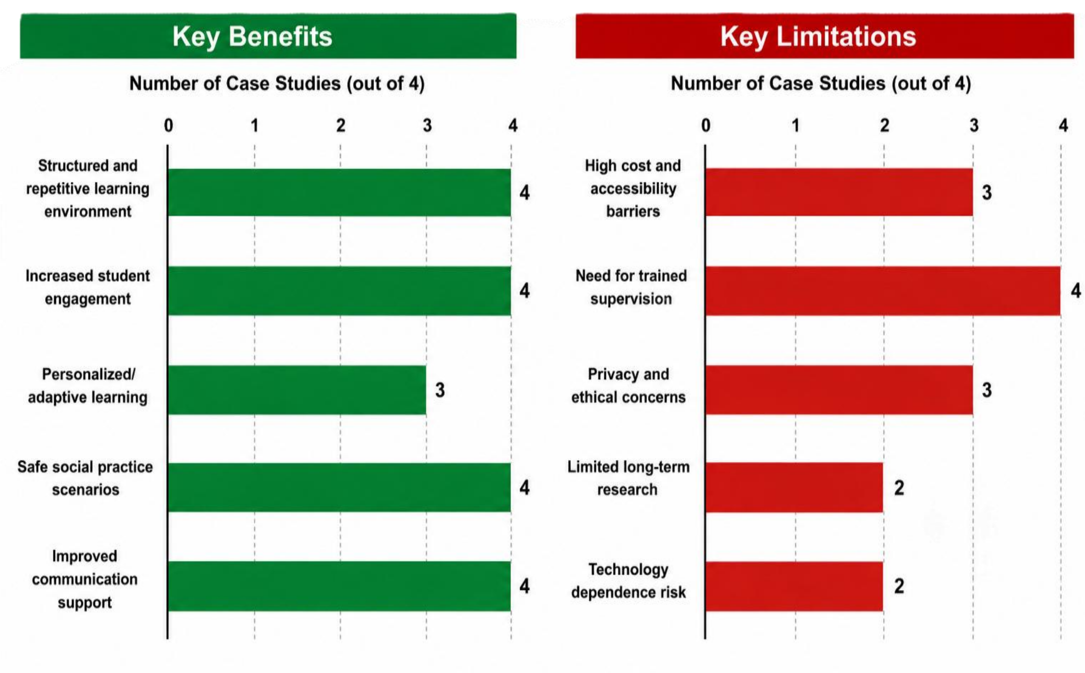

Figure 3. Key Benefits and Limitations of AI and VR Technologies Across the Case Studies

Note. Values represent the number of the four case studies in which each benefit or limitation was identified.
Sources. Pennisi et al. (2016); Ganz (2015); Floreo Inc. (2024); Lorenzo et al. (2016); Parsons (2016); Zhao et al. (2018)

Common Patterns Across the Case Studies

The four case studies reveal one very important observation. autistic students can benefit greatly from structured, predictable teaching in a low-stress environment which does not overwhelm them. All the tools discussed above provide safer spaces for social practice. While Floreo provides a controlled virtual setting where students can repeatedly practice specific social skills such as eye contact, recognizing emotions and responding to social cues (Ravindran et al., 2019), the Milo humanoid social robot helps students with recognizing emotions, initiating and holding conversations and other social skills through repeated familiar interactions (Pennisi et al., 2016). Proloquo2Go gives nonspeaking or minimally verbal students a structured way to communicate by allowing them to select symbols and words that the app then speaks aloud (AssistiveWare, 2024), while VR job interview programs allow autistic youth to practice answering questions before facing a real-world job interview situation (Smith et al., 2021). Although these technologies vary greatly and serve different purposes, they all have one thing in common: they all provide controlled and structured low-pressure environments where autistic students can practice communication and social skills before using them in real-life social interactions (Pennisi et al., 2016; Parsons, 2016).

Repetition is another common trait observed in all the case studies. Whether it's repeating a social-cue lesson with Milo, or practicing communication skills using Proloquo2Go or Floreo, or running through the same interview questions again and again in VR, students are able to practice skills multiple times until they reach a level of both comfort and familiarity. Since students can keep practicing as many times as necessary, they can learn at their own pace before using these learnings in the real world (Ganz, 2015; Smith et al., 2021).

Personalization is another common feature as all these programs can be customized to various levels based on a student's current ability, observed progress and future needs. All these tools can adapt to the student instead of forcing the student to adapt to the tool. This is particularly important as different students may respond differently to the same technology and each student learns at a different pace.

Another important observation is that none of these technologies are intended to or can completely replace human interaction and involvement. Instead, they act as learning aids to assist teachers, therapists, employers, and others in helping autistic students develop and practice the skills they need to navigate social situations in the real world.

Differences Between AI and VR Approaches

Though both AI and VR technologies provide good support to autistic learners, there are some important differences between the two. AI-based tools such as Proloquo2Go primarily offer support in the area of communication. Proloquo2Go, for example, allows nonspeaking or minimally verbal users to select words and symbols which the app then speaks aloud. Milo uses AI technology to assist communication in a different way. Unlike Proloquo2Go which communicates on behalf of the user, Milo acts as a social partner for autistic students teaching them to recognize emotions, take turns in conversations and respond to social cues through repeated practice (Ganz, 2015; Pennisi et al., 2016).

