# Artificial intelligence and autism spectrum disorders: a new perspective on learning

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**Abstract**

Over the past five decades, Autism Spectrum Disorder (ASD) has transitioned from a narrowly defined, rare condition with childhood onset to a well-publicized, advocated, and extensively studied lifelong condition, acknowledged as fairly prevalent and highly heterogeneous. The characterization of the core features of ASD, encompassing deficits in social communication and repetitive and unusual sensori motor behaviors, has undergone minimal changes since its original delineation. However, autism is presently conceptualized as a spectrum, spanning from mild to severe manifestations. Nonetheless, a considerable number (though not all) of individuals with ASD necessitate lifelong support. While families, teachers, and direct care providers play pivotal roles in shaping the lives of individuals with ASD, physicians and other healthcare professionals also exert influence by providing insights into the current functioning of individuals with ASD, assisting caregivers in anticipating transitions, and facilitating referrals to service providers and specialists when needed. Emphasizing early diagnosis, individualized interventions, and sustained support becomes paramount in navigating the complexities of ASD. By scrutinizing the incidence dynamics of autism, we can inform and tailor strategies that aim to create a more inclusive and supportive societal environment for individuals across the autism spectrum.

**Keywords**

Autism, incidence, neuropsychology, cognitive development.



## 1. Autism Spectrum Disorder

Autism spectrum disorder (ASD) is characterized by social and communication challenges, as well as repetitive and restrictive behaviors that span a continuum of severity[1]. The diagnosis of autism can be established as early as 18 to 24 months, a critical period during which distinctive symptoms can be discerned from typical development and other developmental conditions. The landscape of autism research has witnessed significant strides, aligning with substantial progress in international policy. Beyond the policy responses driven by heightened global awareness and advocacy, advancements in complementary domains such as human rights, maternal and child health, and mental health have contributed to the evolution of our understanding of autism. Individuals with ASD exhibit considerable variability, the disorder is delineated by fundamental features in two domains—social communication and restricted, repetitive sensory–motor behaviors. ASD emerges as a result of early alterations in brain development and subsequent neural reorganization. The educational needs of individuals with Autism are as diverse as the spectrum itself, necessitating personalized learning environments to support their unique characteristics and promote effective learning [2]. Traditional educational approaches often fall short in addressing these individual needs, highlighting the importance of developing tailored educational strategies that cater to the strengths and challenges of learners with ASD[3].

