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A Comprehensive Review on Teaching Students with Learning Disabilities: The Potential of VR and AR Technology

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Abstract

In terms of enhancing learning experiences, the use of virtual reality (VR) and augmented reality (AR) in education has shown encouraging outcomes. These technologies offer immersive, interactive environments that are extremely beneficial to students who struggle with learning. to assess how VR and AR affect learning outcomes in general as well as motivation, engagement, and academic performance. We'll examine how these resources might be applied to support children who face learning challenges. It also looks to determine the difficulties and possibilities these technologies may provide in special education in the future. A comprehensive search of the literature was carried out utilizing a range of sources, including PubMed, Google Scholar, and specialized academic databases. It was found that a great deal of potential is needed for VR/AR technology to transform special education. They provide students with learning challenges and individualized flexible learning experiences that improve their motivation, engagement, and academic achievement. Although VR/AR can be useful tools for improving the educational experiences of children with learning impairments, more study and funding are required to remove current obstacles and reach VR and AR's full potential in children with special needs. Students may study and engage with complicated subjects in a safe, supervised environment by using VR and AR, in particular, to construct simulations and scenarios that are not possible in conventional classroom settings. With the ability to create personalized learning pathways that suit various learning styles and speeds, these technologies can also be customized to match the particular needs of each student. Also, the excitement and engagement that VR and AR provide can encourage a deeper interest in learning, which is essential for long-term academic achievement.

Keywords: Virtual reality (VR), augmented reality (AR), learning disabilities, special education, personalized learning

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INTRODUCTION

Background and Context

A person's capacity to learn new things can be severely hampered by a range of neurodevelopmental conditions known as learning disabilities (LD). Consequently, the individual can experience difficulties in speaking, writing, reading, focusing, comprehending information, recalling details, executing mathematical computations, or coordinating actions (Vidyadharan V et al., 2019) [1]. LD can manifest in various forms, including dyslexia, which affects the ability to read and decode words, and attention-deficit/hyperactivity disorder (ADHD), which can interfere with learning due to issues with focus and concentration. The phrase "learning disabilities" was first used during a

small meeting of parents and educators at the Palmer House in Chicago. LDs are highly prevalent, impacting approximately one in five children (Moreau & Waldie, 2016) [2]. Approximately 5–15% of school-age children worldwide have been diagnosed with specific learning disorders, like dyslexia, dyscalculia, and dysgraphia, according to the most recent statistics. The Individuals with Disabilities Education Act (IDEA) provided special education services to approximately 7.1 million students in the United States between the ages of 3 and 21 in the 2020–2021 academic year. Of these, 33% had specific learning disabilities, according to the National Center for Education Statistics (NCES, 2022). If these difficulties are not adequately resolved, they may result in poor academic performance, frustration, low self-esteem, and behavioral problems (Cortiella & Horowitz, 2014) [3].

A variety of complex challenges greatly impacts the educational experiences of students with LDs. First, their academic performance frequently falls behind their chronological age because of underlying processing issues, making academic challenges prevalent. Second, there is a significant psychosocial impact, since social barriers, emotional stress, and problems with self-esteem all negatively impact their general well-being. Plus, the possibility of bullying or rejection from others might cause them to feel alone, anxious, or depressed (Elbaum & Vaughn, 2003) [4]. Third, there's a lack of understanding among educators, which causes a delay in timely identification and intervention. Fourth, early detection is critical; evaluating kids between the ages of 5 and 7 enables prompt assistance and customized tactics. Fifth, a more accurate estimate of the prevalence of LD is ensured when the native language is taken into account during evaluation. Lastly, because of the limited exposure to school environments, there is a possibility of overestimation, highlighting the importance of precise identification and support systems. According to Fletcher et al. (2019), the prompt identification and execution of focused interventions can greatly enhance academic results and cultivate a more welcoming and encouraging learning atmosphere [5].

Virtual Reality (VR) and Augmented Reality (AR)

Technologies like Virtual reality (VR) and Augmented reality (AR) are becoming more and more effective tools for improving education, especially for those with LD. These immersive learning opportunities provide a special combination of advantages that can solve certain issues and accommodate various learning preferences. By superimposing digital content over the actual world, Augmented Reality (AR) improves the user's surroundings. On the other hand, Virtual Reality (VR) gives consumers a sensation of presence by submerging them in fully virtual worlds.

