Computer Science

E-ISSN No : 2456-5040 | Volume : 10 | Issue : 10 | October 2025

EXPLORING IMMERSIVE TECHNOLOGIES AND THEIR ROLE IN ENHANCING ACCESSIBILITY AMONG AUTISTIC ADOLESCENTS THROUGH A CASE STUDY APPROACH

Ms. Parikh Tinal[1], Prof. (Dr.) Vishal Dahiya[2]

Access Online

Article DOI:
10.5281/zenodo.17839421

[1] Ph.D. Research Scholar, Sardar Vallabhbhai Global University
tinalparikh@svgu.ac.in
[2] Professor and Director, Sardar Vallabhbhai Global University
director-i-mca@svgu.ac.in

How to Cite:
Ms. Parikh Tinal, Prof. (Dr.) Vishal Dahiya (2025), Exploring Immersive Technologies and Their Role in Enhancing Accessibility among Autistic Adolescents through a Case Study Approach, International Educational Applied Scientific & Research Journal (IEASRJ), Vol: 10, Issue: 10, 35-40

ABSTRACT

The integration of immersive technologies, including Virtual Reality (VR), Augmented Reality (AR), and the Metaverse, has the potential to significantly improve accessibility and promote the development of social skills in autistic individuals. This review brings together key findings from important studies, exploring how virtual reality, augmented reality, and other immersive technologies are being thoughtfully designed and utilized to support autistic individuals. These technologies provide safe and engaging environments where autistic individuals can practice real-world social interactions, improve cognitive flexibility, and develop creative problem-solving skills. By exploring advancements in immersive platforms, this paper highlights their potential to enrich social skills, provide personalized learning experiences, and promote inclusive design. The metaverse emerges as a powerful tool to foster meaningful social connections, ease sensory challenges, and empower autistic individuals toward greater independence. The usefulness of these technologies is demonstrated through case studies showcasing the successful implementation of virtual environments and participatory design involving autistic individuals. Despite these advancements, challenges such as ethical considerations, usability barriers, and financial feasibility remain significant. This paper provides actionable insights and outlines future research directions to ensure that immersive technologies become a sustainable and inclusive approach for improving accessibility and enhancing the quality of life for autistic individuals.

KEYWORDS: Immersive Technologies, Accessibility, Autistic Individuals, Social Skill Development

1. INTRODUCTION

1.1 Background & Significance

The digital era has unlocked immense potential for transforming accessibility and enhancing learning experiences, particularly for neurodivergent individuals. Technologies such as Augmented Reality (AR), Virtual Reality (VR), and the Metaverse are redefining how autistic individuals interact with their environment, offering adaptive, gamified, and personalized learning experiences. Unlike traditional interventions, these immersive technologies provide structured yet flexible platforms where individuals can develop social, cognitive, and behavioral skills in a safe and controlled environment (Sahin et al., 2018; Pérez-Fuster, Herrera, Kossyvaki, & Ferrer, 2022).

Autism Spectrum Disorder (ASD) encompasses a range of neurodevelopmental conditions, often characterized by challenges in social communication, sensory processing, and behavioural adaptability (World Health Organization, 2023; Centers for Disease Control and Prevention, 2024). While traditional educational and therapeutic methods have provided significant support, they often fail to address the individual learning needs of autistic individuals effectively. Many interventions

Case Study

rely on generalized teaching approaches, which may not be engaging, customizable, or anxiety-free for all learners (Autism Speaks, 2021; Cleveland Clinic, 2025).

Recent advancements in AR, VR, and the Metaverse present a paradigm shift in how we approach autism education and therapy. These technologies enable simulated real-world experiences, allowing autistic individuals to practice social interactions, emotional recognition, and everyday tasks in an environment where they feel comfortable and in control (Lee et al., 2023; Abd El-Sattar, 2024). For instance, studies have demonstrated how VR-based social skills training helps adolescents with ASD build confidence in real-life social settings (Schmidt & Glaser, 2021), while AR-assisted interventions improve joint attention and engagement (Pérez-Fuster et al., 2022).