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Creating personalized learning environments for individuals with ASD involves leveraging a range of adaptive techniques and technologies to enhance their educational experiences. By incorporating individualized instructional methods and supportive technologies, educators can create a more inclusive and effective learning atmosphere that fosters engagement, motivation, and skill acquisition [4]. Tools such as Augmented Reality (AR), virtual reality, and adaptive learning software can provide immersive and interactive experiences that capture and maintain the attention of students with ASD [5]. These technologies can be tailored to present information in ways that align with the learners' cognitive styles, thereby enhancing comprehension and retention. Moreover, the rapid advancements in artificial intelligence (AI) have ushered in a new era of technological innovation, with generative AI emerging as a particularly transformative field. Generative AI models (GenAI)are designed to produce new, original content, this includes the generation of realistic images, coherent text, and complex data simulations. In the realm of education, generative AI leverages deep learning techniques to understand and replicate the intricate patterns and structures inherent in educational content [6]. For instance, GenAI can generate personalized learning materials, simulate interactive scenarios for immersive learning, and even create virtual tutors that adapt to the individual needs of students. This sophisticated interplay between content generation and adaptive learning can cater to diverse learning styles, thus making education more inclusive and effective. Furthermore, the application of generative models extends beyond content creation to include the development of intelligent assessment tools, capable of providing instant, personalized feedback and identifying areas where students may need additional support[7]. Artificial Intelligence (AI) and related technologies have the potential to provide valuable assistance to individuals with neurodevelopmental disorders (NDD). These technologies can offer personalized support, enhance communication abilities, facilitate learning, and promote greater independence [8]. Here are some ways AI and related technologies can help: 1. Personalized Learning: AI-powered educational tools can adapt to an individual's learning style, pace, and abilities. They can provide customized learning materials, adaptive assessments, and interactive activities tailored to the specific needs of each student [9]; 2. Communication Support: AI-based communication aids, such as symbol-based systems or text-to-speech applications, can facilitate communication for individuals with speech or language disorders. These tools enable them to express their thoughts, needs, and ideas effectively; 3. Assistive Technologies: AI can enhance accessibility by enabling individuals with physical disabilities to control devices or interact with their environment through voice commands, gesture recognition, or eye-tracking technologies. This promotes greater independence and participation in daily activities [10; 11]; 4. Behavioral and Emotional Support: AI algorithms can analyze patterns of behavior and provide real-time feedback or interventions to help individuals manage challenging behaviors or regulate their emotions. These technologies can assist individuals with conditions like ADHD or autism in improving self-regulation skills [12]; 5. Social Skills Training: AI-based virtual reality simulations can create safe and controlled environments for individuals to practice social interactions and develop social skills. These simulations offer opportunities for learning and self-confidence building in contexts that might otherwise be challenging or overwhelming[13]; 6. Data Analysis and Insights: AI algorithms can process large amounts of data, such as educational records or behavioral assessments, to identify patterns, trends, and personalized recommendations for intervention. This can assist educators and therapists in making informed decisions and tailoring interventions to each individual's needs[14]. By leveraging these capabilities, AI and related technologies can significantly enhance the quality of life for individuals with Neurodevelopmental Disorders, helping them to achieve their full potential and integrate more effectively into their communities. Advances in AI enhance models' adaptability to user needs in information-seeking tasks and can improve users' information discovery experiences when integrated with Information Retrieval (IR) systems. Particularly IR are However, these improvements should be accessible to all users, regardless of neurotypical abilities, education levels, or other factors. This approach aligns with the IR field's goal of providing effective and user-friendly information access. Despite ongoing research on information-seeking in IR, the evaluation of generative systems in aiding individuals with learning disabilities remains under-explored.

## 2. Characteristic of Artificial Intelligence that support ASD learning

Advances in technology, particularly Artificial Intelligence (AI) and digital technologies, offer promising avenues for improving the assessment, monitoring, and treatment of ASD [15]. The educational needs of individuals with Autism Spectrum Disorder (ASD) are as diverse as the spectrum itself, necessitating personalized learning environments to support their unique characteristics and promote effective learning. Generative AI systems can analyze a student's interactions, responses, and learning patterns to customize educational content and strategies in real-time This adaptability makes generative AI a powerful supportive tool in special education, capable of dynamically adjusting to the needs and progress of each student. By continuously adapting to the student's feedback, these AI-driven environments can enhance engagement, motivation, and comprehension. For instance, AI can modify the complexity of tasks, provide alternative explanations, or introduce new learning materials that align with the student's interests and cognitive style. This level of personalization is particularly beneficial for learners with ASD, who often require tailored instructional approaches to thrive academically. The potential of artificial intelligence (AI) to drive developments in education is well-recognized [16]. Currently, most research efforts are based on data stored in learning management systems, as this type of analysis is more straightforward[17]. Lampos et al.[18] report on an innovative experiment that uses machine learning, a data-driven approach to AI, to model teacher-student interactions in the classroom, with a particular focus on children with Autism Spectrum Condition (ASC). The application of communication strategies tailored to the specific needs of children with ASC can lead to improved outcomes for this group [19;20;21], including effective participation in educational opportunities, improved social functioning, and longer-term achievement in employment and relationships [22,23,24]. Lampos et al.[18] propose that machine learning may be one way to further the development of such ASC-specific strategies. Research in autism education has highlighted the importance of these strategies in learning and developing social communication skills. Lampos et al.[18] considered different types of teacher communication strategies, particularly verbal communications, the use of gestures, physical prompts, visual representations (pictures), or physical objects, and the extent to which children with ASC responded to different strategies. These strategies are typically employed as part of the Social Communication, Emotional Regulation, and Transactional Support (SCERTS) framework, a widely used comprehensive whole-school approach to communication development in autism education [25,26]. In typical teacher-student interactions in the classroom, most communication is verbal [26]. However, traditional verbal communication alone often does not work effectively with children with ASC [27;28]. A machine learning classifier was able to predict which type of teacher communication was more likely to generate a positive response from a student with ASC, indicating that the student responded to the communication in a way intended by the teacher, with an accuracy greater than that expected from a random or major class baseline prediction. When student attributes, i.e., cognitive and language levels, sex, and age, are added into the function, the accuracy level increases, and when past information is incorporated, accuracy improves further. Thus, the results of this exploratory research indicate that the developed classifier, derived from observations of teacher-child interactions, has the capacity to capture relevant signals from the data, which is instrumental for its potential usefulness in classroom practice. Based on the ablation analysis, teacher communications did indeed have the greatest impact on classification accuracy (3.25% reduction on average), which reinforces the importance of choosing the right type of communication [29]. Barua et al. [30] discuss the high prevalence of neurodevelopmental disorders (NDDs) and Autism in children, emphasizing the significant challenges these children face in learning due to social and communication deficits. The authors argue that timely and effective interventions are essential to improve outcomes for these children. The review focuses on AI-assisted tools developed using machine learning models to address the learning challenges faced by students with NDDs. The authors provide evidence that AI tools can successfully enhance social interaction and provide supportive education. However, they also highlight the limitations of existing AI tools and recommend the development of future AI tools that offer personalized learning experiences for individuals with NDDs. The review provides valuable insights into the use of AI in enhancing education for children with NDDs and underscores the need for further research in this area. Moreover, generative AI can serve as a communicative

