SOCIAL INTERACTION DEVELOPMENT THROUGH IMMERSIVE VIRTUAL ENVIRONMENTS

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ABSTRACT

The purpose of this pilot study was to determine if participants could improve their social interaction skills by participating in a virtual immersive environment. The participants used a developing virtual reality head-mounted display to engage themselves in a fully-immersive environment. While in the environment, participants had an opportunity to explore and interact in a variety of scenarios that were designed to help develop their social interaction skills. The study observed and interviewed participants with Autism Spectrum Disorders (ASD) to determine the effectiveness of virtual environments and examine how they can be used to develop and improve social interaction skills.

KEYWORDS

Autism, Social Interaction Skills, Virtual Reality

1. INTRODUCTION

Understanding the context of a joke, sarcasm, and knowing when someone is bullying are all experiences that typical people take for granted each day. Students with Autism Spectrum Disorders often struggle to understand the subtle nuances of everyday social interactions. Autism Spectrum Disorder (ASD) is a term that encompasses a variety of neurodevelopmental disorders. In May 2013, The American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5), redefined the autism spectrum to include diagnoses of Asperger syndrome, Rett Syndrome, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (PDD-NOS) (Kupfer & Regier, 2013). The reclassification allows researchers to help spread awareness of these disorders to the general public and still target neurodevelopmental disorders on a case-by-case basis.

As researchers learn more about neurodevelopmental disorders, they have to leverage new technologies to help students develop their social interaction skills. One type of technology that shows promise is immersive virtual environments (IVE). IVEs have been utilized for many years in a variety of settings including entertainment, military training, and corporate applications. Unfortunately, these environments are costly to build and are typically designed around a specific scenario or activity. The nature of these virtual environments was usually centered on a specific product, which made it difficult to develop a flexible environment that could be adapted and modified for educational purposes.

In 2003, Linden Research, Inc. released Second Life, a three-dimensional modeling program designed to let users design and develop virtual environments. The creators of Second Life wanted to create a virtual world where users could freely create and interact. Second Life differs from other three-dimensional games in general because there are no tasks users have to complete, and users are able to create content for any

purpose. Researchers have been the studying how Second Life can be used in educational settings. Ke & Tami (2013) examined social interaction in a virtual reality environment (Second Life) for students with high functioning autism. Researchers collected data through behavior observation and analysis, interviews, and questionnaires. The participants showed increased performance across a variety of social interactions including responding, initiation, greeting, and social competence. Unfortunately, researchers have not been able to create and fully implement a completely immersive experience to practice social interaction skills.

Autism researchers, while looking for ways to address social learning concerns, have united with technology researchers to develop a focused specialty area body of work. Technology integration, in terms of social interactions, has been discussed both positively (Rajendran, et al., 2005; Goodwin, 2008) and negatively (Howlin, 1998; Latash, 1998). As with many research endeavors, early results can vary widely until the body of knowledge is more thoroughly established. For example, Porayska-Pomsta et al., (2012) concluded that working with technology increases opportunities for communication between adults and children. The primary difference in this study's focus is the development of interaction related to Immersive Virtual Environments (IVE). Slater (2009) contends that the best IVE experiences provide visual, auditory, and haptic input. Traditional virtual environments do not have the same sense of "really being there". Wallace et al (2010) was one of the first to explore the way children with autism perceive IVE compared to typical children. Jarrold et al. (2011) investigated children's scanning patterns in IVE classroom environments and found that children with autism were less focused on distant virtual peers than the central character in the digital classroom. Rajendran (2013) points out that future research in IVE arguably holds greater promise (than traditional virtual reality) because of its incorporation of both sensory motor and social cognition qualities.

The purpose of this study was to examine if students could alter their social interaction skills by practicing them in an IVE. The researchers also examined if the students were able to transfer the skills they learned in the IVE to similar situations in the real-world environment. Unlike previous studies, this study utilized a head-mounted unit that provided a full visual sensory experience for the user. Students were completely immersed in the environment and were able to look and move in all directions unimpeded. The results of this study will add to the research body of knowledge related to social learning, IVEs, and the interaction between these two fields.

2. THE STUDY

The pilot study was designed to determine if high functioning students with ASD were able to improve their social interaction skills by participating in scenarios designed in an IVE. The researchers partnered with a special education coordinator from a regional school system to select students that were willing to participate in the study. The participants were selected from a pool of students who attended a yearly summer camp that invites students in grades K-12 from different parts of the state to practice their socials skills in a variety of settings and activities. Two students were selected based on their age, stage of life, social ability level, and self-awareness. The study was conducted in conjunction with the summer camp that lasted for two weeks. The participants would spend three hours at the camp, followed by two hours in the IVE at the university.

