7-2020

Factors Influencing the Adoption of Immersive Virtual Reality for Individuals with Autism Spectrum Disorder: Parents Perceptions

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in Curriculum and Instruction

by

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July 2020
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Abstract

The purpose of this qualitative study was to identify factors that affect the adoption of a spherical video virtual reality (SVVR) mobile application among parents of adults with Autism Spectrum Disorder (ASD). The study used the diffusion of innovation theory by Rogers (2003) as a framework to explore parents' perceptions of an SVVR transportation model designed to improve the quality of life of adults with ASD. In addition, the study sought to learn what might increase adoption of VR technology among other parents of individuals with ASD and what life skills that might be addressed using VR technology in the future. The study employed interviews, focus groups, and observation to collect data. The factors that negatively affected the perception of VR technology among parents were categorized into themes: awareness of VR learning applications, availability, disadvantages of SVVR, and technical issues related to the SVVR transportation model. Factors that positively affected the parents' decision to adopt VR were immersion, realism, ease-of-use, enjoyment and motivation. To increase the adoption of VR by other parents of individuals with ASD, parents suggested that understanding of VR learning applications needs to increase, more teachers should be trained to use VR, the SVVR model should be improved, and there should be greater exposure to VR in schools and at home. Potential future life skills that need to be addressed through the VR technology were also identified. The findings of this study may help eliminate concerns about using VR technology as a therapy for ASD individuals and encourage more parents, teachers, and other stakeholders to adopt it.

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CHAPTER 1: Introduction and Overview

Introduction

Technology has great potential to help individuals with Autism Spectrum Disorder (ASD) improve certain skills and behaviors. The promise of virtual reality (VR) technology is huge, as it can help individuals with ASD enhance a variety of targeted skills in a controllable and safe environment in both academic and home settings (Gleason, 2017). However, research has highlighted concerns of individuals with ASD who interact with and within an immersive virtual learning environment. One issue regarding ASD individuals who engage with a VR environment is understanding their precise feelings and thoughts about the technology, since they often have deficits in social interaction, communication, and expression (Chen, Lee, & Lin, 2016; Girli & Dogmaz, 2018). Another concern reported in some research studies is that VR can cause different symptoms of cybersickness such as eye strain, headache, and sweating (Laviola, 2000). Lastly, given the large variety of technologies available, parents of individuals with ASD sometimes feel overwhelmed; they do not understand the various functionalities or which option might best meet their ASD individual's needs (Brosnan, Parsons, Good, & Yuill, 2016).

The current literature says little about the factors that might influence parents of individuals with ASD regarding the adoption of VR technology or how they perceive the its use. Therefore, it is important to understand the benefits and challenges of using VR technology from the perspective of parents of individuals with ASD. This knowledge will help teachers and specialists to provide service, , practice, and design for individuals with ASD, which is the focus of this study. This chapter provides an overview of studies on technological intervention with individuals with ASD, which will be addressed in greater detail in the literature review. The Problem Statement section reviews the problem and the research gap addressed by the study. The

Purpose section of the study looks at parents' perceptions of VR and the research questions. An overview of the Diffusion of Innovation theory is then be provided, as the theory was used as a theoretical framework for the study, as well as details of the nature of the study and definitions of key concepts used in the study. The Assumptions section describes the study's assumptions, scope, and delimitations. The Significance section describes the study's potential to advance knowledge and practice in the field. The last section summarizes the main points in the chapter.

Background

Over the years, many individuals with ASD have been exposed to a variety of technological tools to support their educational outcomes or social skills. Significantly, many educational practices indicate the effectiveness of using technology with individuals with ASD (Desai, Chow, Mumford, Hotze, & Chau, 2014; Dixon, Verenikina, Costley, & Pryor, 2015; Ennis-Cole, 2011). Ennis-Cole (2011) notes that several technology tools can be used effectively to develop autistic learners' social and communication skills. Such tools need to be "…. engaging, intuitive, offer visual and auditory instructions, and present content that gradually increases in complexity" (p. 59).

In a world of technological innovation, it has been shown that, through the use of technology and its applications, teaching and learning among students with developmental disabilities can be significantly improved (Dixon et al., 2015; Stump, 2017). The daily use of technology as an educational tool is popular among individuals with developmental disabilities (Cano, Fernández-Manjón & García-Tejedor, 2018). Several studies have explored various technological interventions for individuals with ASD (Desai et al., 2014; Dixon et al., 2015). A relatively recent technology, Virtual Reality (VR), has shown promise in helping individuals with ASD improve their communication and social skills (Beach and Wendt, 2014; Bozgeyikili,

Raij, Katkoori, & Algasemi, 2018; Cheng, Huang, & Yang 2015; Ke & Moon, 2018; Yu-Ju, Hsiao, & Mei-Feng 2018). Although technology, including virtual reality, offers opportunities for individuals with ASD, some research studies report concerns regarding frustrations with the technology, cybersickness, and problems with communication among individuals with ASD (Brosnan et al., 2016; Chen, Lee, & Lin, 2016; Girli & Dogmaz, 2018; Laviola, 2000). In a recent study, Gleason (2017) examined the impact of VR technology on individuals with ASD from the perspective of directors of special services. The study revealed the potential effect of VR intervention in both the school and home setting and the experimental nature of using VR technology with a focus on life and social skills. The study suggested that future research should investigate the perceptions of VR among parents of ASD individuals, which could reveal significant information about instruction and learning and enable individual life skills and academic capabilities to be prioritized. This study, therefore, focused on factors that influence the perceptions of parents of ASD adults regarding the adoption of a spherical video-based virtual reality (SVVR) mobile application specifically designed to help improve the adaptive skills of their ASD individuals. The applications are intended to help foster skills that will help ASD individuals supervise themselves and interact with people independently in their everyday lives (Schmidt, Schmidt, Glaser, Beck, Lim, & Palmer 2019).