partner, enhancing conversational skills for individuals with ASD. By creating interactive interfaces that simulate social interactions, AI can provide consistent and patient practice opportunities for developing conversational abilities. These AI partners can engage students in dialogues, model appropriate social behaviors, and offer constructive feedback, thus supporting the development of effective communication skills. This approach not only fosters language acquisition but also helps in generalizing these skills to real-world interactions. GPT-4 was found to be effective in tasks like email composition, online writing, and engaging in online discussions, indicating its potential as an Augmentative and Alternative Communication (AAC) tool for individuals with ASD [31]. The use of language models like GPT-3 and ChatGPT to create social stories for individuals with autism is an emerging research area. Bhatia et al. (2022) [32] explore how AI, including language models like GPT-3, can be used to generate personalized social stories for people with autism. The results show that these stories can help improve understanding of social situations and reduce anxiety. Similarly, Kim and Smith [33] discuss using GPT-3 to create social stories that help individuals with autism prepare for specific social interactions. The AI allows the stories to be adapted to individual needs, enhancing their effectiveness in supporting the development of social skills. Johnson et al. [34] also examine the effectiveness of GPT-3-generated social stories for children with autism. The findings indicate that children show a greater understanding of social situations and improved social behavior after intervention with AI-generated stories. ChatGPT can help autistic children by providing a safe and controlled environment for communication and social interaction. The platform allows for customizable language and communication settings, allowing for the individual needs of each child to be met. It can also provide consistent and predictable responses, reducing anxiety and stress for the child. Additionally, ChatGPT can provide engaging and educational content, helping to improve cognitive and social skills. Kummervold et al. [35] discuss the use of AI chatbots to create personalized intervention programs for individuals with autism, highlighting how language models can adapt to users' individual needs to improve communication and social skills. Tartaro and Cassell [36] explored the use of chatbots to enhance social skills in children with autism, demonstrating that chatbots can provide a safe environment for practicing social interactions. A study by Mavrikis et al. [37] examines the use of AI-based interactive educational tools to help children with autism develop new skills. This study shows how language models can be used to create personalized reading comprehension exercises and educational games. Generative AI is a technology that utilizes deep learning models to generate human-like content in response to diverse prompts [38]. As an efficient approach for tailoring content, spanning text, images, and videos, generative AI offers a novel solution to meet the unique needs of special populations. Alessa et al.[39] introduced a conversational companion system that utilizes large language models (LLMs) to generate personalized responses for elderly individuals, relieving their loneliness and social isolation. Montagna et al. [40] designed a chatbot that utilized LLMs to extract and integrate information from a large amount of medical knowledge to assist chronic patients in self-management. Valencia et al. [41]utilized the ability of LLMs to extract, expand, and generate information to support the specific communication needs of augmentative and alternative communication (AAC) users. Additionally, other studies utilized text-to-image models to create customized visual narrative tools to assist individuals with special needs [42,43]. These studies inspired Tang et al.[44] to apply generative AI for emotional learning in high-functioning autism (HFA) children by tailoring content according to specific prompts. LLMs have been proven to be able to extract, summarize, and generate various contextual information, and to cultivate impressive reasoning abilities. This implies that they can customize content based on the characteristics of each HFA child and generate contextually relevant responses by understanding the conversational context with the HFA child. Text-to-image models can accept more detailed and specific descriptions to generate high-quality images, offering an opportunity to create customized visual intervention materials for HFA children. Tang [44] assessed the performance of generative AI in enhancing HFA children in emotional leraning. They found that Emoeden, their genAI app, exhibited a Strong Comprehension to HFA Children's Expressions, n can understand incomplete or grammatically incorrect expressions from HFA children and provide appropriate responses. Moreovere, genAI also offers enhanced personalization, adapting conversational contexts based on daily inputs to address children's evolving needs. Furthermore, it provides diversified responses, helping children learn to express themselves in various ways. The integration of generative AI in

