International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Survey on Multifaceted Impacts: Assessing the Integration of Augmented Reality (AR) and Virtual Reality (VR) in Education for Autistic Children

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ABSTRACT

This project seeks to develop a groundbreaking Augmented Reality (AR) and Virtual Reality (VR) learning platform tailored for autistic children, addressing their unique educational and social challenges. Featuring multi-user access for collaborative learning, the platform incorporates behavioral analysis to customize learning paths based on individual preferences and challenges. Immersive AR/VR environments simulate real-world scenarios, facilitating the practice of everyday life skills and social interactions in a controlled virtual space. Parental involvement is key, with features for progress tracking and guidance, aiming to empower autistic children with a personalized, inclusive, and supportive learning experience that bridges the gap between home and school. The user-friendly interface ensures accessibility, contributing to the educational empowerment of autistic children in an engaging virtual environment.

Keywords: Ar/Vr, Autism,Learning Platforms

INTRODUCTION

Autism, a neurodevelopmental condition, represents a wide-ranging spectrum of experiences and abilities. Prioritizing the support of individuals with autism on their educational journeys is of utmost significance, as it paves the way for them to achieve their fullest potential and lead enriched lives. By tailoring learning paths to the specific needs of individuals with autism, we can create inclusive and supportive educational environments that empower them to reach their full potential and contribute meaningfully to society.Developing and implementing personalized autism learning paths demands significant resources, including time, specialized personnel, and funding. These resources may not always be readily available, limiting accessibility for many individuals and their families.Some educational systems and programs adopt a one-size-fits-all approach, which fails to account for the individualized needs and preferences of those with autism. This lack of customization can hinder progress and engagement.In some instances, there is a disconnect between various support systems, such as schools, therapy services, and community resources. This fragmented approach can result in gaps in care and support.Despite increased awareness, stigma and misunderstanding about autism persist in society. Negative perceptions can hinder acceptance and inclusion, making it more challenging for

individuals with autism to thrive in educational settings.Certain educational approaches may prioritize compliance and conformity over fostering independence and self-advocacy, potentially stifling the development of essential life skills.Creating learning paths for individuals with autism involves thoughtful consideration of their unique needs and preferences, whether through traditional methods or augmented reality/virtual reality (AR/VR).

LITERATURE SURVEY

Chistol,M developed the Human-Centered Design methodology, prioritizing end-users' needs—therapists, children with special needs, and caregivers.Design elements, such as proto-personas and wireframes, were crafted and validated in collaboration with ABA therapists. The iterative process refined the platform, integrating ABA therapy principles and educational techniques like video modeling.This provides advanced technologies like the Unity game engine and Ruby on Rails, we created efficient modules for optimal mobile performance. The versatile platform suits home-based therapy and educational centers, offering personalized content for individual or group learning and featuring a collaborative gaming module.Ms. Ashlesha Jadhav utilizes the built-in camera and speaker of standard Android devices to create educational content,[2] is an app that captures images and videos of objects in the environment, associates them with AR content via QR Codes, and presents them on the screen. Parents or teachers can instantly generate personalized AR lessons in real-time without the need for paper. Features include functional reading, visual schedules, and speaking albums, enhancing children's learning through real-life situations. Two distinct cognitive training interventions were implemented byDe Luca, R .Initially, a one-month course of cognitive behavioral therapy (CBT), followed by a one-month rest period. Subsequently, a combined approach utilizing virtual reality (VR) through the BTS-Nirvana System and CBT was employed. Notably, only the combined approach demonstrated a notable enhancement in attention processes and spatial cognition skills, accompanied by a significant reduction in ideomotor stereotypes. [3] suggested that integrating VR with CBT holds promise as a valuable tool to enhance cognitive functions in individuals severely impacted by Autism Spectrum Disorder (ASD).Autism Spectrum Disorder (ASD) encompasses various brain development disorders, with a predominant visual learning profile. The affordability of VR and AR devices, coupled with emerging content creation tools, presents a favorable landscape for educational access.Herrera, G[12] proposed guidelines for creating AR and VR learning content tailored to individuals on the autism spectrum.

The existing literature on the utilization of VR/AR technology in individuals with both Autism Spectrum Disorder (ASD) and Intellectual Disabilities (ID) is at an early stage, marked by limited quantity and quality of studies. Notably, when focusing on participants with concurrent ASD and ID, the scarcity of eligible studies becomes even more pronounced. Within this limited pool, substantial variations were identified in key intervention elements such as duration, type of technology, and targeted skills, which significantly constrains the ability to draw definitive conclusions about the efficacy of the technology at this juncture.