Participant One was a fifteen-year-old Caucasian who at the time of the study just finished his freshman year in high school. He had participated in the summer camp for three years. He overheard the teachers discussing the project and asked if he could participate. He had heard of the technology, and wanted to see what it looked like. Participant One was adept at computers and enjoyed building in Minecraft and hosting Minecraft servers. The teachers at the camp chose to focus on his inability to recognize the cues of when a friendly conversation began moving towards an aggressive situation. The first scenario was designed around him looking at a classic truck owned by an aggressive senior in high school. The second scenario was designed in a public library where he was studying with a small group and they were annoyed by the way he acted. The third scenario was focused on his ability to leave a situation where he was being bullied.

Participant Two was an eighteen-year-old Caucasian who recently graduated from high school. Participant Two struggled maintaining eye contact during typical conversation. He had attended the summer camp since it began six years ago. The director of the camp selected him to participate, and when told about the project, he was excited to participate. The teachers designed his scenarios around situations where he needed to maintain eye contact. The first scenario focused on him walking up to a person sitting on a park bench and asking for directions. The second scenario was designed around him applying for a job at a local hospital. The third scenario took place in a library where he needed to ask a librarian for help finding a book.

The researchers worked in conjunction with the camp leaders to build social interaction scripts. The scripts were designed around each student's identified social interaction weakness. Once the scripts were completed, each participant's special education teacher vetted them for accuracy and quality. After approval, the scripts were then given to the researchers to design the events in a virtual space. The researchers used Second Life to design the virtual environments. Second Life is a virtual world developed by Linden Research, Inc. According to the Linden Research (Linden Labs, 2013), Second Life has about 1 million regular monthly users that actively interact and build 3D based content. The researchers utilized existing content that was already created in the virtual space. The researchers and participants interacted in a variety of areas that replicated real-life environments that matched the scripts.

Research Questions

This study addressed two research questions:

1.) Can students with ASD transfer and maintain skills learned in a virtual scenario and to a real-life scenario?
2.) Can students with ASD alter their social interaction skills by practicing them in a virtual immersive environment?

Conceptual Framework

The researchers used the following frameworks and concepts to understand the intricacies of technology application, social interaction and awareness, and human performance: The Technological, Pedagogical, and Content Knowledge framework (Koehler & Mishra, 2008), Social Skill Menu for age 14 through Adulthood (Baker, 2007), Performance Improvement/HPT Model (Van Tiem, D. et al., 2012). The frameworks and concepts were used to help guide the researchers when coding and interpreting the data. They guided the researchers in understanding how technology can be used to develop and deliver meaningful curricula that could be enabled through immersive virtual environments. The frameworks also provided a reference point for social skill development. This helped the researchers understand which targeted tasks needed to be mastered in the virtual environment, and then reexamined in the natural environment. Finally, the HPT model was used to examine gap analysis to determine the difference between desired performance and actual performance.

Research Design

The researchers incorporated a case study approach using an ethnographic perspective (Hymes, 1982; Gee & Green, 1998). An ethnographic perspective, in contrast to ethnography, does not focus on understanding an entire culture but instead focuses on the actions of smaller groups (Hymes, 1982; Bloome, 1989). This approach is also used when studying practice-oriented theories in smaller group settings (Ortner, 1984). The case study was guided by the case study structure created by Lincoln and Guba (1985) that starts with the overall problem (how can students improve their social interaction skills), the context (using IVEs that replicate real-life situations), the issues (can the students relate to the virtual world as well as the real-world), and lessons learned (develop skills in the virtual space and transfer them to real-world settings).

Data Verification

To ensure the credibility of the data, the researcher incorporated a variety of validation strategies. Qualitative researchers utilize a variety of validation strategies to make their studies are credible and rigorous (Creswell, 2007). Credibility and validity for this study were achieved through the validation strategies of triangulation, thick rich description, researcher reflexivity, and peer debriefing. Triangulation was achieved though the collection of interviews, reflective journals, and field notes. The researcher also incorporated Stake's (1995) "critique checklist" to analyze the case study quality.