Statement of the Problem

Recently, increased attention has been paid to the use of a controllable immersive technology (virtual reality) as a therapy for individuals with special needs (Miller & Bugnariu, 2016). Many studies indicate that the use of a three-dimensional virtual reality environment intervention may improve educational outcomes and/or social skills for individuals with ASD (Beach & Wendt, 2014; Chen et al., 2016; Cheng et al., 2015; Cobb, 2007; Kandalaft,

Didehbani, Krawczyk, Allen, & Chapman 2013; Ke & Im, 2013; Ke & Moon, 2018; Lorenzo, Lledo, Pomares, & Roig, 2016; Yu-Ju et al., 2018). There is a need for innovative interventions and partnerships between professionals and families to help support the growing ASD population (Boyd, Odom, Humphreys & Sam, 2010). Several intervention studies have shown that partnering with parents can also positively affect individuals diagnosed with ASD (Brookman-Frazee, Stahmer, Baker-Ericzen, & Tsai, 2006; Brown & Woods, 2016; Constantino & Gruber, 2007; Crane-Mitchell & Stafford, 2017; Dunn & Dunn, 2007; Freuler, Baranek, Tashjian, Watson, Crais, & Turner-Brown 2013; Hillier, Greher, Queenan, Marshall, & Kopec 2016; Lu, Chan, Cai, Huang, Nay, & Goei 2018; MacMullin, Lunsky, & Weiss 2016; McConachie & Diggle, 2007; Meadan, Snodgrass, Meyer, Fisher, Chung, & Halle 2016; Pickard, Kilgore, & Ingersoll, 2016; Sani-Bozkurt & Ozen, 2015; Stahmer & Pellecchia, 2015; Stump, 2017; Stump, Dunn, & Tomcheck, 2016).

Studies have shown the importance of the parental role in implementing technology intervention with their disabled individuals (Stahmer, Schreibman, & Cunningham 2010; Wong, Odom, Hume, Cox, Fettig, Kucharczyk, Brock, Plavnick, Fleury, & Schultz, 2015). Parents have been involved in research in which they collaborated with educators to facilitate communication and implement the intervention with their individuals with ASD (Brown and Woods 2015; Desai et al., 2014; Stump, 2017). Another study involved parents as primary data collectors to determine the effectiveness of the intervention (Acar, Tekin-Iftar, & Yikmis 2017; Crane-Mitchell, & Stafford 2017; Meadan et al., 2016; Özen 2015; Sani-Bozkurt & Ozen 2015). Parents were interviewed to gather their opinions, perspectives, and concerns; asked to complete surveys and questionnaires; or to write daily diaries to reflect and report on the effectiveness of the intervention. Other research showed that parents were involved in creating and implementing

the intervention (Acar et al., 2017; Cardon, 2012; Olçay-Gül & Tekin-Iftar, 2016). For example, a recent study by Acar et al. (2017) investigated the role of parents in developing and delivering social stories and video models to improve the social skills of children with ASD. The social stories intervention was written and implemented by trained parents, as was the development of the video imagery and implementation of the video modeling intervention. Acar et al. (2017) concluded that parents were not only able to develop social stories and video images with high accuracy and implement both interventions with high degree of integrity; they were also able to collect data from their individuals with ASD.

Parental involvement is an important factor in the effectiveness of technology interventions (Ross, Cox, Reeve, Brown, Moncrief, Schmitt, & Gaffney 2018). When parents are involved in the intervention process, they gain new understandings of their autistic individuals regarding their behaviors, environmental factors, and communication skills (Stump, 2017). Meadan et al. (2016) added that parents can learn and implement the learning strategies with high fidelity to support the communication skills of their ASD individuals. In addition, parents can be involved in developing high-accuracy interventions such as social stories and video modeling (Acar et al., 2017). This involvement leads to effective and successful interventions that enhance ASD individuals' skills.

Parents of individuals with ASD have been introduced to many technologies that demonstrate effective skills development, as parents tend to seek solutions that offer the best outcomes for their children (Curran, 2017). However, given the many technological choices available, parents can become confused and frustrated when trying to choose the ones that will best meet their ASD individual's needs (Brosnan et al., 2016). Being overwhelmed by the many technology choices and not understanding their functionality could be a barrier to adoption.

Moreover, some technologies like VR may produce side-effects, including cybersickness. Cobb, Nichols, Ramsey, & Wilson (1999) reported that most of the participants in their study experienced cybersickness in different degrees after using a head-mounted display (HMD). Symptoms of cybersickness may include eye strain, headache, and sweating (Laviola, 2000). These symptoms could negatively impact both individuals with ASD and their families (MacMullin et al., 2016) and may negatively influence the perceptions of VR among parents of individuals with ASD.

In addition, some individuals with ASD are unable to express their feelings (Chen, et al., 2016; Girli & Dogmaz, 2018) due to their lack of social and communication skills. As a result, they rely heavily on their family members (Howlin, Goode, Hutton, & Rutter, 2004; Seltzer, Shattuck, Abbeduto, & Greenberg, 2004 as cited in Lee, Harrington, Louie, & Newschaffer, 2008). Therefore, it is appropriate that parents be involved in the early stages of the SVVR intervention so that their feedback and attitudes can be taken into account. This could help educators, directors, expert, and decision makers deliver better services for the ASD population and provide optimal intervention design.

The existing literature contains limited research on the perceptions of parents/caregivers regarding the adoption of a VR environment as a learning tool for individuals with ASD. More specifically, there is an obvious gap in the literature regarding how parents perceive wearable immersive virtual reality equipment and mobile applications designed to promote acquisition of adaptive skills for individuals with ASD. Specifically, no single study could be found that explored the perceptions of parents or caregivers of individuals with ASD regarding the factors that may influence their decision to adopt VR or how they perceive the use of Google Daydream (a VR technology), which may promote the acquisition of adaptive skills. Therefore, this study

aims to understand these factors, along with benefits and challenges of a spherical video-based virtual reality (SVVR) and mobile application designed to promote acquisition of adaptive skills.

Purpose of the Study

The purpose of this qualitative study was to explore the factors that may influence the adoption of the SVVR mobile application among parents of individuals with ASD who are currently enrolled in the EMPOWER program at the University of Arkansas. According to Rogers' theory, there are several stages in the innovation-decision process; these include knowledge, persuasion, decision, implementation, and confirmation. In this study, the researcher focused on the first three stages only. When they understand each stage and the factors embedded in each stage, educators, administrators, and experts in the special education field can provide better service and establish high-quality tools to support individuals with ASD. Therefore, the purpose of this qualitative study was to determine the factors that may affect the adoption of VR and applications among parents of the adults at the EMPOWER program who diagnosed with ASD. Moreover, the study considered ways to increase the adoption of VR among other parents as well as other future skills that needed to be addressed thought the VR technology.