AR has the potential to improve visual perception and comprehension for those with visual processing problems by superimposing digital information onto the physical environment. AR apps, for instance, might draw attention to particular things or give more context to help with understanding. They can be customized to meet the specific learning needs of each user by changing the pace or complexity of the content in response to their actions or advancement. This flexibility can help students with different types of learning difficulties by providing individualized challenges and assistance. López-Navajas et al. (2023) [6] investigated the possibilities of AR for kids with specific educational needs in a comprehensive review. The review emphasizes how AR might improve accessibility by offering different information representations that accommodate a range of learning styles. For students with sensory processing problems, VR offers immersive experiences that can assist lessen sensory overload or distractions. It is possible to tailor virtual worlds to reduce sensory cues and produce a more concentrated learning environment. With the use of VR, students can hone their abilities in a secure setting before applying them elsewhere. For those with intellectual disabilities like dyscalculia (difficulties with math) or dyspraxia (difficulties with coordination), this method can improve learning outcomes.

Importance of exploring new teaching methods for students with LD

By investigating innovative teaching strategies, educators may better meet the varied requirements of their students and guarantee that they receive instruction that is appropriate for their level of proficiency. Teaching techniques need to change along with technology and ideologies of education.

By exploring novel approaches, educators can better equip students with learning disorders with the necessary skills and adaptive strategies to meet the difficulties of an increasingly complex and digital world in the future. To better serve the needs of children with learning difficulties, it motivates them to try out novel strategies, work together with colleagues, and constantly enhance their teaching methods.

EXISTING RESEARCH ON VR/AR

Bashir et al., (2022) conducted a study to determine whether AR overlays can help dyslexic kids become more proficient readers [7]. Through multimodal interaction, AR strives to improve knowledge and retention by combining digital upgrades such as visual signals and auditory prompts with physical text. With the use of this technology, each reader's demands and reading level may be catered to individually. Creating reading materials more approachable and interesting promotes a more welcoming educational setting and may change the way dyslexic students learn. Immersion simulations offered by VR give pupils a secure setting in which to hone a variety of skills. Students who struggle with social anxiety or sensory processing issues, who might find typical learning situations stressful, can particularly benefit from this. VR simulations help students hone their social skills, problem-solving techniques, and other capabilities in a safe virtual environment. This promotes a more inclusive approach to learning for all students (Shapiro & Gerber, 2023) [8].

Kysela & Štorková (2015) explored that visually captivating and interactive experiences using AR/VR have the potential to revolutionize education for kids with learning difficulties. AR/VR can improve engagement by providing immersive settings and interactive components, which will motivate and enjoy studying more. This increased involvement is advantageous since it can help pupils concentrate better on academic assignments and help them retain information better. Parsons et al., 2006 stated that the children with ASD who took part in the VR therapies showed improvements in their social abilities [9]. Additionally, the participants demonstrated enhanced communication abilities, a greater awareness of social cues, and a greater willingness to engage in social interactions over time. By making instructional information more interactive, accessible, and customized to individual learning styles, AR can improve learning outcomes and engagement for kids with impairments. Thus, applications for AR have been discovered to benefit a variety of learning challenges, including issues with auditory and visual processing (Pallavicini et al., 2018) [10]. As reported by Bioulac et al., (2019), the findings showed the potential of virtual reality as a diagnostic and therapy tool for ADHD [11]. In a controlled environment, VR simulations enable in-depth study of behaviors and cognitive processes associated with ADHD. Additionally, behavioral management techniques and attentional abilities could be strengthened using VR-based therapy.

METHODOLOGY

To find pertinent systematic reviews and meta-analyses published in English within the last ten years, the methodology involved searching automated databases like Google Scholar, Shodhganga, PubMed, Medline, and PsycINFO using keywords like Virtual Reality, Augmented Reality, Learning Disabilities, and Special Education.