VR follows a different model from the communication-centric approach of AI-based tools. It focuses more on creating immersive, realistic situations in which social skills can be practiced. Floreo enables learners to practice responding to social cues and carrying out day-to-day communication by placing them in virtual environments which are realistic but controlled (Ravindran et al., 2019), VR-based job interview programs virtually recreate job interview situations, allowing students to experience sitting across from an interviewer and answering questions (Smith et al., 2021).

Another difference is in the way these technologies can be personalized. Proloquo2Go can be customized based on the individual learner's existing communication ability, vocabulary and needs (AssistiveWare, 2024). Milo also offers some personalization, as teachers and therapists can select and repeat lessons based on their assessment of an individual student's needs and progress (RoboKind, 2024). Customization of VR programs follows a different approach. Here experiences can be personalized by changing scenarios, difficulty levels and the social skills being practiced. For example, Floreo provides different scenarios depending on the social skills being practiced (Floreo Inc., 2024), while VR interview training can change the difficulty level and complexity of the questions being asked (Smith et al., 2021).

Therefore AI-based tools generally focus more on helping autistic individuals express themselves and practice communication skills while VR is better suited to preparing students for specific real-life situations like job interviews or social interactions. However, it is important to point out that the distinction is not watertight. For example, Milo combines both communication support and social practice.

A potentially desirable approach is to combine the strengths of both technologies to the benefit of autistic students. VR can create immersive, realistic and controlled environments for practicing social situations while AI could be used to make these environments more responsive to the individual learner. For example, an AI-supported VR system could adjust the difficulty of a social situation, change the complexity of the responses from virtual characters or provide real-time feedback based on how the student responds (Lorenzo et al., 2016; Zhao et al., 2018).

Future Potential of AI and VR in Autism Support

It is expected that these technologies will become more personalized and easier to use in the future. As discussed earlier a collaboration between these two technologies could result in the best elements of both being combined to benefit autistic learners. This could create immersive virtual environments which could analyze and respond to a student's performance in real time and give feedback and adjust the type of interactions and the difficulty levels (Zhao et al., 2018). Thus, different students could receive different levels of support based on their individual needs and progress.

There is also the possibility of these technologies being used more widely outside specialized therapy clinics including in homes and schools. However wider use requires these technologies to become more affordable and easier to operate. It is also important to ensure that a wider population of teachers, therapists and parents get proper training on using these systems so that technology becomes part of the student's everyday learning. Additionally, bigger and longer-term studies are needed to understand which technologies are most useful, and skills learnt during practice sessions are retained and successfully used in real world social situations (Parsons, 2016).

Ethical Concerns and physical challenges

In spite of its many benefits, the use of AI and VR technologies for autistic learners comes with its own set of ethical and practical concerns. High cost and unequal access remain important barriers. Underfunded schools and economically vulnerable families may struggle to access these devices which not only require expensive hardware and software, but also need specially trained staff to set them up and maintain them (Zhang et al., 2022). Teachers and therapists also need specialized training to administer these programs to their full potential.

Privacy is another major concern. Many of these AI and VR technologies collect personal information about the student such as responses to various stimuli, speech, eye movements or behavior in order to track progress or to fine-tune learning experience. This raises questions about the possible misuse of this extremely personal information and the concern is further compounded by the fact that many of these learners are minors with special needs. Therefore, there is a clear need for safeguards around how the data is collected, used and stored. These concerns related to privacy and confidentiality have been specifically highlighted by research on VR tools used for autistic children (Zhang et al., 2022).

Another concern is overdependence on technology for developing skills directed towards human interaction and people to people conversations. This is particularly important because the ultimate purpose of practicing communication and social skills through technology is to help autistic learners use those skills in the real world. Therefore, these tools should act as supports to human teachers rather than replacing them.

Additionally, some users have reported sensory overload, dizziness, strain on eyes and other forms of physical discomfort while using VR systems. Therefore, the length and intensity of VR sessions has to be carefully monitored and adjusted as per the tolerance of the individual learner (Mesa-Gresa et al., 2018).

CONCLUSION

AI and VR-based tools are now being increasingly used in schools and therapy centers to help improve communication and social skills for children with autism spectrum disorder (ASD). The literature review and case studies show how each of these technologies and related tools address different needs of autistic learners and help them develop practical skills to cope with different social situations.

Each of the case studies which form a part of this paper shows a different way in which AI and VR-based tools can benefit autistic learners, depending on the skill being developed. Despite the different uses and settings, they all share the same underlying principle. They all provide structured, controlled learning in a relatively low-pressure environment. All of them also allow repeated practice of the same social skills and most of them can be paced to suit individual needs and capabilities.

At the same time, the findings also show that technology comes with its own limitations and barriers which can prevent the widespread adoption of these tools. To start with, these tools are generally expensive and most of them are technically complex, so accessibility becomes an issue. Adequate funding is needed in addition to trained staff, to encourage schools and individuals to use these technologies. Other barriers include privacy concerns, and the uncertainty around whether autistic learners can successfully use the skills learnt in a controlled environment in real-life situations.

Overall, the findings suggest that traditional methods of therapy and teaching involving human interaction remain important. These tools cannot take the place of teachers, therapists and parents who remain central to supporting autistic learners. However, these AI and VR-based technologies can be used to enhance, improve and support traditional teaching methods by making them more structured and personalized. For these technologies to be adopted on a wider scale, they first need to become more affordable and accessible to people and institutions of all economic and social backgrounds. Also, larger and longer-term research needs to be done to understand how well the skills learned through these technologies are retained and used in day-to-day life.

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