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Immersive Technology as an Intervention Tool for Autistic Students: Potential and Risks

Abstract

The study uses a qualitative approach and in-depth interviews to explore the views of parents, specialists, teachers, and autistic individuals of the use of virtual reality in education and therapy. The results suggest that VR has considerable potential as a tool, but that longitudinal research is required to investigate its effectiveness and safety and that VR should be used to support rather than replace other approaches. Effective use of VR will require appropriate training for teachers and therapists, consideration of individual needs, the diversity of autistic individuals and their sensory issues and have the potential to incorporate future technological developments.

Keywords: immersive technology, autistic, education, therapy

Introduction

Virtual reality (VR) covers three main technologies under the umbrella term extended reality (XR): augmented reality (AR), mixed reality (MR), and virtual reality (VR) (Vasarainen et. al, 2021). Augmented Reality (AR) combines the real world with computer-generated content and provides interactive experiences that blend digital elements into the user's real-world environment. AR experiences vary from the use of simple overlays to more complex interactions, depending on the level of integration of the real and virtual elements (Rauschnabel et al., 2022).

Mixed Reality (MR) integrates the real and virtual worlds so that physical and virtual objects can interact in real time. MR provides a more immersive experience than VR by allowing users to engage with both the real and digital elements at the same time.

Virtual Reality (VR) provides a completely separate, simulated environment where users can interact exclusively with virtual objects through a headset. This technology offers varying levels of immersion in the virtual environment, from basic presence to deeply immersive experiences that can affect the user's perceptions and interactions (Rauschnabel et al., 2022).

These technologies are characterized by different degrees of immersion, presence, and interaction. Immersion refers to the depth of engagement and sensory involvement in the virtual environment, while presence is the subjective feeling of being physically situated in a virtual world. In the classic approach, presence includes spatial awareness, self-presence (the feeling of being part of a virtual environment), and social presence (interaction with others in the virtual world). Modern researchers consider presence as a combination of "being there" and perceived realism (Weber et al., 2021). In this context, the sense of embodiment is crucial, referring to the sensations of being inside, possessing, and controlling a body, which in virtual reality can be replaced by an avatar (Guy et al., 2023).

Advances in XR technologies have motivated research into its applications in education and rehabilitation, particularly for autistic individuals. Autism is a type of neurodiversity associated with different forms of thinking, moving, interacting, and sensory and cognitive processing (Hersh & Elley, 2019), giving rise to a need for personalized and evidence-based approaches in education and therapy. At the same time, to fully harness the potential of XR technologies while mitigating risks, a solid ethical framework is essential (Kourtesis et al., 2023).

Research Methodology

Research Background

Research on applications of XR in education and therapy for autistic people dates back two decades. While new applications are regularly being developed, high equipment costs are acting as a barrier to their use in practice. Research on the effectiveness of XR in training and therapy has generally focused on social skills (Ghanouni et al., 2019), communication skills (Khowaja et al., 2019), adapting to various situations (Miller IT et al., 2020), and improving executive

functioning (JI et al., 2022). XR has also been used in the treatment of phobias and anxieties (e.g., Maskey et al., 2019). Features of virtual environments which may make XR appropriate for autistic people include safety, options for individual customization, controllability and reduced interaction with other people.

Recent review articles have found the greatest representation of publications on the use of XR in social skills training with VR the most frequently used technology. For instance, (Mosher & Carreon, 2021) identified 41 research studies of the use of VR to teach skills including emotion recognition, developing relationships, cooperation, and executive functioning. The review found that the use of VR was effective in 63% of the studies, ineffective in 10%, and had mixed results in the remaining 27%. The main reason for using immersive technologies was the high motivation of students, but the researchers stressed the need to involve parents, teachers, and students in skill selection and developing evaluation tools.

Zhang et al. (2022) reviewed the literature up to 2020 on the use of VR in social skills training for autistic people. They concluded that VR is a promising tool for improving social skills, such as understanding emotions and social interaction, but further research is needed on its long-term effects and suitability for particular individuals. Ghasem Alizadeh-Dizaj et al, 2023) review of publications from 2012–2021 identified the potential of VR for use in therapy, but that results to date were inclusive. They stressed the need for systematic long-term research and the involvement of families and therapists. Another review addressed the ethical issues related to the use of VR tools, including informed consent, confidentiality, and privacy.

Sample

The study involved 13 participants presented below with the abbreviations used to identify them in quotations. They were chosen to have diverse perspectives and experiences of the use of VR in education and therapy.

1. Two autistic secondary school students, aged 17 [S1] and 18 [S2]. Both are interested in immersive technology and have used VR applications.
2. An academic researcher and university teacher who is autistic [R].
3. Parents of autistic individuals: the mother of a 17-year-old autistic student, who is a university teacher and therapist [M]; the father of a 16-year-old autistic student, who is a computer scientist, and programmer [F].
4. Three teachers and therapists who work with autistic individuals and use VR.
5. Two special educators with 20 years' experience [Th1], [Th2].