IMPACT of VR and AR on TEACHING

Enhanced engagement and motivation among students

With the creation of immersive and engaging learning environments, VR/AR are transforming the educational landscape. According to research, these tools can greatly increase student motivation and engagement, which will improve learning results. VR offers immersive settings that enhance and captivate learners (Akçayır & Akçayır, 2019) [12]. By allowing students to go to space, tour historical locations, and learn about the human body, abstract ideas become more relatable and simpler to comprehend. AR projects digital data into the physical world, enabling students to engage with the material dynamically. Due to the ability for students to edit 3D models, conduct virtual experiments, and display complex data, this interactivity may result in more interest and participation. Individual learning styles and speeds can be catered for with VR/AR. Mosher et al., 2023 said that students' attention is maintained by this customization, which meets their demands and offers prompt feedback

[13]. Thereupon, it is possible to include game-like features like challenges, rewards, and progress monitoring in both VR/AR. Because of this gamification, learning is made enjoyable and competitive, which keeps pupils interested and motivated as shown in Figure 1 (Feng et al., 2020) [14].

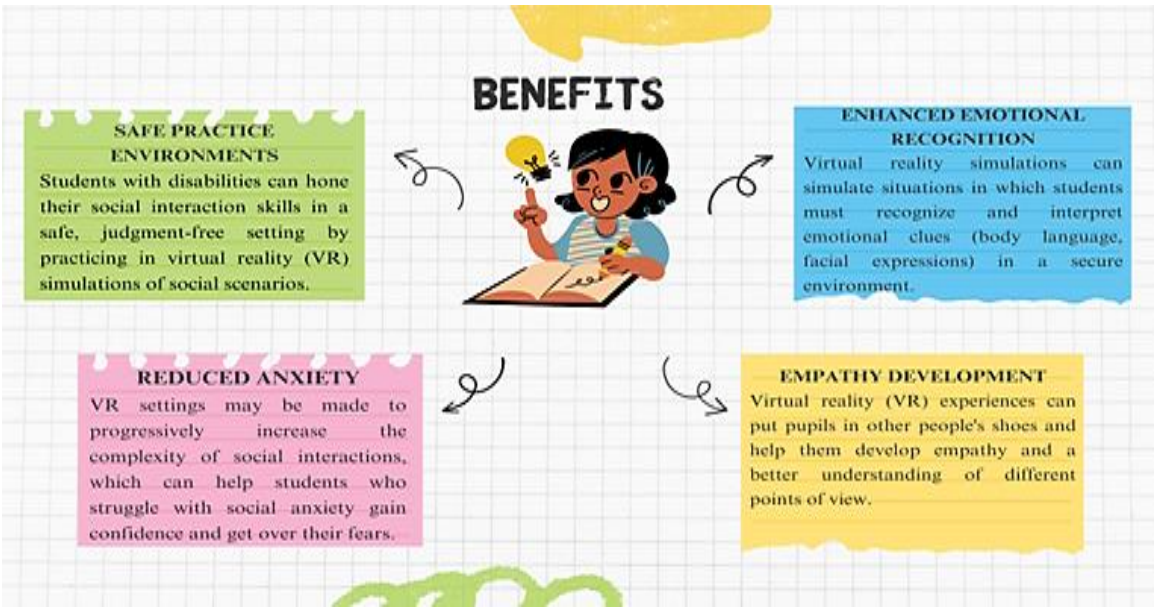

Figure 1. Benefits of VR and AR.

Vibrant and multisensory experiences offered by VR/AR have the potential to enhance and invigorate learning. The intrinsic motivation of students to learn may rise as a result of this sensory engagement. VR/AR can boost motivation by encouraging active learning, in which students participate actively in the educational process. By allowing students to collaborate in virtual environments, VR/AR can promote collaborative learning. This kind of cooperation creates a feeling of belonging and purpose that may be quite inspiring as shown in Figure 2.