[4] accentuates its significance by offering a comprehensive overview of current themes while shedding light on the existing gaps in the literature. A notable observation is the lack of uniformity and high-quality experimental methodology across studies. Additionally, Erb, Emily M came up with insights into research and practice-based implications, emphasizing the need for future investigations to address the current

limitations and methodological disparities. Noteworthy is the indication that the current technology and literature fall short in appropriately catering to the diverse range within the autism spectrum.[5]also delved into the effects of a Virtual Reality Social Cognition Training program aimed at enhancing social skills in children diagnosed with Autism Spectrum Disorder (ASD). Thirty participants, aged 7–16, underwent ten one-hour sessions over a span of five weeks. Pre- and post-assessments were conducted in [5]across three key domains: emotion recognition, social attribution, and attention and executive function. The results indicated notable improvements in emotion recognition, social attribution, and executive function with analogical reasoning.Participants in[8]exhibited notable improvements in social functioning, emotion recognition, and speech and language through VR-based intervention.Zhang M[8] addresses technology limitations, ethical concerns, and expand applications, focusing on brain-based models. Additionally, [8] states efforts are needed to include autistic children speaking tonal languages, ensuring a globally inclusive perspective in VR-driven education and intervention research.These preliminary findings suggest that utilizing a virtual reality platform [4],[5],[8]presents a promising and effective treatment avenue for addressing social impairments commonly associated with ASD.

Safi, M. F.[6] investigated the impact of Virtual Voice Assistants (VVAs) on speech and social interaction skills in children with Autism Spectrum Disorder (ASD).[6]involves three participants aged 4-11, VVAs, including Apple's Siri, were used for three months, leading to improved speech production and increased social interactions. Safi, M. F. suggest that readily available voice assistant software, such as Siri, can positively influence communication and social skills in children with ASD.

Ibrahim El Shemy employs a Participatory Design (PD) approach, addressed three research questions to understand relevant dimensions for vocabulary acquisition in autistic children, methodologies used for vocabulary teaching, and design features necessary for a mobile Augmented Reality (AR) application to enhance vocabulary learning in autistic children.

The findings[19] suggest that an effective mobile AR application for this purpose should: incorporate realistic content to facilitate generalization and contextualization, combine visual content with auditory stimuli, offer multiple interaction modalities to enhance learning and visual attention, and include learning activities centered on association, classification, simulation, and repetition. It is crucial to note that the AR solution is designed not to replace but to complement existing teaching methods, serving as a supportive tool to foster motivation and attention in children.
Patricia Pérez-Fuster focused on enhancing Responsive Joint Attention (RJA), specifically following another person's gaze and pointing to a shared object. The Pictogram Room was utilized in a multiple baseline Single-Subject Experimental Design (SSED) with six participants, demonstrating improved RJA skills post-intervention. These enhancements were sustained over time and generalized to real-world scenarios.[7] highlights the effectiveness of the Pictogram Room as an accessible and affordable AR system, offering a targeted and engaging intervention for autistic children to improve their RJA skills. The potential application extends beyond JA to include other skill areas such as body knowledge or imitation.Amat AZ developed InViRS, a VR gaze system for children with Autism Spectrum Disorder (ASD), incorporating personalized learning features.[10] demonstrated improved gaze sharing and following skills in ASD children. While gaze sharing improved, challenges persisted in following rapid gaze prompts, highlighting differences with typically developing children. Overall, InViRS shows

potential in enhancing ASD children's interpretation of communicative gaze-based information.

Ahn SN.examined the combined impact of virtual reality (VR) and computer game-based cognitive therapy on visual-motor integration in children with intellectual disabilities. Thirteen participants underwent a 12-session intervention using WiiVR and CoTras games. Evaluation, using the Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2) and Developmental Test of Visual Perception-2 (DTVP-2), demonstrated significant improvements in overall visual motor integration, particularly in motor skills and visual perception. The study [9] suggests that VR and cognitive therapy positively affect visual motor integration in children with intellectual disabilities, emphasizing the enhancement of sensorimotor systems for processing visual information.

In individuals with Autism Spectrum Disorder (ASD), de Moraes ÍAP explored motor performance during coincident timing tasks in virtual and real environments. Young people with ASD and a typically developing (TD) control group underwent a randomized controlled trial using Kinect (no physical contact) and Keyboard (with physical contact) tasks. While the virtual task presented more difficulties, the ASD group exhibited enhanced performance in subsequent real tasks, outperforming the TD group. [11]suggest that individuals with ASD can transfer skills from virtual to real environments, highlighting the potential of virtual methods to enhance motor and cognitive skill learning.

