A Prototype Immersive, Multi-user 3D Virtual Learning Environment for Individuals with Autism to Learn Social and Life Skills: A Virtuoso DBR Update

Matthew Schmidt[1(✉)], Dennis Beck[2], Noah Glaser[1], and Carla Schmidt[3]

[1] Department of Instructional Design & Technology, University of Cincinnati,
Cincinnati, OH, USA
{matthew.schmidt,glasernh}@uc.edu
[2] Department of Curriculum & Instruction, University of Arkansas, Fayetteville, AR, USA
debeck@uark.edu
[3] Department of Special Education, University of Cincinnati, Cincinnati, OH, USA
carla.schmidt@uc.edu

Abstract. The specific aim of this session is to discuss the early design of a collaborative, immersive learning intervention for youth with Autism Spectrum Disorders (ASD), named Virtuoso. Building on our presentation at AECT 2016, this session will describe design and development progress to date, share our design narrative, explicate underlying theoretical and design principles, provide session participants an overview of the Virtuoso system, and present a timeline of ongoing research and development.

Keywords: Immersive · Virtual worlds · Autism

1 Project Description

Virtuoso is an immersive 3D learning intervention for youth with Autism Spectrum Disorders (ASD). This immersive learning intervention adopts a multidimensional approach for providing learners with ASD the ability to acquire both social competencies and life skills in a safe environment that can be manipulated so as to reduce input stimuli and adapt to learner needs. ASD is a pervasive developmental disorder characterized by a triad of impairments, including deficits in social interaction, verbal and nonverbal communication, and repetitive behaviors [1] which greatly influences an individual's independent functioning and quality of life. ASD affects one in 68 individuals [2], or nearly 2% of the U.S. population [3]. Given this high prevalence and the significant impact of the disorder, effective interventions are imperative to address the difficulties in social interaction and communication that individuals with ASD experience.

The aims of Virtuoso include (1) reducing barriers and promoting independence and self-efficacy; (2) providing explicit, direct instruction related to social competencies; and (3) creating an immersive virtual space that is safe, controllable, and highly accessible. To this end, Virtuoso is being developed using a participatory design approach. Researchers, intervention specialists, and graduate students are working together with

individuals with ASD in an young adult day program to design an intervention program of curricular and technological supports.

This work contributes to and extends extant research on immersive learning for individuals with ASD, including that of the iSocial project, which delivered a 5-unit social competence curriculum to youth with ASD in a 3D collaborative virtual learning environment [3D CVLE; 4, 5] and of the AS Interactive project, which had a focus on using public transportation in a 3D single-user virtual environment [6]. This work differentiates itself from prior research in that, to date, the majority of work in this area has focused on providing interventions and supports for individuals with high-functioning autism. Individuals with ASD are regularly categorized on a spectrum that spans from severely affected to high functioning. Individuals with an IQ lower than 70 and with other cognitive impairments are considered to be cognitively lower functioning. Our work focuses on individuals with more severe manifestations of ASD.

For example, like the AS Interactive project, one of the training foci of Virtuoso is on using public transportation in a safe and socially appropriate manner. The adult day program provides internship and employment opportunities for individuals with ASD; however, employment settings are often geographically distant from where the day program is housed. Day program associates (individuals with ASD who are involved with the day program's services) need transportation to these settings. However, transportation is one of the most cited barriers for individuals with disabilities to be included in community settings. The Virtuoso public transportation training combines curriculum, technological supports, and behavior interventions to help associates become more independent users of public transportation. Specific details and a brief demonstration will be provided at the presentation.

We are currently developing a rapid prototype of Virtuoso using High Fidelity [7]. High Fidelity is a next-generation virtual worlds toolkit that supports collaborative, avatar-based virtual world interaction using desktop displays as well as emerging virtual reality hardware such as Oculus Rift and HTC Vive. High Fidelity is designed to easily scale and to reduce latency problems that have long plagued virtual worlds platforms. This platform allows us to quickly and easily create rapid prototypes that can be used for evaluation and analysis, while at the same time providing a platform that can scale as our project continues to grow.

2   Research Methods

Virtuoso uses a design-based research (DBR) methodological approach. This methodology is a technique that integrates rigorous research with meaningful and relevant solutions to problems often involving educational technology. DBR relies on multiple iterations of analysis and exploration, design and construction, and evaluation and reflection to establish the impact of educational interventions over time [8]. Using this iterative approach over phases of design, implementation, and evaluation, Virtuoso is steadily evolving into a highly refined intervention that is sensitive to the local context and needs.