1.2 Purpose & Scope

This paper explores the evolving role of immersive technologies in supporting social skill development, accessibility, and inclusion for autistic adolescents. The review synthesizes evidence on Metaverse-based interventions, AR/VR training programs, and participatory design models, emphasizing their impact on learning, independence, and emotional regulation (Mitsea, Drigas, & Skianis, 2025; Soltiyeva et al., 2023). Additionally, the paper addresses barriers to adoption, including usability, ethical concerns, and financial feasibility, while highlighting emerging research directions to ensure immersive technologies remain a sustainable and inclusive solution.

1.3 Research Objectives

1. To analyse case studies demonstrating how the Metaverse and AR create safe, structured environments that support autistic individuals in developing essential social skills.
2. To examine the impact of Metaverse and AR technologies on behaviour, cognitive engagement, and real-world socialization, using insights from experimental studies and user feedback.
3. To identify and address barriers related to accessibility, personalization, and scalability, providing recommendations for advancing inclusive and sustainable immersive solutions.

2. LITERATURE REVIEW

2.1 Summary of Key Studies on Digital Interventions for Autistic Individuals

Digital interventions, particularly Augmented Reality (AR) and Virtual Reality (VR), are unlocking new opportunities to support autistic individuals in developing essential social skills. Studies have demonstrated how AR-based classroom interventions significantly improve social communication, cognitive engagement, and motivation, with positive feedback from educators and parents (Sahin et al., 2018). Similarly, research on adaptive VR environments highlights the power of carefully crafted virtual experiences to support skill development and connect virtual practice with real-world applications (Schmidt & Glaser, 2021). These studies emphasize the remarkable ability of immersive technologies to inspire meaningful change. Building on these findings about the effectiveness of digital interventions, we now explore how immersive training programs apply these technologies to create practical, tailored solutions for autistic individuals.

2.2 Review of Existing Immersive Training Programs

Immersive training programs have proven invaluable in developing social skills among autistic individuals. A Metaverse-based training program provided children with a safe, controlled space to practice social interactions, leading to measurable improvements (Lee et al., 2023). Augmented reality interventions have also been effective in enhancing joint attention skills, a critical element of social interaction (Pérez-Fuster, Herrera, Kossyvaki, & Ferrer, 2022). Moreover, customized VR experiences have created secure, engaging environments where autistic individuals can build confidence and explore creative potential (Soltiyeva et al., 2023). These findings highlight the adaptability and inclusivity of immersive interventions in supporting growth. While these programs demonstrate the current possibilities of immersive technology, ongoing technological advancements, such as those in the Metaverse, are pushing the boundaries of accessibility and inclusion even further.

2.3 Key Theories and Technological Advancements in Metaverse Accessibility

Finally, this section examines technological

advancements in the Metaverse that address accessibility challenges for autistic individuals. The Metaverse is emerging as a revolutionary tool for accessibility and inclusion, providing autistic individuals with virtual spaces for social engagement in environments designed to reduce anxiety. Researchers have explored its potential to facilitate meaningful social connections, allowing users to simulate real-world experiences safely (Sharma & Babu, 2023). Studies show how Metaverse-based education improves academic learning and helps autistic learners build daily living skills, enabling them to become more independent (Abd El-Sattar, 2024). Further advancements in learning analytics and neurotechnology have been shown to personalize virtual learning environments (Lampropoulos & Evangelidis, 2025; Mitsea, Drigas, & Skianis, 2025).

The reviewed studies collectively open the door to a future where immersive technologies overcome barriers to inclusion, turning bold ideas into realities.

3. CASE STUDIES & ANALYSIS

This section explores real-world applications of immersive technologies like Augmented Reality (AR), Virtual Reality (VR), and the Metaverse for enhancing social and vocational skills in autistic individuals. These case studies highlight the transformative power of digital spaces in supporting structured learning and equipping individuals for real-world experiences.