H. Lee introduces an immersive virtual environment with a vehicle simulator featuring loosely synchronous motion based on contextual content. The simulator utilizes precise localization through sensor fusion with PGV, wheel encoders, and IMU, guided by a kinematic controller. Human testing validated hypotheses related to Quality of Experience (QoE), with results indicating the impact of loosely synchronous motion on immersion and motion sickness. Recommendations for optimizing QoE include applying loosely synchronous motion for increased immersion across various environments but limiting its use for motion sickness reduction to VR with Head-Mounted Display (HMD) settings.[13] work involves exploring different game contents and investigating alternative localization methods, such as ultra-wideband positioning sensors or visual Simultaneous Localization and Mapping (SLAM).

Adapting Information and Communication Technologies (ICT) for users with Autism Spectrum Disorder (ASD) is a significant concern. [14]presents an application designed for easy customization using web technologies. Managed through the standard file system explorer, users can create folders with personalized content, allowing swift customization of images, videos, audio, and the platform's appearance. This user-friendly system aims to assess whether tailoring the application to the specific preferences of children with ASD encourages motivation and contributes to the development of communicative and social skills. Margarida Lucas da Silva provides a comfortable means for interaction with peers and facilitates easy access to preferred content.

The presented robots in this paper[15] have demonstrated their effectiveness in engaging children with autism in various roles, contributing to their social and emotional education. Activities involving imitation, joint attention, emotion and facial recognition, triadic interaction, and tactile social behavior were explored in these studies. While robots play a crucial role in autism therapy by enhancing social skills and emotional development, ethical considerations, such as emotional attachment and their overall percentage of use in

the treatment process, need careful attention. It is emphasized that robots should complement human involvement rather than replace it in autism therapy. Various robots, such as "ROBOTA" from the AuRoRa project and the humanoid robot KASPAR, have shown success in fostering social skills and collaboration in children with ASD. Despite advancements in technology, the collaborative use of robotics technology and human interaction is considered essential for effective autism therapy[15].

Dechsling, A. aimed to identify intervention studies utilizing Virtual Reality (VR) and Augmented Reality (AR) to enhance social skills in individuals with autism. The study showcasing varied focuses, intervention types, and technologies within the autism and social skills domain. Notably, the field is relatively young, and despite the essential nature of participant numbers for study validity, most studies featured a small number of participants and short intervention durations. An additional noteworthy observation is the underrepresentation of female participants with autism in the sample, suggesting potential challenges related to social interaction detection and differences in social strategies between genders[16].

In this single-arm feasibility clinical trial[17],Amaral, C.investigated the use of an EEG brain-computer interface (BCI) in training social cognition skills in individuals with high-functioning Autism Spectrum Disorder (ASD). Fifteen participants underwent BCI training using a virtual reality interface over seven sessions, with a follow-up assessment conducted 6 months later. The BCI paradigm involved identifying objects based on the gaze direction of an avatar, extracting attentional responses from the EEG P300 component. The study demonstrated the feasibility and potential clinical effects of this technology in ASD, revealing improvements in autism symptoms, adaptability, and daily living skills[17].

Wedyan, M. employed Augmented Reality (AR) to present faces with six basic expressions, aiding children in recognizing facial features and associating expressions with corresponding emotions. It prioritized a friendly and safe interaction for both autistic and typical children, leading to enhanced social interactions, communication, and facial expressions. AR demonstrated its potential as a therapeutic tool for children with Autism Spectrum Disorder (ASD), offering efficient and simultaneous visual and auditory signals. While the findings are encouraging, the study's limitations, such as small sample sizes, highlight the need for further research to validate the methodology in a larger sample[18].

Aaisha & AlSariri involved conducting experiments with school students using Virtual Reality Glasses to assess the effectiveness of this method in providing knowledge. The participation of mathematics teachers and parents was sought to ensure accuracy and credibility. The results showed a 89.74% student response rate with only 10.25% of students not completing parts of their solutions. The findings suggest a growing demand for the use of modern technologies in education. Challenges faced during implementation included the need for specialized personnel to deal with children and budget constraints for widespread application of virtual reality glasses in schools. Seeking financial support from companies is considered a potential solution to overcome the latter challenge. Additionally, the research aimed to gauge opinions on adapting VR technology for teaching math topics to young students, involving interviews with teachers and parents. The study found that VR technology was a new and unused tool for both students and educators in the educational context[20].

CONCLUSION

The proposed AR/VR learning platform for autistic children offers a personalized, socially interactive, and practically applicable educational experience. Its advantages over existing initiatives and traditional methods lie in its dynamic personalization through behavioral analysis, real-time collaborative features, and the incorporation of realistic simulations for hands-on learning. By addressing the unique needs of autistic learners, the project has the potential to redefine educational approaches and empower individuals on the autism spectrum academically, socially, and in their everyday lives.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to all those who contributed to the development of this AR/VR learning platform for autistic children. Special thanks to my project supervisor for guidance and support, the participants and their families for their involvement, and the broader community for their encouragement. This project would not have been possible without the collective efforts and support from everyone involved.

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