For the presentation, we will discuss the simulation we are currently developing for using public transportation and results of our usability evaluation with 10 participants. We are using a multidimensional approach to assess usability that was developed in the context of e-Health for serious games by systematically observing patients and families under controlled conditions [9–11]. This approach considers functionality, layout, flow, and content (system) and learning, reflection, and satisfaction (user). Participants with ASD undergo a 1–2 hour-long testing session. Think alouds will also be used to enable the evaluation of the thought processes or decision making of someone performing a specific task. Participants' gaze behavior will be captured using an eye-tracking device. Eye-tracking allows for analysis of eye fixations and movements, thus enabling additional insights into errors, how participants interact with Virtuoso, and expectations.

The Morae usability software suite will be used to record sessions, including screen, webcam, and audio recordings, and eye-tracking data capture. Individuals with ASD may have difficulty thinking aloud due to increased cognitive load and ASD effects. Hence, we will couple the think-aloud methodology with an approach developed for conducting usability evaluations with individuals with cognitive impairments, All-Views Empirical Analysis [12]. This approach utilizes simultaneous analysis of screen capture, webcam and audio recordings, eye-tracking, and trace data (usage analytics) to establish a holistic snapshot of human-computer interaction. This allows researchers to infer usability issues in the absence of think-aloud narrative. Difficulties using the system as a result of ASD will be analyzed and used to refine the 3D CVLE. Upon completion of each usability session, participants will complete the 10-item System Usability Survey to quantitatively assess usability [13]. Our goal will be to make appropriate modifications to our program to attain a usability score >65, indicating high usability.

3   Conclusion

Our current work centers on the development of a rapid prototype 3D CVLE for providing training on life skills for individuals with low-functioning ASD. We are exploring the use of logged trace data to represent user behavior in the environment and how we might incorporate those data into our research analyses. We are also exploring how to develop supports in the 3D CVLE that are sensitive to the unique needs of the participants. For example, we are interested in providing individualized feedback mechanisms that respond to user behavior. The question of generalization and transfer of skills from within the 3D CVLE to the real world is an issue that has been noted in the literature. Our future work will focus on this problem in particular. To this end, we are developing a family of diverse strategies. Examples include a fading of prompts approach, job aids delivered via virtual and real-world mobile devices, and incorporation of multi-modal supports within our broader curricular approach.

Due to the high prevalence of ASD, and the significant impact of the disorder, effective interventions are imperative to address the difficulties in social interaction and communication that individuals with ASD experience. The Virtuoso immersive learning intervention adopts a multidimensional approach for providing learners with ASD the ability to acquire both social competencies and life skills in a safe environment that can

be manipulated so as to reduce input stimuli and adapt to learner needs. Research and development is ongoing. We will present an overview of work to date and a projection of future work (approximately one year).

References

1. American Psychological Association: Diagnostic and Statistical Manual of Mental Disorders: DSM-5. American Psychiatric Association, Washington, D.C. (2013)
2. Centers for Disease Control: CDC Estimates 1 in 68 Children has been Identified with Autism Spectrum Disorder. (2014). https://www.cdc.gov/media/releases/2014/p0327-autism-spectrum-disorder.html
3. Blumberg, S.J., Bramlett, M.D., Kogan, M.D., Schieve, L.A., Jones, J.R., Lu, M.C.: Changes in Prevalence of Parent-Reported Autism Spectrum Disorder in School-Aged US Children: 2007 to 2011–2012. Natl. Health Stat. Rep. **65**(20), 1–7 (2013)
4. AUTHOR 1 (2012)
5. AUTHOR 1 (2014)
6. Leonard, A., Mitchell, P., Parsons, S.: Finding a place to sit: a preliminary investigation into the effectiveness of virtual environments for social skills training for people with autistic spectrum disorders. In: Proceedings of the 4th International Conference Disability, Virtual Reality & Associated Technologies, Veszprém, Hungary (2002)
7. High Fidelity (2017). https://highfidelity.io/
8. McKenney, S., Reeves, T.C.: Educational design research. In: Michael Spector, J., David Merrill, M., Elen, J., Bishop, M.J. (eds.) Handbook of Research on Educational Communications and Technology, pp. 131–140. Springer, New York (2014)
9. Moreno-Ger, P., Torrente, J., Hsieh, Y.G., Lester, W.T.: Usability testing for serious games: making informed design decisions with user data. Adv. Hum.-Comput. Interact. **4** (2012)
10. van Oostendorp, H., Warmelink, H., Jacobs, R.: The Evaluation of Health-Oriented Serious games and Apps: A Differentiated Approach (2016). http://growinggames.nl/wp-content/uploads/2016/03/DifferentiatedApproachHealthGameValidation_v11-2.pdf
11. Worthen-Chaudhari, L., Logan, K., McGonigal, J., Yeates, K., Mysiw, W.J.: Concussion symptoms in adolescents are alleviated through use of a gamified health app. Arch. Phys. Med. Rehabil. **12**(96), e8 (2015)
12. AUTHOR 1, 2011
13. Brooke, J.: SUS-a quick and dirty usability scale. Usability Eval. Ind. **189**(194), 4–7 (1996)