Research Questions

The following research questions guided this study:

1- What factors impact the adoption of SVVR mobile application by the parents of students in the EMPOWER program?
2- How might changes to the EMPOWER program increase adoption of the SVVR mobile application adoption among parents of individuals with ASD?

3- What are the perceptions of parents of students with ASD in regard to the potential for other skills that might be addressed using VR technology?

Theoretical Framework

The Diffusion of Innovation theory by Rogers is well known as a way to understand the adoption of new technological innovations (Medlin, 2001; Parisot, 1995, Sahin, 2006). The theory is defined as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (p. 18). Rogers (1971) defines diffusion as a type of communication that distributes new ideas to members of the social system. This study utilized the Diffusion of Innovations Theory – first presented by Rogers in 1971 – as a theoretical framework. The main idea of Roger's theory is grounded in the adoption of an innovation. It's a process to determine whether an innovation is helpful or not.

The Diffusion of Innovation Theory presents a model for a five-stage innovation adoption process. The stages are: Knowledge, Persuasion, Decision, Implementation, and Confirmation. The first stage, Knowledge, occurs when an individual understands the functionality of the innovation after hearing about it or being exposed to it. The second stage, Persuasion, involves learning about the innovation and forming an opinion and attitude of it. In the third stage, Decision, a person determines whether to adopt or reject the innovation. The fourth stage is Implementation, or actually using the innovation. The fifth stage is Confirmation, which means verifying that the innovation is a worthwhile new technology.

Rogers (2003) defines levels of Innovativeness in the early adoption of a new idea by individuals. There are five adopter categories: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards.

Parents of individuals with ASD expressed some concerns when their individuals interacted with or within technology interventions (Bronsan et al., 2016; Chen, Lee, & Lin, 2016; Girli & Dogmaz, 2018; Laviola, 2000).

Therefore, the researcher of this study viewed the Diffusion of Innovation Theory as a way to explore the factors that affect the adoption of VR technology by parents of the associates in the EMPOWER program.

Nature of the Study

This study used a qualitative research methodology. In particular, a hermeneutic phenomenological approach was used to understand the essence of the shared experience of participants using the SVVR mobile application. According to Van Manen (1990), "Phenomenology describes how one orients to lived experience; hermeneutics describes how one interprets the "texts" of life" (p. 4). Between six and eight parents of individuals with ASD enrolled in the EMPOWER program at University of Arkansas participated in this study. Data were collected through a focus group, observations, and follow-up interviews. The gathered data were analyzed to develop the central phenomenon.

Definitions

Autism Spectrum Disorder (ASD): A pervasive developmental disorder that affects individuals' social communications and behavior (Lostan, 2018).

Transition: Individuals aged between 18 and 22 years who are diagnosed with autism spectrum disorder undergo a "transition" when they move from secondary school to college or university (Friedman, Warfield, and Parish, 2013).

Virtual Reality: A three-dimensional environment that allows users to interact virtually with computer-generated objects (Bozgeyikli et al., 2018).

Immersive VR: A virtual environment in which the user is fully surrounded by a virtual world via an HMD (Bozgeyikli et al., 2018)

SVVR: Spherical video-based virtual reality (SVVR), with a mobile application designed for individuals with ASD to support skills learning (Schmidt et al., 2019).

HMD: A wearable Head Mounted Display that covers the user's eyes to allow them to see and experience the three-dimensional immersive environment (Bozgeyikli et al., 2018).

Adaptive skills: The skills people need to supervise themselves and interact with others independently in their everyday life (Schmidt et al., 2019).

Assumptions

Based on findings of previous studies, the researcher assumed that parents of individuals with ASD held attitudes about technology that would directly impact the adoption of VR as a learning tool for ASD individuals (Curran, 2017; Lin, 2018; Zhu, Yang, MacLeod, Shi, Wu, 2018). The researcher also assumed that all parents possess different levels of knowledge about the use of technology with individuals with ASD. Thus, they could provide valuable information that would help answer the research questions. Moreover, the researcher assumed that all participants would deliver honest responses. That said, the researcher expected that some participants might not be truthful with their answers because a) they wanted the best technology for their adult or child with ASD, and thought that assisting the researcher with appropriate but untruthful responses might help to successfully establish SVVR as an accepted support option

for ASD individuals, or b) they might be afraid to share personal information about their adults with ASD as it may evoke their emotional memories.

Scope and Delimitations

This study involved parents of ASD adults enrolled in the EMPOWER program at the University of Arkansas. The EMPOWER program was chosen because it limits access to individuals with ASD living in Fayetteville, Arkansas. The program provides a comprehensive training program to young adults with intellectual disabilities. In the study, parents of young adults with ASD provided feedback regarding the adoption of SVVR as a learning tool to help the young adults acquire adaptive skills. Parents of young adults were chosen to in order to identify factors that may influence their decision on whether or not to adopt SVVR. To help interpret these factors, the Diffusion of Innovation Theory by Rogers (2003) was used as a conceptual framework.

Limitations

There were several anticipated limitations to this study. First, the study explored the perceptions of only six parents of individuals diagnosed with ASD. As a result, the ability to generalize the findings is limited, as the views of these six parents may not necessarily represent the views of all parents of individuals with ASD. Second, time sometimes limited the researchers' ability to meet with the participating parents. Most of the parents live out of state, except for one who lives locally. Thus, it was difficult for the researcher to arrange times for all the participants to meet for interviews and the focus group. Therefore, the researcher had to divide the participants into two groups for the focus-group interview. Third, since the participants were parents of adults with ASD, the findings of this study are limited to adults on the autism spectrum. Fourth, the participants' ASD individuals enrolled in the EMPOWER

program were high-functioning. Fifth, the researcher role through the dissertation process may be a limitation as being a graduate student. To overcome these challenges, the researcher worked with the dissertation committee. The researcher also used member checking and triangulation to eliminate researcher bias.

Significance of the Study

The significant increase of individuals diagnosed with autism should inspire educators to develop new ways of teaching and learning that will meet their needs (Mintz, Branch, March, & Lerman, 2012). One way this has happened is through the integration of technology such as computer games, mobile apps, and VR technology designed to develop social and communication skills (Burke, Andersen, Bowen, Howard, & Allen, 2010; Hillier et al., 2010; Lu, et al., 2018). For several years, parents of individuals with ASD have been involved in a variety of VR interventions. Research has confirmed that parents can be involved in and interact with and within the intervention with high fidelity and accuracy (Acar et al., 2017; Meadan et al., 2016).