3.1 Case Study 1: AR-Based Classroom and Joint Attention Interventions (Sahin et al., 2018; Pérez-Fuster et al., 2022)

Objectives and Implementation

(Sahin et al., 2018) implemented an AR intervention within school classrooms to improve social communication, cognitive engagement, and motivation in autistic students. The program used interactive visual prompts and structured digital aids, seamlessly integrated into classroom routines. Similarly, (Pérez-Fuster et al., 2022) focused specifically on improving joint attention, a foundational social skill, using AR-mediated tasks that encouraged shared focus and nonverbal coordination between children and their facilitators.

Outcomes and Findings

Both studies reported notable improvements. (Sahin et al., 2018) observed enhanced cognitive focus and motivation, with educators and parents noting increased engagement and communication. (Pérez-Fuster et al., 2022) found that children developed stronger joint attention skills, becoming more capable of sharing focus on objects and tasks which is essential for initiating social interactions.

Challenges and Limitations

While results were promising, challenges included limited access to AR hardware and the potential for sensory overload in some students (Sahin et al., 2018; Pérez-Fuster et al., 2022). Although AR performed well in controlled environments, its long-term effect on spontaneous, unstructured social behaviours remains an area for further research (Sahin et al., 2018; Pérez-Fuster et al., 2022).

3.2 Case Study 2: Metaverse-Based Social Skills Training (Lee et al., 2023)

Objectives and Implementation

(Lee et al., 2023) introduced a Metaverse-based intervention offering autistic individuals a safe and controlled digital space to rehearse real-life social scenarios. The virtual environment simulated group conversations, team tasks, and interactive role-play, allowing users to gradually develop their social skills in a way that suits them best.

Outcomes and Findings

Participants demonstrated improved verbal communication, reduced anxiety, and greater self-confidence in handling social challenges (Lee et al., 2023). The program's strength lay in its ability to personalize experiences, tailoring each session to the individual's developmental needs and comfort levels, which was crucial for sustained engagement and skill transfer (Lee et al., 2023).

Challenges and Limitations

Despite its adaptability, the intervention faced technical barriers, including dependence on high-speed internet and immersive hardware (Lee et al., 2023). Additionally, some participants needed close caregiver support to avoid overstimulation, especially during complex simulations (Lee et al., 2023).

3.3 Case Study 3: VR for Social and Vocational Training (Schmidt & Glaser, 2021; Soltiyeva et al., 2023)

Objectives and Implementation

(Schmidt & Glaser, 2021) explored VR as a platform for teaching real-life social skills, such as ordering food, initiating conversations, and seeking help. Their program used dynamic role-play with real-time feedback to immerse participants in everyday situations.

Expanding on this, (Soltiyeva et al., 2023) introduced My Lovely Granny's Farm, a VR-based vocational training simulation. It allowed autistic individuals to engage in realistic job roles such as interacting with customers or making independent decisions in a safe, feedback driven environment.

Outcomes and Findings

Both interventions yielded significant benefits. (Schmidt & Glaser, 2021) found that the VR setup promoted more active engagement compared to traditional teaching, with participants showing improved confidence and communication. (Soltiyeva et al., 2023) emphasized VR's capacity to nurture vocational readiness and independence, marking a step forward in long-term life skills training.

Challenges and Limitations

As with other immersive solutions, VR programs remain costly and resource-intensive (Schmidt & Glaser, 2021; Soltiyeva et al., 2023). Participants often needed tailored sensory configurations to reduce overstimulation. Both studies highlight the need for user-centric design and flexible adaptation to ensure inclusivity and usability (Schmidt & Glaser, 2021; Soltiyeva et al., 2023).

4. DISCUSSION

4.1 Effective Strategies and Challenges

A closer look at these case studies highlights patterns that reveal what drives the success of immersive interventions and where challenges remain. The table below provides a clear, comparison of the strengths, outcomes, and challenges for AR, Metaverse, and VR interventions. Each technology brings distinct advantages, adding unique value to the learning experience while also facing hurdles like scalability, adaptability, and user engagement.