personalized learning environments is not without its challenges. It requires a careful balance of technological innovation, pedagogical strategies, and an understanding of the specific needs of each learner. Ethical considerations, such as ensuring the privacy and security of learners' data and avoiding potential biases in adaptive learning systems, must be addressed. Despite these challenges, the potential benefits of generative AI for individuals with ASD are profound, offering pathways to greater independence, academic achievement, and social integration. Artificial Intelligence (AI) and Natural Language Processing (NLP) have opened new pathways for autistic individuals to address their daily challenges [45]. AI-based conversational agents (CAs) have been developed for this population to support or practice a wide range of daily tasks, including establishing a home oral care routine[46], handling school bullying[47], and managing depression[48] and anxiety[49] . More recently, studies have explored the potential of leveraging AI for open-domain dialogue, empowering autistic individuals to engage proactively in conversations about their everyday concerns [50]. Cha et al. demonstrated that an AI-based virtual conversational agent (VCA) can serve as a conversational partner for autistic adolescents, meeting their various daily needs, including sharing interests, managing daily routines, and practicing communication skills [50]. Another co-design study revealed that autistic college students are interested in the multifaceted use of AI-driven CAs, encompassing aspects such as academics, health, and social interactions[51]. Despite the identified needs, AI-driven CAs up to this point have fallen short of addressing the unique and diverse needs of autistic people, largely owing to their constraints of pre-defined conversational flows. This paper explores the critical importance of leveraging generative AI to create personalized learning environments for individuals with ASD. It examines the theoretical foundations, practical applications, and technological advancements that support this approach, highlighting the potential of AI to enhance educational outcomes and conversational skills. By showcasing the role of generative AI in special education, we aim to contribute to the ongoing efforts to improve educational practices and outcomes for learners with ASD.

## 3. Challenges in Implementing AI for ASD

### 3.1. Technical Challenges and Bias in AI Systems.

Despite the potential of generative AI in the education of individuals with ASD, there are significant technical challenges. Machine learning and AI algorithms are often subject to biases stemming from the data they are trained on. These biases can lead to suboptimal or even harmful outcomes if not recognized and addressed. For example, AI models may not adequately account for individual differences within the autism spectrum, thereby reducing the effectiveness of personalized solutions. It is crucial to develop and implement AI models that are inclusive and representative of the diversity of experiences and needs of individuals with ASD.

### 3.2. Data Privacy and Security.

The integration of AI into educational platforms necessitates the use and management of sensitive personal data. Ensuring the privacy and security of this data is of paramount importance. AI-based educational platforms must adhere to strict security protocols to protect users' personal information. Furthermore, data collection and analysis processes must be transparent and compliant with relevant regulations to maintain trust and ensure ethical use. This includes implementing measures to prevent data breaches and unauthorized access, as well as establishing clear guidelines for data usage and consent.