The results of this study will inform educators, decision makers, and experts about the factors that may influence parents' decision to adopt VR technology and the benefits and challenges that individuals with ASD usually encounter when engaging and interacting with and within virtual reality learning environments. The parents' perceptions provide valuable information and a better understanding of factors that may affect the decision to acquire VR technology for home use. The use of VR technology in the home setting has the potential to improve the social and life skills of individuals with ASD (Gleason, 2017).

Parents of individuals with ASD may be overwhelmed by the sheer number of technologies available, which may result in doubt and uncertainty regarding their adoption

(Brosnan et al., 2016). Understanding how to use VR technology and experiencing it will help increase their knowledge. Thus, exploring factors like the parents' level of knowledge of VR – which may influence their decision to adopt it – is important (Gleason, 2017). Gleason (2017) has written that VR technology is a valuable tool that teachers and specialists can use to improve teaching and learning in both the school and home settings. Interactivity is an important feature that enhances the engagement of individuals with ASD and helps them focus on tasks (Gleason, 2017). Therefore, exploring the obstacles and distractions that may affect their focus when they interact with and within task-completion training may help improve teachers' and specialists' practice and enrich the learning environment for individuals with ASD. Lastly, the study suggests the potential use of VR technology at home. Gleason (2017) states that "… parents may also see the value in VRTs and reinforce the application in the home setting, thus increasing the opportunity for transference of skills" (p. 73). Mimicking some environments such as public transportation, a water fountain, or walking to the cafeteria (which may be associated with fear, phobias, or anxiety in some cases) may help individuals with ASD interact with and practice using such things in a safe and controllable environment (Gleason, 2017).

Summary

This chapter presented an introduction to the study. The Background section included an overview of the studies on technological intervention with ASD individuals. The Problem Statement section reviewed the problem under study and the knowledge gaps addressed by the study. The Study Purpose section addressed parents' perceptions of VR and the research questions. A short description of the theoretical framework was presented. Details of the nature of the study, along with definitions of key concepts, assumptions, the study's scope and delimitations, and the significance of the study were described.

The sections in the next chapter will describe the literature review and contain an introduction, the literature search strategy, the conceptual framework, a definition of ASD, the characteristics of ASD, educational best practices for ASD, parental interventions with ASD individuals, and ASD technology interventions.

CHAPTER 2: Review of the Research Literature

Introduction

In the last decade, technology development has rapidly increased in the field of education. Many different types of technologies have been investigated and have shown positive results when used with individuals who were diagnosed with ASD (Brown & Woods, 2016; Crane-Mitchell, and Stafford 2017; Desai, Mumford, Hotze, and Chau 2014; Dixon, Verenikina, Costley and Pryor 2015;Meadan, Snodgrass, Meyer, Fisher, Chung, & Halle 2016; Smith, Ginger, Wright, Wright, Taylor, Humm, Olsen, Bell, & Fleming 2014; Stump 2017). Virtual Reality (VR) has been used in therapy for these individuals in educational settings (Beach & Wendt, 2014; Lu, Chan, Cai, Huang, Nay, & Goei, 2018; Yu-Ju, Hsiao, & Mei, 2018). However, some concerns have been found regarding VR use by individuals with ASD (Brosnan et al., 2016; Chen, Lee, & Lin, 2016; Girli & Dogmaz, 2018; Laviola, 2000). These concerns may have an impact on the decision regarding the adoption (Akman, Kocglu 2016; Clelik, Sahin, & Aydin 2014). Therefore, the focus of this study is to determine the factors that may affect the decision of adopting the SVVR mobile application by parents of ASD individuals. The following section of the literature review will focus on understanding autistic spectrum disorder, characteristics of autistic spectrum disorder, educational best practice for student with ASD, technology intervention to support individuals with ASD.

Literature Search Strategy

The purpose of the presented literature review is to shed light on articles that are related to technology interventions with individuals with ASD along with their parents. The following database were used for the literature review: EBSCO Education Research Complete database,

ERIC, ProQuest Dissertations and Theses Global, and the integrated research engine on University of Arkansas library website. Keywords used when searching *autism spectrum disorder,* ASD adults, *technology, computer, tablet, mobile phone, smartphone, internet, virtual reality, virtual environment, parents, caregivers, family member, social skills, communication skills*. This literature review will provide information to the researcher to understand the use of the technology with individuals with ASD along with their parents. Moreover, the chapter will help identify the gap in research of that manner.

Diffusion of Innovation Theory

The researcher of this study sees the Diffusion of Innovation Theory as a way to explore the factors that affect the diffusion in regard of individuals' perceptions and the diffuse of the innovations among the social system using communicative processes (Rogers, 2003).

There are five characteristics to determine the innovation. Relative Advantage, Compatibility, Complexity, Trialability, and Observability (Roger, 1971). Relative advantage (the need of the technology) refers to how the adoption of new significant outcomes are needed for comparison to the current situation, which identified by the social system. Compatibility (user characteristics*)* refers to understanding values, previous experience, and individual's needs. *Complexity* (the ease of using the technology) refers to the ease of understanding and use by members of the social system. Also, it refers to the adopter's perception of using the innovation as easy (Agarwal & Prasad, 1997). The complexity of innovation could affect negatively on the rate adoption (Roger, 2003). Trialability (experimenting the technology) refers to trying out and experiencing how the new technology will increase the adoption and reduce the uncertainty regarding the cons and pros of the innovations (Akman, 2017). The trialability of innovation could affect positively on the rate of adoption (Roger, 2003). *Observability* (visualizing the

results) refers to the outcome's visibility of the new innovation, where the adopter can actually see the effectiveness of the new innovation.

The diffusion of innovation could be affected by three types of innovation decision. Optional innovation-decisions, collective innovation-decisions, and authority innovation-decision. The first type is the decision of adoption or rejection that made by the individual independently of the social system. Second, type refers to the decision of adoption or rejection by consensus of the members of the system. The last type refers to the decision of adoption or rejection by a group who possesses power, social criteria, and technical expertise (Rogers, 2003).