Data Analysis

Before the researchers analyzed the data, the interviews, reflective journals, and field notes were transcribed. The process of transcribing allowed the researchers to become acquainted with the data (Riessman, 1993). All coded data was reviewed through the lens of prevalent theories already mentioned to build logical explanations and add to the internal validity through the use of comparative analysis with rival theories (Yin, 2003). The emerging themes were discovered through the process of in vivo coding (Strauss & Corbin, 1998). The researchers followed the step-by-step guidelines provided by Braun and Clarke (2006) for thematic analysis. Themes that were prominent across both cases were documented as well as those that were extremely different. The guidelines provided rigor, but still allowed for flexibility that is often needed in qualitative data analysis. The guidelines were: (1) familiarize yourself with the data, (2) generate initial codes, (3) the researcher reads each transcript to immerse himself in the data, (4) analyze the themes, (5) define and name the themes, (6) produce the results.

Results

Due to the nature and length of qualitative analysis, this section reflects only a small portion of the documented information from the full study. Table 1.1 provides the themes and categories that were prevalent within the data. The results of the study are presented with each corresponding research question.

1.1 Themes, Categories, and Definitions Identified in the Data

Themes	Definition	Categories
Social Awareness	Participants' awareness of their inability to engage and maintain conversation with their peers. Developing and enhancing their social interaction skills was a task they worked on daily.	Apprehension Being Normal
Sensory Engagement	Participants' experience in the simulator and use of the head-mounted device.	Realistic Scenarios Authentic Engagement

Two themes and four categories were prevalent in the data. Social Awareness was the first theme to emerge, and it yielded the categories of Apprehension and Being Normal. The second theme was Sensory Engagement, and it yielded Realistic Scenarios and Authentic Engagement. The answers to the research questions are embedded in the themes and categories that relate to the research questions. The researchers chose to use as many excerpts from the transcribed data as possible in an attempt to allow the reader to understand the participants' experience in the virtual environment.

Findings

Can students with ASD transfer and maintain skills learned in a virtual scenario and to a real-life scenario? The theme of Sensory Engagement answered the first research question. Both participants did describe the virtual world as realistic and they felt that they were part of the actual environment. Participant One explained, "The places were life-like. You could walk into a building and go through doors. There was even a person sitting behind the desk waiting to talk to me." Participant Two enjoyed the freedom to move and the ability to engage with a variety of objects. He explained, " I walked into the hospital and looked around. I was able to run, walk, and sit down. I liked exploring the building and finding my way on the roof. When I jumped off, it felt like I was falling for real, it was cool." When the participants were introduced to the environment, they both were amazed at how they could look around. Participant One explained, " When I put on the Oculus Rift, I heard someone talking behind me. I thought someone had walked into the room behind me. Then he (researcher) told me that he was in the simulator."

When asked if the scenarios seemed real, Participant One said, "The library scenario was the most realistic. I could see the library books, the desk and the other students looking back at me. I knew they were not real people but it seemed pretty realistic." Participant Two also agreed. He said, " I like the scenario where I went to the hospital and asked about a job. The guy behind the desk looked at me, then looked down like he was going to type on his computer, then he did!" Participant One experienced a glitch during one of his scenarios. His reaction reinforced the notion that the virtual experiences can be engaging. During his scenario the character he was talking with closed his eyes and fell asleep. He stopped and said, "Why are you asleep? Are you ok?" When asked if he would have responded in the same way in the real world. He replied, "Yes. I would ask if they are ok."

Both participants were authentically engaged during the scenarios. The researchers decided to have the students travel to the location of the scenario instead of starting the scenario at its location. Both participants responded that traveling to the scenario helped them become more acquainted with the environment and made if feel more realistic. Participant Two explained, " I had to walk on the sidewalk to the library. I even had to open the door before I was able to go in." Participant one also felt that traveling to the scenario made the experience more realistic. He explained, "I couldn't fly to the location. I had to walk. When I was walking I was able to see more of the town and the truck. Walking made it more realistic."

The teachers at the summer camp reenacted the scenarios in a real-life environment. The researchers noticed that the participants were less nervous during the scenarios. Both participants agreed that they felt less stress when interacting in the real-life scenario after participating in the virtual scenario. Participant One described his experience. He explained, " I kinda knew what the teachers were going to ask me. So that helped. I knew the teachers so it helped me not feel as nervous." Participant Two also acknowledged that knowing the teacher made the scenario easier. He explained, "I know the teacher so I knew she was acting. I liked the scenario. I know the teacher doesn't work at a hospital (referring to the scenario at the hospital)."