Table 1: Comparative Summary of Immersive Interventions for Autistic Individuals

Aspect	AR-Based Classroom Interventions (Sahin et al., 2018; Pérez-Fuster et al., 2022)	Metaverse Social Skills Training (Lee et al., 2023)	VR-Based Social & Vocational Programs (Schmidt & Glaser, 2021; Soltiyeva et al., 2023)
Strengths	Boosted joint attention, motivation, and communication in structured learning settings.	Provided a safe space for gradual, personalized social practice; increased confidence and verbal skills.	Simulated realistic social and vocational tasks; offered interactive and engaging learning.
Challenges	Limited access to AR hardware; risk of sensory overload in some learners.	Required strong connectivity and immersive tech; some users needed caregiver support.	High costs, limited scalability, and need for sensory customization to avoid over-stimulation.
Outcomes	Improved focus and peer interaction; strong educator and parent feedback.	Reduced social anxiety; participants engaged better with real-world social situations.	Boosted communication, independence, and job-readiness skills; encouraged real-world application.

Table 2: Key Insights from the Comparison

Category / Insights	Key Takeaways	Supporting Studies
Successful Strategies		
Personalized Learning	Tailored interventions adapted to individual needs improved engagement, confidence, and skill development.	(Sahin et al., 2018; Lee et al., 2023; Schmidt & Glaser, 2021; Soltiyeva et al., 2023)
Immersive & Gamified	Gamified, interactive scenarios kept participants motivated and encouraged sustained practice.	(Lee et al., 2023; Schmidt & Glaser, 2021; Soltiyeva et al., 2023)
Safe Environments	Controlled, low-pressure settings (AR/VR) reduced anxiety and promoted social communication.	(Sahin et al., 2018; Pérez-Fuster et al., 2022; Schmidt & Glaser, 2021)
Challenges Identified		
Accessibility Issues	High-tech demands, hardware requirements, and costs limited scalability and inclusion.	(Sahin et al., 2018; Lee et al., 2023; Schmidt & Glaser, 2021)
Sensory Overload	Overstimulation risks required individualized sensory adjustments for effective engagement.	(Lee et al., 2023; Schmidt & Glaser, 2021; Soltiyeva et al., 2023)

4.2 Practical Implications of the study

Improvements in AR/VR-Based Interventions

To fully realize the potential of immersive technology, future work must address the following areas:

1. **Scalability:** Develop budget-friendly, hardware-light solutions to expand reach across educational and therapeutic settings (Sahin et al., 2018; Schmidt & Glaser, 2021).
2. **User-Centered Design:** Involve neurodivergent individuals and their caregivers directly in the design process to ensure contextual relevance and comfort (Pérez-Fuster et al., 2022; Soltiyeva et al., 2023).
3. **Adaptive Features:** Incorporate sensory customization to prevent overstimulation, including adjustable visuals, sounds, and interaction pacing (Lee et al., 2023; Schmidt & Glaser, 2021).
4. **Interdisciplinary Collaboration:** Facilitate partnerships between educators, technologists, and clinicians to create holistic and inclusive solutions that integrate educational and therapeutic needs (Pérez-Fuster et al., 2022).