Five adopter categories that presented by Rogers (2003). Innovators, Early adopters, early majority, late majority, and laggards. Innovators are individuals with new ideas, mostly well educated and have the potential of making a change (Rogers, 2003). Early adopters who are playing a role model for most of the social system members. They make their own adoption decision at early stage after using the provided data from innovators, therefore, reducing uncertainties of the new idea and transport their evaluation of the innovation to near associates within the interpersonal network. In fact, Roger (2003) stated that "The adopter category, more than any other, has the highest degree of adoption leadership in most systems. Potential adopters look to early adopters for advice and information about an innovation. The early adopter is considered by many to be "the individual to check with" before adopting a new idea" (p. 283). Early majority is longer process of adoption decision than the first two categories and they provide the significance to the new idea of their ingroup (Rogers, 2013). Late majority is individuals' decision of the innovation adoption as a react to the pressure from peers (Roger 2003). The last in the social system regarding the adoption of an innovation is laggard. The

decision of adoption often built on the previous categories and individuals with traditional values who they interact with.

With taking the VR technology into consideration of intervention for individuals with ASD to aid learning skills. The theoretical framework of this study is be based on the Diffusion of Innovation Theory by Rogers (2003) to investigate the adoption of the SVVR technology for learning purposes. Thus, the purpose of this study is to explore parents' perceptions regarding the SVVR technology based on Rogers' theory.

Understanding Autistic Spectrum Disorder

As of May 2013, new diagnostic criteria have been standardized to help healthcare workers diagnose individuals with autism. The 5th edition of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, also known as DSM-5 has combined autism, autism spectrum, and Asperger's into a single category referred to as autism spectrum disorder (ASD; APA, 2013).

The DSM-5 lists five diagnostic categories for ASD that are based on current or historic evidence of failures within the criteria. These categories include: (1)Ongoing issues with social communication/interaction throughout a variety of scenarios (2) at least two behaviors, interests, or activities from a more concise list that are restrictive in nature and repetitive; (3) inherent symptoms, which have been noted in early development, that may have become worse as socialization increased or lessened as "self-established" coping mechanisms were developed by the individual(4) profound clinical impairment of social, occupational, or other functioning areas; (5) a lack of other development disorders that could explain symptoms (although other intellectual and global development delays and disorders are often found in ASD patients, so a development level below the expected norm should be considered; APA, 2013). When looking at

these categories individually, two of them have been broken down into more precise criteria. They are explored further below:

As mentioned above, the first diagnostic criterion should include multiple deficits in the following areas:

1) Social and/or Emotional Interchange. Inability to carry out a typical exchange of conversation, little or no sharing capabilities regarding hobbies, activities, emotions, or distress, inappropriate or unusual social responses, as well as the inability to begin or reciprocate social interactions.
2) Nonverbal Communication. Body language, facial expressions that are required for appropriate social interaction. This can include issues with or a complete inability to maintain eye contact and/or a lack/incapacity to understand and/or use body language in social interactions to complete failure with reading and/or emoting facial expressions.
3) Relationship Failure. This includes developing, maintaining, and even understanding the concept of relationships. The individual may be unable to assume to appropriate behavior for a specific social situation. There could be a lack of interest in making friends or no desire to do so. This includes not being able to or having a hard time joining others or sharing in playtime that involves imagination (APA, 2013).

The second criterion has been broken down into the following restricted, repetitive behaviors. A patient must exhibit at least two of the following:

1) There is stereotypical repetition of motor movements, speech, or use of objects (such as lining up items, mimicking speech, repeating phrases, etc.)

2) ASD diagnosed individuals will often experience difficulty when things are not kept the same. This includes maintaining a routine and/or ritualized patterns, such as eating at a specific time. Deviation from the routine will cause distress that can be extreme even with small changes.
3) Highly restricted individuals may fixate or focus on interests or strange items and may even form abnormal attachments/obsessions with objects, etc.
4) Another consideration is the reaction to sensory input, such as over- or under-reacting to pain, sounds, textures, and smells. There may also be an abnormal fixation on sensory aspects (i.e., touching items, fixating on lights, movements, or sounds; APA, 2013).

The seriousness of ASD is based on the severity level of these various categories and sub-categoreis.. It should be noted that individuals who have previously been diagnosed with Asperger's, autism, or "pervasive developmental disorder not otherwise specified" (APA, 2013) would now receive the diagnosis of autism spectrum disorder. In addition, it should be noted, if the individual has intellectual impairment, language impairment, medical or genetic condition or environmental factors, as well as other neurodevelopmental, mental, or behavioral disorders. Individuals with additional conditions will need to be coded accordingly.

Characteristics of Autistic Spectrum Disorder

Impairment of Social Interaction

Social interaction impairment is considered the basis for ASD. This category is broken up into three subsets for diagnosis purposes. Because social interaction begins to develop at birth (Wing, 1988), the symptoms of ASD may be observed in infants, which can lead to an earlier diagnosis. Research has found that early intervention, especially when it involves clinical,

parental, and school involvement, can have very beneficial results. The triad is broken down into the three categories with the impairment divided by severity.

Social recognition. Wing (1988) noted that social recognition begins within the first weeks of life. The levels of severity ranged from a complete absence of social recognition to a deficit. With social recognition, a child within normal ranges will view people as the most "interesting and potentially rewarding" part of their environment. ASD children may avoid eye contact and interaction completely at the most severe levels, while milder cases or situations where adults have adapted, may come off as awkward or socially inept. This is attributed to their inability to understand the rules of social interaction (Wing, 1988).

Social communication. The variables for ASD individuals in the social communication portion of the triad can range from mild to severe. This is one of the most obvious impairments because individuals with ASD are unable to carry on a conversation at all or in the same way that children and adults with normal development can. This area of social interaction includes verbal, nonverbal, preverbal, and conversational skills. Parents may notice that their infant does not interact with them by smiling, making noises, such as laughter to show enjoyment, or movements of acknowledgment (i.e., reaching for a mother's face, etc.). In the most severe cases, the person may be unable or uninterested in communicating verbally or nonverbally. Others with ASD may be able to communicate through nonverbal means using writing, sign language, or devices. It is important to understand that not speaking is not always a sign of ASD because nonverbal communication can be used when individuals are unable to vocalize what they want to say (Wing, 1988). In mild cases, there may be a great deal of verbal communication, but it may be repetitive in nature. The child/adult might ask the same question over and over. These individuals may also ramble on about something that has no context to the

situation. Even if the listener shows facial or body cues that indicate they are uninterested or board, the ASD individual will not recognize these social signs and continue their speech. In addition, the listener will be ignored when they respond in some way (Wing, 1988).