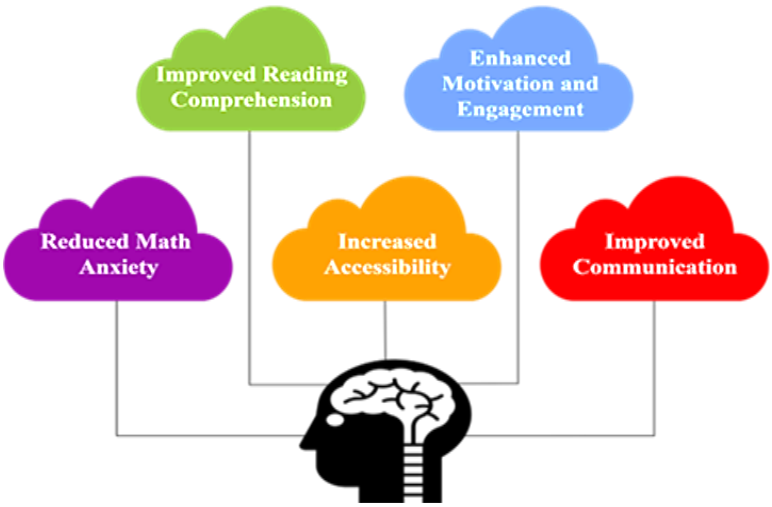

Figure 2. Benefits of cognitive development.

Limitations specific to students with learning disabilities

i. Because AR and VR environments can be very exciting, kids with learning difficulties may experience cognitive overload. These kids frequently find it challenging to integrate several sensory inputs at once, which makes it challenging for them to concentrate and study well in an immersive setting.

ii. Accessibility is not taken into consideration when creating AR and VR content. For instance, interacting with visually demanding AR/VR applications may be difficult for students with vision impairments. In a similar vein, those experiencing motor impairments could find it challenging to operate controllers or navigate virtual worlds.
iii. In VR, disorientation or rapid movement can cause cybersickness, which can cause nausea and discomfort. Students who suffer from vestibular issues may be more vulnerable.

FUTURE DIRECTIONS

i. *Enhanced Realism and Immersion:* VR and AR experiences are becoming more lifelike and engaging thanks to developments in display technology, featuring higher resolution screens and better optics. Users' sense of presence in virtual worlds will be further enhanced by developments in haptic feedback systems, which will enable individuals to feel textures and physical sensations.
ii. *Portable and Affordable Devices:* These technologies are becoming more widely available with the release of stand-alone VR headsets as well as AR glasses that don't require a connected computer. More educational institutions and students will be able to integrate VR/AR within their classrooms as hardware costs come down.
iii. *Focus on Physical and Mental Wellbeing:* User well-being should be given priority in future VR/AR development. This includes functions that reduce cybersickness, encourage proper posture in virtual reality settings, and incorporate tools for tracking mental health.

IMPLICATIONS FOR EDUCATORS, POLICYMAKERS, AND TECHNOLOGY DEVELOPERS

Working together, developers, legislators, and educators can transform special education through VR/AR technology. By providing funds, encouraging the development of open-source content and standardized platforms, and protecting the privacy of student data, policymakers may exercise a significant role. Lastly, a greater variety of information created especially for kids with learning disabilities, accessibility features, psychological wellness considerations, and user comfort must all be given top priority by technology developers. By working together, we can fully utilize the promise of VR/AR, empowering teachers and creating inclusive learning environments that will ultimately help learning-disabled kids realize their full potential.

CONCLUSION

Even though VR/AR have the potential to completely transform education, implementing these technologies in regular classrooms will require a multifaceted strategy. Cost is still a barrier, but VR/AR may grow more widely available via funding, open-source materials, and equipment shared by schools. The effectiveness of utilization depends on qualified teachers. Online forums, technical support personnel, and professional development programs are essential for providing teachers with the knowledge and tools they need to easily incorporate VR/AR into lesson plans and curricula. VR/AR experiences will complement conventional approaches and accommodate a range of learning styles thanks to standardized platforms and an emphasis on learning objectives. And finally, it's critical to overcome technical obstacles. Good VR technology, accessibility features, and cybersickness reduction techniques are all essential for a satisfying VR experience. Through the resolution of these problems and the promotion of cooperation among educators, developers, and legislators, virtual reality and augmented reality hold great promise for enhancing education and stimulating student interest in traditional classroom settings.

Conflict of interest

The authors declare no conflict of interest.

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