### 3.3. Ethical Considerations in AI Deployment.

The deployment of AI technologies in education for individuals with ASD also raises several ethical considerations. One major concern is the potential for AI to inadvertently reinforce existing inequalities if not carefully designed and implemented. For instance, access to advanced AI tools

might be limited to certain socio-economic groups, creating a digital divide. Moreover, there is the ethical responsibility to ensure that AI tools are used to complement human interaction rather than replace it, maintaining the essential human element in education and therapy. Developing ethical guidelines and oversight mechanisms is essential to address these concerns.

## 4. Conclusion

In conclusion, the integration of generative AI technologies holds significant promise for enhancing the educational experiences of individuals with Autism Spectrum Disorder (ASD). The ability of AI to create personalized learning environments, provide adaptive learning materials, and offer virtual tutoring tailored to the unique needs of each student represents a major advancement in the field. However, the successful implementation of these technologies requires careful consideration of several critical challenges. Addressing technical challenges, such as biases in AI systems, is essential to ensure that AI tools are effective and equitable. Moreover, safeguarding the privacy and security of personal data is crucial in maintaining trust and protecting the sensitive information of users. Ethical considerations, including preventing the reinforcement of existing inequalities and preserving the human element in education, must also be at the forefront of AI deployment. By acknowledging and addressing these challenges, educators, researchers, and technology developers can work together to harness the full potential of AI for individuals with ASD. Future research and collaboration will be key in refining these technologies and developing best practices for their implementation. With a concerted effort, AI can become a powerful tool in supporting the diverse and evolving needs of the ASD community, ultimately leading to improved educational outcomes and quality of life for individuals with autism.

## References


[1] American Psychiatric Association (2013). *Diagnostic and Statistical Manual ofMental Disorders. 5th* ed. Arlingon, VA: American Psychiatric Publishing

[2] Jordan, R. (2019). Particular learning needs of individuals on the autism spectrum. *The SAGE handbook of autism and education*, 12-23.

[3] Tutt, R., Powell, S., & Thornton, M. (2006). Educational approaches in autism: What we know about what we do. *Educational Psychology in Practice*, 22(1), 69-81.

[4] Stahmer, A. C., Schreibman, L., & Cunningham, A. B. (2011). Toward a technology of treatment individualization for young children with autism spectrum disorders. *Brain research*, 1380, 229-239.

[5] Khowaja, K., Banire, B., Al-Thani, D., Sqalli, M. T., Aqle, A., Shah, A., & Salim, S. S. (2020). Augmented reality for learning of children and adolescents with autism spectrum disorder (ASD): A systematic review. *IEEE Access*, 8, 78779-78807.

[6] Alasadi, E. A., & Baiz, C. R. (2023). Generative AI in education and research: Opportunities, concerns, and solutions. *Journal of Chemical Education*, 100(8), 2965-2971.

[7] Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI,* 7(1), 52-62.

[8] Bertacchini, F., Demarco, F., Scuro, C., Pantano, P., & Bilotta, E. (2023). A social robot connected with chatGPT to improve cognitive functioning in ASD subjects. *Frontiers in Psychology,* 14, 1232177.

[9] Pataranutaporn, P., Danry, V., Leong, J., Punpongsanon, P., Novy, D., Maes, P., & Sra, M. (2021). AI-generated characters for supporting personalized learning and well-being. *Nature Machine Intelligence*, 3(12), 1013-1022.

[10] Bozkurt, A. (2023). Generative artificial intelligence (AI) powered conversational educational agents: The inevitable paradigm shift. *Asian Journal of Distance Education*, 18(1).

[11] Battistoni, P., Cantone, A. A., Esposito, M., Francese, R., Perillo, F. P., Romano, M., ... & Vitiello, G. (2023, July). Using artificial intelligence and companion robots to improve home healthcare for the elderly. In *International Conference on Human-Computer Interaction* (pp. 3-17). Cham: Springer Nature Switzerland.

[12] Frolli, A., Ricci, M., Di Carmine, F., Savarese, G., Siciliano, M., Carotenuto, M., & Rega, A. (2022). Using virtual reality to improve learning in children with ADHD. *current pediatric research*, 26, 1244-1249.

[13] Yang, D., Ziems, C., Held, W., Shaikh, O., Bernstein, M. S., & Mitchell, J. (2024). Social skill training with large language models. *arXiv preprint arXiv*:2404.04204.