Social imagination and understanding. Baren-Cohen, Leslie, and Firth (1985) described this part of the triad as the inability for people with ASD to recognize in "any theory that other people have minds."(p. 94) (as cited in Wing, 1988) This area is a vital part of learning empathy for others, as well as how to determine what other people may or may not know. This inability to copy the actions of other people and generate understanding of their meaning and feelings can prevent individuals with ASD to mimic other people, and putting themselves in the same position to experiencing the act. Although the child may engage in the behavior of copying actions, they do not grasp the concept that it is anything more tangible. Children with normal development will engage in this form of play starting around age 2 or 3, so this can be a warning sign for parents that their child should be tested. The concept of "pretend play" or imaginative play is either deficient entirely or to some extent in those with ASD. There are levels of severity for this impairment like the others (Wing, 1988). In the most severe cases, the ability to copy others and "pretend play" can be completely absent, while mild cases can grasp the concept that other people have minds and feelings, but they do not have the empathy that is present in normal development (Wing, 1988). ASD functionality varies greatly, and individuals can fall within these extremes to incorporate some middle ground. Adults tend to be more likely to recognize feelings in others even if the capacity is limited.

According to Wing (1988), parents of children with ASD have the opportunity to reach out for support sooner. It provides answers regarding the behavior or lack of reaching development goals, which is very distressing. With a diagnosis, parents will have the ability to research the

latest therapies and treatments. In addition, the diagnosis can open doors to potential therapies and special education classes that can help the child progress faster. Parent involvement can make a tremendous difference in an ASD diagnosed child's progress. Through the different services and information available, some of the most distressing behaviors, such as self-injury, temper tantrums, etc., can be remedied or reduced using various occupational and other therapies.

Educational Best Practices for Students with ASD

According to The National Professional Development Center on ASD (2017), the newly evidence-based practices that counted between 2015 and 2018 on Autism Focused Intervention Resources and Modules are Cognitive Behavioral Intervention (CBI), Structured Play Groups (SPG), Exercise (ECE), Technology-aided Instruction and Intervention (TAII), Modeling (MD), and Scripting (SC).

Cognitive behavior intervention (CBI) is known as the change of thinking and behavior of individuals after engaging with a diversity of correlated interventions to better understand their own thoughts and emotions. These interventions are designed to be used with individuals with behavior issues that are linked to emotions or feelings, specifically anger or anxiety (Brock, 2013). This intervention showed promises for learners in elementary school (6-11 years old) and high school (15-18 years old). Sofronoff, Attwood, Hinton, and Levin (2007) mentioned that parents could also benefit from CBI as they can identify the change of the behavior or attitude of their child. Moreover, teachers reported a behavioral change of individuals in the school setting as they were trying to use the learned strategies after the intervention.

Structured Play Groups (SPG) are small groups that provide activities for children with ASD under a certain area, activity, theme, and roles with support by adults (leading, prompting, scaffolding) to achieve the goals of the activity when working with peers (Sam, Kucharczyk, Waters, & AFIRM team, 2018). Another definition by Wong et al. (2015), stated that "Small group activities characterized by their occurrences in a defined area and with a defined activity, the specific selection of typically developing peers to be in the group, a clear delineation of theme and roles by adult leading, prompting, or scaffolding as needed to support students' performance related to the goals of the activity." With structed play groups, children with ASD can be taught a broad range of skills and behaviors, such as social skills and communication skills. Structured play also showed a decrease in maladaptive behavior, an increase in language diversity and complexity, a decrease in isolated play, and an increase in functional object play (Sam et al., 2018). Odom (2013) added that SPG could be used effectively in play, school readiness, and academic skills. In a research study conducted by Owens, Granader, Humphrey, & Baron-Cohen, (2008), LEGO therapy and Social Use of Language Programme (SULP) was used with children with ASD. The study showed that the LEGO therapy intervention improves participants' social interaction as well as decreasing their maladaptive behavior.

Physical fitness, exercise (ECE), can be used as an intervention for individuals with ASD (Griffin & AFIRM Team, 2015). ECE is an approach that contains physical effort by individuals with ASD to reduce behavior issues or increase appropriate behavior while increasing physical activity (Cox, 2013). In one study, Nicholson, Kehle, Bray, & Heest (2011) showed that ECE intervention could significantly increase the academic engagement of children with ASD that participated in physical activity. Additionally, it is proven that the more time children with ASD spend running or walking, the more they participate in the classroom (Cox, 2013). Other benefits

of ECE intervention include decreases in challenging behavior. Cannella-Malonei, Tullis, & Kazee (2011) cited the reduction of challenging behavior of children with intellectual disabilities, autism, and emotional behavior disorder after the ECE intervention. Participants were engaged in eight exercises each day; the duration of each exercise is between 1 to 20 min in a school setting. According to Cox (2013), ECE intervention could be effective in preschool (3–5 years old) and middle school (12–14 years old). Cox (2013) added, "With ECE, learners engage in a fixed period of programmed physical activity on a regular basis. ECE sessions often begin with warm-up exercises and end with cool-down activities and may include aerobic activities (e.g., jogging, jumping, swimming), strength training, and/ or stretching that can take place indoors, outdoors, or at a swimming pool for aquatic exercise programs. ECE is often used in conjunction with prompting, reinforcement, and visual supports."

Technology-aided instruction and intervention (TAII) is increasingly common among individuals with ASD (Chen, 2009). The TAII practice is widening the definition of technology intervention for ASD learners, which is under the umbrella of computer-aided and speech generating devices (Wong et al., 2015). Therefore, TAII Intervention is using technology as the central feature to support learners with ASD to achieve their goals (Hedges & AFIRM team, 2017) across a variety of areas and ages (Wang et al., 2015). With the variety of technology tools and applications, teachers can concentrate on helping students acquire the targeted skills and behaviors. Odom, Boyd, Hall, & Hume (2014a) as cited in Wong et al. (2015) stated that technology is "any electronic item/equipment/application/or virtual network that is used intentionally to increase/maintain, and/or improve daily living, work/productivity, and recreation/leisure capabilities of adolescents with autism spectrum disorders." Some of the forms of technology that are involved in the definition include "…smart phones, tablets, laptops,

desktop computers, speech generating devices, interactive whiteboards, software for computers, and the internet" (Hedges & AFIRM, 2017).