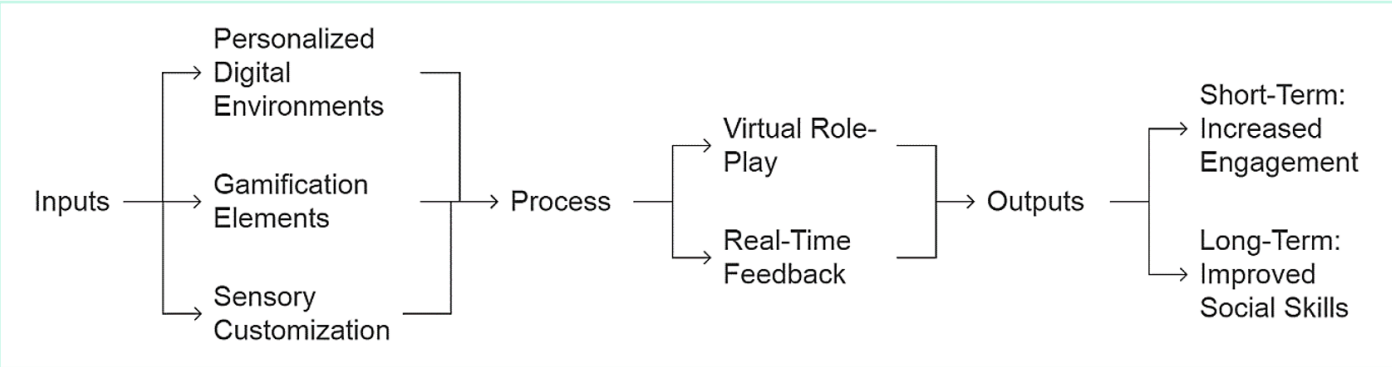

Fig. Process Flow Using an Input–Process–Outcome Model for Immersive Technologies in Social Skill Development of Autistic Adolescents

As shown in Figure 1, immersive technologies operate through a structured flow of inputs and processes that support both engagement and skill development.

Policy Recommendations for Inclusive Digital Learning

1. **Funding for Accessibility:** Governments should invest in the procurement and development of AR/VR tools, learning from scalable models like the UK's Autism Education Trust (2024). This initiative demonstrates how policy-driven frameworks can successfully integrate assistive technologies into classrooms and train educators offering a replicable model for inclusive digital learning globally.
2. **Standardized Privacy Guidelines:** Ensure data protection and transparency in AI-driven personalization (Lee et al., 2023).
3. **Inclusivity Training** – Prepare educators and therapists to effectively use immersive platforms (Sahin et al., 2018).
4. **Scaling Pilot Programs:** Broaden successful case studies to diverse populations for testing adaptability and long-term benefits (Schmidt & Glaser, 2021).

5. CONCLUSION AND SCOPE FOR FUTURE RESEARCH

Augmented Reality (AR), Virtual Reality (VR), and the Metaverse are reshaping how autistic individuals connect with the world—offering more than just support tools, but powerful mediums for growth, confidence, and real-life readiness. Case studies reveal how these immersive environments provide safe, structured, and interactive spaces that nurture communication, reduce anxiety, and foster independence (Sahin et al., 2018; Lee et al., 2023; Schmidt & Glaser, 2021).

These technologies have already shown promise whether through AR's visual guidance, Metaverse-based roleplay, or VR's dynamic simulations. Yet, their greatest impact is still unfolding. With inclusive design, wider accessibility, and thoughtful integration into education and therapy, they can move from being experimental tools to everyday enablers of change (Pérez-Fuster et al., 2022; Soltiyeva et al., 2023).

What we innovate today could define a future where neurodivergent youth aren't just participating but succeeding leading conversations, navigating

challenges, and contributing fully to their communities. In that vision, technology becomes more than a solution it becomes a bridge to belonging.

Scope for the Future Research

To extend the impact of current interventions and fulfil the review's objectives, future research should pursue:

- Tracking long-term effects of AR/Metaverse use in education and therapy to evaluate sustained improvements in social adaptability and life skills (Abd El-Sattar, 2025).
- Integrating learning analytics to monitor and adapt experiences in real-time (Lampropoulos & Evangelidis, 2025).
- Interventions should be tried in various cultural and economic backgrounds to make sure they work for all kinds of learners (Chalim et al., 2024).
- Designing low-cost versions of these tools can make immersive learning more accessible to schools and families with fewer resources (Sharma & Babu, 2023).