6. A diagnostician with 15 years' experience [P].
7. Two professionals who use VR in education and therapy: a psychologist, co-creator of a VR platform and application for disabled children [Th3]. a teacher, therapist, and diagnostician with eight years of experience, who uses VR technology in therapy [Th4].
8. Four school teachers who use VR technology in their teaching: an English teacher at a center for deaf and hard-of-hearing children [ET], an IT teacher with 22 years' experience in a mainstream school, who has taught autistic students [IT], a geography teacher with 15 years' experience in a special school, who has taught autistic students [GT], a history teacher with 14 years' experience in a mainstream school, who has taught autistic student [HT].

Instruments and Procedures

The interview procedure followed Lichtman's (2023) five phases of in-depth interviewing: advanced planning, opening, starting, the core of the interview, and closing. The analysis involved multiple cycles of initial coding, revising the initial codes, refining the preliminary list of categories, adjusting the generated categories and subcategories, and ultimately transitioning from categories to broader concepts. Investigator triangulation was employed to enhance research quality and provide a broader perspective by comparing findings from multiple researchers (Denzin, 2017).

Data Analysis

The objective of the work was to draw on the perspectives of the main stakeholders including autistic students to increase understanding of the use of immersive technologies to support autistic students and answer the research question "What is the potential and what are the limitations of the use of immersive technologies in education and therapy for autistic students?"

In-depth, semi-structured interviews were conducted to investigate:

1. Participants' experiences as users of technologies employing virtual reality.
2. Participants' views on the potential for using immersive technologies in education and therapy for autistic people, as well as the associated limitations.

Results

Based on the independent analysis of the research material conducted by the researchers, it was found that the themes they identified encompassed the same or similar subcategories and categories. The main point of discussion was whether to distinguish the specificity of sensory information reception and processing in autistic individuals as a separate theme. Ultimately, it was agreed that this aspect should be considered as a contextual factor that enables the interpretation of themes and the identification of participants' opinions on the use of immersive technologies for autistic individuals.

Four main thematic areas were identified.

I. The multidimensional nature of the virtual world

The multidimensional nature of VR involves experiences that are both real and unreal and present unique opportunities and challenges to users. A student using AR and VR applications described their experience as: "VR is both a real and unreal world. I like being in it because I am outside of my own world. In this virtual one, I feel so detached, curious. It has what I want" [S1]. This quote illustrates how VR can provide an escape from reality and encourage curiosity and engagement.

Similarly, a father reflected on the immersive experience of XR technologies: "I understand the fascination with XR. It is a completely different world that offers many sensations and the feeling that you are really there. You can do anything" [F1]. This comment highlights how VR can transport users to different environments and provide a sense of freedom and excitement that is not available in their everyday lives.

However, this immersion has its drawbacks. A mother pointed out that VR's immersive nature can lead to difficulties in transitioning back to reality: "This multisensory learning, deep experience, independent actions in a 'super world,' also has its dark side. A child, any child not just one on the spectrum, acting on such a strong experience, has trouble stepping out of it. Additionally, there is often fatigue and irritability with stimuli" [M]. Her comment underscores the challenge of balancing VR's engaging experiences with the need for students to return to everyday life and manage sensory stimulation.

II. Immersive Technology Tools: Availability and Use

Participant comments included the importance of high-quality tools for achieving therapeutic outcomes: "For me, it is a tool that I use in therapy. Meta Quest 2 are goggles that do not require connection to a computer, which is important in the school space. They are autonomous, small, and convenient.

Choosing the right equipment is the first issue. Immersion and high-quality lead to engagement, and subsequently to positive therapy outcomes" [Th4].

Another respondent emphasized the need for careful selection of VR applications to achieve specific educational or therapeutic goals: "I do not conduct VR therapy; I conduct pedagogical therapy sessions using VR tools. I usually browse applications, select a few, for example, logical, strategic, educational applications and then check how they work, what possibilities they offer" [Th4]. These comments show that effective use of VR tools requires the right technology as well as a reflective approach to applying this technology and evaluating the outcomes.

A researcher noted that sensory issues can affect how autistic individuals interact with VR environments: "Research evidence shows that autistic people's reaction to sensory stimuli is generally different from non-autistic people and that a high percentage of autistic people experience sensory overstimulation which may affect all senses. The solution may be VR with limited sensory channels or reduced input on these channels. There is also the question of whether VR is more effective than other types of simulation, which will probably depend on the particular skills being taught" [R]. This insight suggests that VR experiences should be carefully designed to take account of the sensory needs of autistic individuals.

III. Ethical Aspects of Using Immersive Technologies

The ethical issues raised included one respondent stressing the need to obtain parental consent and use technologies with the correct age groups: "Before I start, I need parental consent. Equipment manufacturers also point out that the goggles should not be used by children under 13. This is because the goggles would simply be too big, thus causing technical problems" [Th4].

Another perspective on the ethical use of VR was its potential for use in training professionals and families to better understand autistic people: "The focus is often on training for autistic people. However, it is equally important to train non-autistic professionals working with autistic people, as well as their family members and friends. VR also has some potential here. For instance, it could be used to help other people better understand the diverse sensory experiences of autistic people and that the distress they are experiencing is very real" [R]. These comments identify the need for those working with or supporting autistic people to have greater empathy and training to better understand them.