Modeling (MD) is an indication of mimicking of the targeted behavior by learners with ASD, which results in acquiring this behavior (Cox, 2013). MD is most effective when combining with prompting and reinforcement strategies to increase attention, social imitation, affect sharing, empathy skills, social greetings, play skills, academic skills, communication skills, and work/job-related skills (Sam et al., 2018). The MD intervention can be used with individuals with ASD at school, in the community, and in the workplace (Eldredge, McLaughlin, 1992).

Scripting (SC). Griffin and the AFIRM team (2017) mentioned that "Scripts are generally considered a support to help learners initiate or sustain communication with others, usually through visual or auditory cues. Scripts enhance interactions within home, school, community, or work routines by providing learners with a predetermined script. In addition, scripts provide a template and cue for a learner who struggles to communicate independently." Fleury (2013) added "The main rationale of SC is to help learners anticipate what may occur during a given activity and improve their ability to appropriately participate in the activity. SC are practiced repeatedly before the skill is used in the actual situation. When learners are able to use the scripts successfully in actual situations, the script should be systematically faded. SC is often used in conjunction with modeling, prompting, and reinforcement." It is good to mention that not all SC could work with all individuals with ASD. For instance, the provided script may contain written and picture cues based on the linguistic level of the learner. Also, it could be provided verbally or require reading aloud to non-readers.

Non-technology Interventions for Children with ASD and their Parents

It has been said that providing care for a child with ASD could affect the well-being of parents even though the presence of severity of symptoms of their individuals with ASD (Ekas, Lickenbrock, & Whitman 2010; Pottie and Ingram 2008). Research reported that parents are mostly use non-technology intervention therapies like for social and communication skills, social stories and PEERS program for their children with ASD (Cole and Parkman, 2012). For example, the intervention of Parent-Child Interaction Therapy (PCIT) has many positive effects for both parent and children with ASD. Zlomke, Jeter, and Murphy (2017) investigated the effectiveness and feasibility of the (PCIT) with ASD children to decreases disruptive behavior. The study suggested that the diminution of communication may be a source for the disruptive behaviors from children with ASD. These behaviors could be affected by poor relationships and lack of parent-child interactions. Zlomke et al. (2017) mentioned that parents reported a reduction in disruptive behavior of children with ASD after the PCIT intervention. Parents also expressed their high satisfaction regarding the intervention process. Another example is Social Stories. A study conducted by Gul and Iftar (2016) to investigate whether or not parent/family member of children with ASD are capable of learning how to write and deliver social story that will aid social skills of their children at home setting. Parents/family member were trained in a small group to structure a social story book that contains ten pages including visual cues like photos of their children. Modeling steps for writing the SS and delivering the SS intervention were presented to the parent/family member. Several founding has been revealed by Gul and Iftar, (2016). First, family members were able learn how to write and implement social story with after the training sessions. Second, family members were able to keep these skills after the intervention and apply it to write a SS for new targeted skill of the children with ASD. Third,

children with ASD were able to generalize the acquired social skills to different setting. Fourth, the performance of social skills of children with ASD is increased after the intervention. Other positive findings were found like the short of time and low of cost regarding the SS intervention along with positive interaction between family member and their individuals with ADS.

Another example of using non-technology intervention for parents of individuals with ASD is intervention which used PEERS program. The Education and Enrichment of Relational Skills (PEERS) program is designed to deliver education and enrichment of relation skills to individuals with ASD through didactic lessons, role-play demonstration, activities, and homework assignments. Karst, Hecke, Carson, Stevens, Schohl, and Dolan (2014) investigated the impact of PEERS program on families of adolescents with ASD to improve social skills. The randomized controlled trial design study focused on family disorganization, stress, and self-efficacy. Several measures were used by parents to assess the environmental confusion at home, parents of individuals with ASD stress, and parenting efficacy scale. The findings revealed the positive effects of the for the participants regarding family chaos. Demonstration increased of arents in the PEERS regarding parenting self-efficacy. Karst et al. (2014), concluded the promising offers of the PEERS program to improve social outcomes of individuals with ASD.

Non-technology Interventions for Adults with ASD and their Parents

It is reported that through the next decade, almost half a million youth with ASD are entering adulthood (Roux, Shattuck, Rast, Rava, Anderson,2015)). When transitioning to adulthood and being more independence, individuals with ASD may have challenges due to social communication deficits, overreliance on family, and the adaptation of changes (Simonoff, Pickles, Charman, Chandler, Loucas, & Baird 2008). These challenges are more likely to result in poor outcomes of this population (Roux et al. 2017 as cited in Oswald et al. 2017) in

socializing, learning outcomes, and vocational outcomes (Taylor and Mailick 2014). Specifically, young adults with ASD are mostly unemployment or absence of college attendance (Newman, Wagner, Cameto, Knokey, & Shaver 2010; Wei, Wagner, Hudson, Yu, & Shattuck 2015). This is related to the lack of social skills including adaptive skills that allow young adults with ASD to solely manage themselves in everyday routines and interact with people independently (Schmidt, Schmidt, Glaser, Beck, Lim, & Palmer, 2019). Ultimately, the independence of young adult individuals ASD along with quality of life is important (Palmen, Didden, & Lang, 2012).

A study conducted by Laugeson, Gantman, Kapp, Orenski, and Ellingsen (2015), to investigate the effectiveness of the PEERS program intervention for young adults with ASD and their parent/caregiver to improve social skills in social skills group sessions through didactic lessons, role-play demonstration, activities, and homework assignments. Parent/caregiver play a vital role in this program. Parents/caregiver in this study were attending sessions that are separated from their individuals for social coaching for 16 weeks 90-min session weekly. Different types of scales that have been utilized by parents of individuals with ASD to measure and report social skills, communication, and attention outcomes. Parent/caregiver were also involved in data collecting as they used reporting scales for their intervals with ASD at home and community setting. Laugeson et al. (2015) suggested that the PEERS program intervention can significantly improve social skills of young adults with ASD using caregiver assistance. Young adults with ASD were able to make and keep friendship and improved the participant's knowledge about social skills after the intervention. Gantman, Keep, Orenski, and Laugeson (2012), also mentioned the importance and the effectiveness of using parent/caregiver along with the PEERS intervention for young adults with ASD. Laugeson et al (2012) also reported in

increasing of cooperative social behavior between caregiver and their individuals and high level of participation in social activities from the individuals with ASD. Another challenge for individuals with ASD when entering adulthood is self-determination skills. Since 1990 the self-determination has become an important intervention for young adult with ASD who are transiting to adult independence (Oswald et al. 2017). It has been found that children with ASD had a very low self-determination, parents reported a poor performance in self-determination skills like making decision, setting goals, and self-awareness (Carter, Lane, Cooney, Weir, Moss, & Machalicek 2013). However, it is mostly associate to employment outcomes, education outcomes, and quality of life for young adult with ASD. In a study by Oswald et al. (2017) investigated the intervention of ACCESS program to improve self-determination along with social and adaptive functioning of young adults with ASD. Parent/caregiver reported significant mean score in self-determination performance. Participants in this case, received a lesson regarding how to initiate, set goals, organize, and self-advocate. Caregivers also reported improvement in adaptive functioning after their individuals received the intervention. Assessment system were used to measure social and adaptive functioning including Social (performance in social skills and leisure), Conceptual (performance in self-direction, communication, and functional academic areas), and Practical (performance in home living, self-care, community use, and health and safety skills areas).