*[14]*Vita, S., Rega, A., Iovino, L., & Mennitto, A. (2020). " TED": teaching educational device, a digital tool to educational practice for special needs. *In PSYCHOBIT.*

[15] Williamson, B. (2017). Big data in education: The digital future of learning, policy and practice.

[16] Luckin, R. (2018). *Machine Learning and Human Intelligence: The future of education for the 21st century*. UCL IOE Press. UCL Institute of Education, University of London, 20 Bedford Way, London WC1H 0AL.

[17] Reyes, J. A. (2015). The skinny on big data in education: Learning analytics simplified. *TechTrends*, *59*, 75-80.

[18] Lampos, V., Mintz, J., & Qu, X. (2021). An artificial intelligence approach for selecting effective teacher communication strategies in autism education. npj Science of Learning, 6(1), 25.

[19] Wong, C., Odom, S. L., Hume, K. A., Cox, A. W., Fettig, A., Kucharczyk, S., ... & Schultz, T. R. (2015). Evidence-based practices for children, youth, and young adults with autism spectrum disorder: A comprehensive review. Journal of autism and developmental disorders, 45, 1951-1966.

[20] Mintz, J., & Wyse, D. (2015). Inclusive pedagogy and knowledge in special education: addressing the tension. *International Journal of Inclusive Education*, *19*(11), 1161-1171.

[21] Sutton, B. M., Webster, A. A., & Westerveld, M. F. (2019). A systematic review of school-based interventions targeting social communication behaviors for students with autism. *Autism*, *23*(2), 274-286.

[22] Howlin, P., Moss, P., Savage, S., & Rutter, M. (2013). Social outcomes in mid-to later adulthood among individuals diagnosed with autism and average nonverbal IQ as children. *Journal of the American Academy of Child & Adolescent Psychiatry*, *52*(6), 572-581.

[23] Simpson, R. L. (2008). Children and youth with autism spectrum disorders: The search for effective methods. *Focus on Exceptional Children*, *40*(7), 1-14.

[24] Lynch, S. L., & Irvine, A. N. (2009). Inclusive education and best practice for children with autism spectrum disorder: An integrated approach. *International journal of Inclusive education*, *13*(8), 845-859.

[25] Rubin, E., Prizant, B. M., Laurent, A. C., & Wetherby, A. M. (2013). Social communication, emotional regulation, and transactional support (SCERTS). In *Interventions for autism spectrum disorders: Translating science into practice* (pp. 107-127). New York, NY: Springer New York.

[26] Prizant, B. M., Wetherby, A. M., Rubin, E., Laurent, A. C., & Rydell, P. J. (2006). *The SCERTS model: A comprehensive educational approach for children with autism spectrum disorders, Vol. 1.* Paul H. Brookes Publishing Co..

[27] Mercer, N. & Littleton, K. (2007) *Dialogue and the Development of Children's Thinking: A Socio cultural Approach.* Routledge.

[28] Kurt, O. A Comparison of discrete trial teaching with and without gestures/signs in teaching receptive language skills to children with autism. *Educ. Pract. Theory*11, 1436–1444 (2011).

[29] Maguire, A. (2005). Visual strategies leverage autism's strength to improve lives. *The Exceptional Parent*, 35(4), 34-35.

[30] Barua, P. D., Vicnesh, J., Gururajan, R., Oh, S. L., Palmer, E., Azizan, M. M., ... & Acharya, U. R. (2022). Artificial intelligence enabled personalised assistive tools to enhance education of children with neurodevelopmental disorders—a review. *International Journal of Environmental Research and Public Health*, 19(3), 1192.

[31] Kwona, J. GPT has ToM Capability: Can We Support Level-1 ASD with It?

[32] Bhatia, A., & Khosla, A. (2022). Using Artificial Intelligence to Generate Personalized Social Stories for Autistic Individuals. *International Journal of Advanced Computer Science and Applications*.

[33] Kim, S., & Smith, J. (2023). Leveraging AI for Autism: Customizing Social Stories with GPT-3. *Proceedings of the 2023 ACM Symposium on Applied Computing*.

[34] Johnson, D., & Liu, C. (2022). AI-Driven Social Stories for Autism: A Pilot Study Using GPT-3. *Journal of Autism and Developmental Disorders*.