Each time the participants engaged in the real-life scenario it was altered to make sure they were not scripting their responses. The researchers noticed several changes in how the participants responded during the scenarios. The teachers also commented that both participants were more responsive and less rigid. A teacher commented, " I was surprised when he (Participant One) didn't keep talking about his Minecraft server. After realizing that the person liked his truck, he complimented him on the truck and said he liked it and walked away. He normally would have tried to talk about computers and fixate on his interest. He started noticing "cues" and responded accordingly." One teacher commented on Participant Two's ability to maintain eye contact. She said, "I saw a big difference in his use of eye contact. This is something that we have been working on for several years. This year, after spending time in the simulator, I noticed that he would look up more and engage in eye contact. This is a big stride for him."

Can students with ASD alter their social interaction skills by practicing them in a virtual immersive environment? The researchers found that both participants were able to alter their social skills by participating in scenarios in the virtual environment. The teachers at the summer camp noticed and documented that both participants were making gains in their social interaction skills. When the participants were at the summer camp, they were more outgoing and excited to talk and discuss their experiences with the project. Participant Two showed noticeable gains in maintaining eye contact during conversations. When asked if he felt that his eye contact has improved, he said, "Yes. I don't look down as much. I'm not as nervous when I'm talking to people."

Participant One also showed gains in handling conversations that would start out civil and lead to bullying. He explained, "The guy really liked his truck. When I was asking him about it I could tell he liked it. I don't know a lot about trucks so I asked him about computers. He thought computers were for nerds. So I told him that I liked his truck and walked away." When asked if he would have handled the situation differently not practicing in a virtual space, he said, "Yeah, I would have started telling him about my server and Minecraft. I would have wanted him to like me so I would keep talking about things I like." Participant Two also showed improvement in his ability to engage in conversation. A teacher commented, " I have known him (Participant Two) for three years and this is the first time that I have seen him participate in group conversation without being asked to participate."

Both participants were apprehensive when engaging and maintaining conversation. When asked how they felt about talking to their peers, they both explained that they did not want to mess up and they were always anxious. Participant One explained, "I try to control what I say and stuff and make sure nothing bad happens or goes wrong. I feel worried, mainly around students and friends. I have to tell myself to act normal. I have to tell myself not to worry about it. Don't be anxious about it." Participant Two also felt anxious about maintaining conversation. He explained, "I have trouble talking to girls. With boys I don't have problems because I talk about boy stuff. With girls I don't know what to talk about." When asked if had more confidence when engaging in conversation, he said, "Yes. I feel more confident now that I have practiced. I am not as anxious because I had do it before and I was ok when I did it in then (in the simulator)."

CONCLUSION

By developing engaging scenarios and presenting them in an IVE, both participants were able to show moderate gains in their areas of weakness. Participant One was able to maintain conversation without redirecting it to his specific interests. He also demonstrated his ability to detach himself from the conversation when he realized the conversation was turning negative. Participant Two maintained eye contact throughout the scenarios consistently, and also increased eye contact in his real-life scenarios. Both participants said they felt less stress when engaging in conversation after practicing in the simulator.

The participants indicated that using the immersive head unit made them feel like they were actually in the environment. They were impressed with how life-like the avatars were, and felt that the characters' head movements and eye blinking added to the virtual scenario. The IVE was real enough for the students to transfer some of their skills from the virtual scenarios to the real-world scenarios. Both participants wanted to continue the project with more social environments that could help them practice their social skills.

While the researchers felt that the study was successful, there were some limitations that impacted the results. The researchers only had three scenarios for each participant to practice. This limited the amount of flexibility that resulted in the development of the conversation. Another limitation was that the participant, and not the researchers, was the only one immersed in the virtual world using the device. The other avatars were controlled with a mouse and keyboard. This limited how much head movement and gesturing was made during the conversation. The final limitation was the lack of time the students had in the virtual world. They spent two weeks engaged with the simulator. The researchers feel that if they had more time in the virtual world, the impact on their social skills would have been greater.

The findings from this study will add to the body of literature on Autism and social skill development. The researchers feel that additional time spent with participants will increase the validity of the findings and give additional insight to broader applications. Beyond the special education applications, students of all ages could benefit from scenarios explored and practiced in an IVE. As software and hardware continue to become more affordable and obtainable, the corporate, military, entertainment, and home applications will become much more involved and expanded.