IV. Measuring the Effectiveness of VR Tools

Difficulties in evaluating the effectiveness of VR use were highlighted by a student's experiences. "I have a problem with shopping. The therapist used an app that helped me work through it, but I don't know how ready I am yet" [S2]. An IT teacher also noted that measuring VR effectiveness in teaching remains

a challenge: "I can say that VR increases my autistic students' interest and motivation, but how effective is it? I don't have the tools to determine this. I also think that parents' opinions and observations would be important here". These comments illustrate the potential of VR tools in engaging students, highlight the difficulties in measuring their effectiveness in teaching and indicate the need to involve parents in this evaluation.

Analysis of the results showed that participants could be divided into three main groups.

1. Advocates of VR Technology

The first group considered VR a very useful tool for education and therapy. One respondent expressed enthusiasm for VR's role in therapy: "It is very important that the child is an active subject who influences the course of therapy. They build their own world by completing challenges and moving up levels. They can independently adjust the pace of their work and provide a lot of feedback that is very important for the course of therapy".

2. Critics of VR Technology

The second group was skeptical about the widespread use of VR. One respondent expressed doubts about using VR in therapy for autistic people: "VR is a tool that certainly provides potentially wide possibilities for students, including those with disabilities. However, at this moment, I do not see a reason to introduce artificially created reality into therapy for children with autism. There is a lack of studies showing long-term effects, a lack of any procedures" [S3]. This perspective emphasized the need for more evidence before VR was integrated into standard practices.

3. VR Practitioners

The third group acknowledged VR's potential, but stressed the need for it to be used with caution. A teacher discussed the benefits and challenges of VR in the classroom: "Students look forward to VR lessons. The availability of ready-made scenarios allows teachers to teach classes that are effective as well as enjoyable. In my opinion, the equipment is not good, there is not enough of it. As to students with special needs, especially those with autism, there are always some concerns due to the simple responsibility for another person" [HT]. This view balances enthusiasm for VR with recognition of the challenges in implementing it.

Discussion

The research has covered four important themes related to the use of VR in education and therapy for autistic students: 1) the multidimensional nature of virtual environments; 2) the availability and usability of VR devices and appli-

cations; 3) ethical aspects of VR use; and 4) the effectiveness of VR in therapy and education.

The multidimensional nature of virtual environments includes the characteristics of immersiveness, presence, and interactivity which affect how well the virtual space can support autistic students (Rauschnabel et. al, 2022). Participants considered that VR enabled users to have very strong experiences of embodiment and presence, but that immersiveness has advantages and disadvantages. Participants considered its advantages to include the potential to improve individual engagement and motivation to learn and its disadvantages possibly causing sensory overload and difficulties transitioning back to the real world (Mosher et al., 2021). VR can reduce social interaction and allows autistic people to participate in customized learning experiences without social judgments. However, participants considered real-world interaction and social presence fundamental to effective education and therapy.

The results of therapy and education may depend on equipment quality and high costs can be a barrier to VR use (Zhang et al., 2022). XR technologies originated in the entertainment industry and were intended to make a profit. The research has highlighted teachers' and therapists' general lack of training and poor opinions of equipment quality.

According to the literature, XR technologies should be subject to legal regulations and specific guidelines for their use (Kourtesis et al., 2023). However, the study participants were unable to identify specific codes of ethics or legal solutions in this area. In the respondents' view, educating children on how to navigate the virtual world safely is crucial for their self-esteem and perception of their environment. This process requires teachers and specialists to make responsible and ethical decisions.

Due to the diverse functioning patterns of autistic students (Hersh & Elley, 2019), the selection of methods and therapeutic tools must always be preceded by a diagnosis. One of the participants, an academic researcher who was also autistic, stressed that "In designing technologies for autistic people, it is important to take account of their great diversity and the fact that the same solutions will not necessarily work for all autistic people. It is also important to consider the state of the art in terms of development of VR and that advances in this technology are likely to take place" [R].

Conclusions

The research indicates that virtual reality (VR) has potential for use in both education and therapy. Participants had three main perspectives on VR use:

1. Supporters of VR Technology considered VR use in education and therapy to have great potential, including to engage students and support therapy.
2. VR Technology skeptics were cautious about widespread VR use. They considered there was insufficient evidence of long-term effectiveness and called for more research.
3. VR practitioners recognized the usefulness of VR and stressed the need for sufficient preparation and training. They recognized both the potential of VR and the need to resolve its challenges.

Participants considered VR as a potentially valuable tool rather than a standalone therapy solution. Proper preparation and following ethical standards were considered essential for VR to be effectively integrated into teaching and therapy while ensuring its safety. The results highlighted the need for tools to measure short- and long-term learning impacts and other outcomes and longitudinal studies to validate the effectiveness of VR. Respondents also stressed the need for parental and student involvement in planning therapy and assessing its effectiveness.

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