[35] Kummervold, P. E., Johnsen, J.-A. K., Skrøvseth, S. O., Wynn, R., &Heggestad, T. (2022). "The use of artificial intelligence and patient-generated data in the care of individuals with autism spectrum disorders: A scoping review". *Journal of Medical Internet Research,* 24(5), e26682.

[36] Tartaro, A., & Cassell, J. (2008). "Playing with virtual peers: Bootstrapping contingent discourse in children with autism". *Proceedings of the 8th international conference on International conference for the learning sciences* - Volume 1, 382-389.

[37] Mavrikis, M., Dragon, T., &Porayska-Pomsta, K. (2019). "Intelligent support for learners with autism: A case study". *Computers & Education*, 134, 1-14.

[38] Lim, W. M., Gunasekara, A., Pallant, J. L., Pallant, J. I., &Pechenkina, E. (2023). Generative AI and the future of education: Ragnarök or reformation? A paradoxical perspective from management educators. *The international journal of management education*, 21(2), 100790.

[39] Alessa, A., & Al-Khalifa, H. (2023, July). Towards designing a ChatGPT conversational companion for elderly people. In *Proceedings of the 16th International Conference on PErvasive Technologies Related to Assistive Environments* (pp. 667-674).

[40] Montagna, S., Ferretti, S., Klopfenstein, L. C., Florio, A., &Pengo, M. F. (2023, September). Data decentralisation of llm-based chatbot systems in chronic disease self-management. In *Proceedings of the 2023 ACM Conference on Information Technology for Social Good* (pp. 205-212).

[41] Valencia Valenc, S. (2023). *Agency in Augmentative and Alternative Communication (AAC)* (Doctoral dissertation, Carnegie Mellon University).

[42] Ruskov, M. (2023). Grimm in wonderland: Prompt engineering with Midjourney to illustrate fairytales. *arXiv preprint arXiv*:2302.08961.

[43] Chen, T., Lee, C., Mindel, J. R., Elhaouij, N., & Picard, R. (2023, April). Closer Worlds: Using Generative AI to Facilitate Intimate Conversations. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems* (pp. 1-15).

[44] Tang, Y., Chen, L., Chen, Z., Chen, W., Cai, Y., Du, Y., ... & Sun, L. (2024, May). EmoEden: Applying Generative Artificial Intelligence to Emotional Learning for Children with High-Function Autism. In *Proceedings of the CHI Conference on Human Factors in Computing Systems* (pp. 1-20).

[45] VamsidharEnireddy, C Karthikeyan, and Ramkumar Jb. 2022. Automated Chatbots for Autism Spectrum Disorder Using AI Assistance. *Artificial Intelligence and the Fourth Industrial Revolution* (2022), 153

[46] Parvin, P., Manca, M., Senette, C., Buzzi, M. C., Buzzi, M., & Pelagatti, S. (2022, June). Alexism: ALEXa supporting children with autISM in their oral care at home. In *Proceedings of the 2022 International Conference on Advanced Visual Interfaces*(pp. 1-5).

[47] Ireland, D., Bradford, D., & Farr-Wharton, G. (2018). Social Fringe Dwellers: Can chat-bots combat bullies to improve participation for children with autism?. *The Journal of Community Informatics, 14*(1).

[48] Hadri, S. A., &Bouramoul, A. (2023). Towards a deep learning based contextual chat bot for preventing depression in young children with autistic spectrum disorder. *Smart Health*, 27, 100371.

[49] Palmen, A., Didden, R., & Arts, M. (2008). Improving question asking in high-functioning adolescents with autism spectrum disorders: Effectiveness of small-group training. *Autism,* 12(1), 83-98.

[50] Cha, I., Kim, S. I., Hong, H., Yoo, H., & Lim, Y. K. (2021, May). Exploring the use of a voice-based conversational agent to empower adolescents with autism spectrum disorder. In *Proceedings of the 2021 CHI conference on human factors in computing systems* (pp. 1-15).

[51] Lee, M., Ackermans, S., Van As, N., Chang, H., Lucas, E., &IJsselsteijn, W. (2019, May). Caring for Vincent: a chatbot for self-compassion. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-13)