REFERENCES

Baker, J. 2007. *Social Skills Training and Frustration Management.* Future Horizons Inc. Publishers, Arlington, TX. USA.

Bloome, D. 1989. Beyond access: A sociolinguistic and ethnographic study of reading and writing in a culturally diverse middle school classroom. In D. Bloome (Ed.), *Classrooms and Literacy* (p. 89). Norwood, NJ: Ablex.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*, 77-101.

Creswell, J. W. 2007. *Qualitative Inquiry & Research Design* (2nd ed.). Thousand Oaks, CA: Sage Publications

Goodwin, M. S. 2008. Enhancing and accelerating the pace of autism research and treatment the promise of developing innovative technology. *Focus on Autism and Other Developmental Disabilities*, Vol. 23, pp. 125–128.

Howlin, P. 1998. Practitioner review: Psychological and educational treatments for autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines,* Vol. 39, pp. 307–322.

Hymes, D. 1982. What is ethnography? In P. Gilmore & A. Glatthorn (Eds.), *Children In and Out of School* (pp. 13-24). Washington, D.C.: Center for Applied Linguistics.

Jarrold, W., Gwaltney, M., Hatt, N., McIntyre, N., Kim, W.,Solomon, M., & Mundy, P. 2011.. A virtual reality study of complex social-attention in autism. Paper presented at the International Meeting For Autism Research, San Diego, CA.

Ke, F., & Tami, Im., 2013. Virtual-reality-based social interaction training for children with high-functioning autism. *The Journal of Educational Research,* 106.6, p.p. 441-461.

Koehler, M. J., & Mishra, P. (2008). Introducing technological pedagogical knowledge. In Routledge/Taylor & Francis Group (Eds.), *The Handbook of Technological Pedagogical Content Knowledge for Educators*.

Kupfer, D. and Regier, D., 2013, May. *Autism Spectrum Disorder.* American Psychiatric Publishing, Arlington, VA. USA.

Latash, M. L. 1998. Virtual reality: A fascinating tool for motor rehabilitation (to be used with caution). *Disability and Rehabilitation*, 20(3), 104–105

Linden Labs, 2013, June. Infographic: *10 Years of Second Life.* Linden Research, Inc., San Francisco, USA. http://www.lindenlab.com/releasees/infographic-10-years-of-second-life

Lincoln, Y. S., & Guba, E. G. 1985. *Naturalistic inquiry.* Beverly Hills, CA: Sage Publications, Inc.

Ortner, S. B. 1984. Theory in anthropology since the sixties. *Society for Comparative Study of Society and History, 26*, 126-166

Porayska-Pomsta, K., Frauenberger, C., Pain, H., Rajendran, G., Smith, T., Menzies, R., & Lemon, O. 2012. Developing technology for autism: an interdisciplinary approach. *Personal and Ubiquitous Computing*, *16*(2), 117-127.

Rajendran, G. (2013), Virtual environments and autism: a developmental psychopathological approach. Journal of Computer Assisted Learning, 29: 334–347. doi: 10.1111/jcal.12006

Rajendran, G., Mitchell, P., & Rickards, H. 2005. How do individuals with Asperger syndrome respond to nonliteral language and inappropriate requests in computer-mediated communication? *Journal of Autism and Developmental Disorders*, Vol. 35, pp. 187–207.

Riessman, C. K. 1993. *Narrative Analysis* (1st ed.). Thousand Oaks, CA: Sage Publications.

Slater, M. (2009). Place illusion and plausibility can lead to realistic behavior in immersive virtual environments. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 364(1535), 3549–3557.

Stake, R. (1995). *The art of case research* (1st ed.). Thousand Oaks, CA: Sage Publications.

Strauss, A., & Corbin, J. 1998. *Basics of qualitative research: Grounded theory, procedures and techniques* (1st ed.). Newbury Park, CA: Sage Publications.

Van Tiem, D. M., Moseley, J.L. & Dessinger, J.C. 2012. *Fundamentals of Performance Improvement: Optimizing results through people, processes,*

and organizations. Pfeiffer, San Francisco, CA. USA.

Wallace, S., Parsons, S., Westbury, A., White, K., White, K., Bailey, A. 2010. Sense of presence and atypical social judgments in immersive virtual environments. Responses of adolescents with autism spectrum disorders. *Autism*, 14, 199–213.

Yin, R. K. 2003. *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.