REFERENCES

1. Abd El-Sattar, H. K. H. (2025). Future metaverse-based education to promote daily living activities in learners with autism using immersive technologies. Education and Information Technologies, 30(3), 3145-3182. https://doi.org/10.1007/s10639-024-12844-3
2. Autism Speaks. (2021). Autism spectrum disorder (ASD). Autism Speaks. Retrieved from https://www.autismspeaks.org/what-autism
3. Centers for Disease Control and Prevention. (2024, May 14). About autism spectrum disorder. Autism Spectrum Disorder (ASD). Retrieved from https://www.cdc.gov/autism/about/index.html
4. Chalim, S., Usman, F., Rokhman, M., Rusydi, I., & Zamawi, B. (2024). Children's Education in the Metaverse Era: Between the Rapid Growth of Information Technology and Self-learning of Generation Z. Nazhruna: Jurnal Pendidikan Islam, 7(3), 608-627. https://doi.org/10.31538/nzh.v7i3.19
5. Cleveland Clinic. (2025, September). Autism spectrum disorder (ASD) symptoms & causes. Cleveland Clinic. Retrieved from https://my.clevelandclinic.org/health/articles/autism
   https://doi.org/10.3389/feduc.2018.00057
6. Lampropoulos, G., & Evangelidis, G. (2025). Learning Analytics and Educational Data Mining in Augmented Reality, Virtual Reality, and the Metaverse: A Systematic Literature Review, Content Analysis, and Bibliometric Analysis. Applied Sciences, 15(2), 971.https://doi.org/10.3390/app15020971
7. Lee, J. H., Lee, T. S., Yoo, S. Y., Lee, S. W., Jang, J. H., jin Choi, Y., & Park, Y. R. (2023). Metaverse-based social skills training programme for children with autism spectrum disorder to improve social interaction ability: an open-label, single-centre, randomised controlled pilot trial. EClinicalMedicine, 61. https://doi.org/10.1016/j.eclinm.2023.102072
8. Mitsea, E., Drigas, A., & Skianis, C. (2025). A Systematic Review of Serious Games in the Era of Artificial Intelligence, Immersive Technologies, the Metaverse, and Neurotechnologies: Transformation Through Meta-Skills Training. Electronics, 14(4), 649. https://doi.org/10.3390/electronics14040649
9. Pérez-Fuster, P., Herrera, G., Kossyvaki, L., & Ferrer, A. (2022). Enhancing joint attention skills in children on the autism spectrum through an augmented reality technology-mediated intervention. Children, 9(2), 258. https://doi.org/10.3390/children9020258
10. Sahin, N. T., Abdus-Sabur, R., Keshav, N. U., Liu, R., Salisbury, J. P., & Vahabzadeh, A. (2018, September). Case study of a digital augmented reality intervention for autism in school classrooms: Associated with improved social communication, cognition, and motivation via educator and parent assessment. In Frontiers in education (Vol. 3, p. 57). Frontiers Media SA.
11. Schmidt, M. M., & Glaser, N. (2021). Piloting an adaptive skills virtual reality intervention for adults with autism: findings from user-centered formative design and evaluation. Journal of Enabling Technologies, 15(3), 137-158. https://doi.org/10.1108/jet-09-2020-0037
12. Sharma, A., & Babu, V. (2023, October). Enhancing social interaction skills for autism spectrum disorder (ASD) individuals in the metaverse. In 2023 14th International Conference on Information and Communication Technology Convergence (ICTC) (pp. 193-198). IEEE. https://doi.org/10.1109/ictc58733.2023.10392788
13. Soltiyeva, A., Oliveira, W., Madina, A., Adilkhan, S., Urmanov, M., & Hamari, J. (2023). My Lovely Granny's Farm: An immersive virtual reality training system for children with autism spectrum disorder. Education and Information Technologies, 28(12), 16887-16907.https://doi.org/10.1007/s10639-023-11862-x
14. World Health Organization. (2023, November 15). Autism spectrum disorders. World Health Organization. Retrieved from https://www.who.int/news-room/fact-sheets/detail/autism-spectrum-disorders