Technology Intervention with Children with ASD and their Parents

Throughout the years, individuals with ASD have been exposed to various technology integration tools to support their social and communication skills, educational outcomes, and behaviors. Significantly, many educational practices indicated the effectiveness of using technology with children with ASD (Desai, Mumford, Hotze, & Chau, 2014; Dixon, Verenikina,

Costley, & Pryor, 2015; Ennis-Cole, 2011). Ennis-Cole (2011) noted that there are several technology tools that can be used effectively to develop autistic learners' social and communication skills. Such tools need to be "…. engaging, intuitive, offer visual and auditory instructions, and present content that gradually increases in complexity" (p.59).Previous research by Wong et al. (2015) has mentioned that parent-implemented intervention refers to parents who are "…trained by professionals one-on-one or in group formats in home or community settings. Methods for training parents vary but may include didactic instruction, discussions, modeling, coaching, or performance feedback. Parents may be trained to teach their child new skills, such as communication, play or self-help, and/or to decrease challenging behavior. Once parents are trained, they proceed to implement all or part of the intervention(s) with their child." (p. 68)

Parent-implemented

Parents have shown the benefits of collaboration with educators. In fact, many studies showed positive outcomes when parents collaborate with educators to select the best intervention that fits their children's needs (Brown & Woods, 2015; Crane-Mitchell, and Stafford 2017; Meadan, Snodgrass, Meyer, Fisher, Chung, & Halle 2016; Stump, 2017). This will result in reducing parents' stress and increasing their confidence, as they usually seek to use the best of technology for their individuals with disabilities (Curran, 2017). Therefore, involving parents in the educational process and collaborating with educators will allow them to better understand the current technology and how it functions.

Video modeling. Stump (2017) investigated the implementation of parent-implemented interventions to develop social and communication skills and learning outcomes for children with ASD. For example, the GoPro camera with video modeling is being used to teach social interaction between parents and their child. Parents expressed that the amount of time of the

social interaction with their child with ASD significantly increased. Additionally, they had the opportunity to ask more specific questions about the shopping experience of their child (Stump, 2017). Brown and Woods (2015) examined the effectiveness of using VM to aid communication between parents and children with ASD. Parents were coached by the interventionists to implement the routines, supports, strategies for the 24 intervention sessions (pre-baseline, baseline, intervention, and maintenance). Families had three routines that designed to helped improve their child communicant. All sessions were conducted at the participants' homes for 60-75min each session. The findings of this study showed that all parents increased their responsivity and modeling strategies at a high level comparing with prompting teaching strategies. Moreover, among the three phases, all children increased at least one of the two communications targets (communication target 1: single verbal words. Communication target 2: multiple verbal words). As for social validity, parents were asked to complete a written questionnaire (Likert scale) after the intervention phase regarding feasibility, utility, and acceptability of the intervention. Also, they were asked to answer three open-end questions.

Social Stories. SS intervention can improve social skills of children with ASD. Acar, Tekin, and Yikmis (2017) examined the effectiveness of SS along with VM what will be delivered by parents of individuals with ASD to improve social skills. Parents were asked questions regarding the daily like in home and social settings, change of behavior in different settings, likability of the intervention, and children's attitude while interacting. The results of the study showed that there is statistically evidence of accuracy of developing both social stories (SS) and video modeling (VM) by the participants as well as implementing them with fidelity. Also, the findings show the effectiveness of the interventions regarding teaching social skills to the children, where

VM was highly effective for two children and SS were highly effective for one child. Lastly, all parents expressed positively regarding social validity of the SS and VM interventions.

Online training programs. Parents perceptions were also collected to determine the effectiveness of an online training program. Meadan, Snodgrass, Meyer, Fisher, Chung, and Halle (2016) conducted a study to examine the effectiveness of an online program constructed to train and coach parents to implement teaching strategies and to improve social-communication skills when interacting with their autistic children. The findings showed high fidelity of implementing the teaching strategies by parents who taught and trained via the internet. Along with the implementation of the strategies, the findings showed improvement in the communication skills of their children. Most importantly, all parents confirmed their satisfaction with the online program. They reported behavioral changes as they learned to find new ways to interact with their children. Moreover, children experienced more positive engagement with their parents' activities through improvements in verbal and nonverbal communication.

Parents reported the positive effective of using the online assistive technology program VizZle on an iPad in the home setting to improve their ASD learners' outcomes. Parents mentioned their child's progress in vocabulary, counting, and reading comprehension (Mitchell, and Stafford (2017). Other iPad programs are used to teach social interaction skills for ASD individuals by family. Parents expressed their satisfaction with the interventions on the outcomes of the sibling of the child with ASD as well as the performance improvements of their child with ASD (Özen, 2015).

Augmentative and alternative communication (AAC). The AAC program showed promise as a treatment approach for individuals with ASD to improve communications (Cardon, 2016). AAC is defined as a device (electronic or non-electronic) that can be used to send and

receive messages from the individual (American Speech-Language Hearing Association, 2008). In a research study, Desai, Mumford, Hotze, and Chau (2014) showed that iPad-based and communication application intervention could statistically increase ASD learners' communication behaviors after using the "GOTalk Now" communication app that was specifically designed for the participant to provide vocabulary layout to help in communication. The AAC device, in this case, was to provide voice output and vocabulary layouts and grids that are systematized based on individual needs. Desai et al. (2014) stated that the student "demonstrate steady gains in his school communication and participation levels post-implementation of his iPad-based AAC" (p. 156). Additionally, the researchers noted that the child was less dependent on his teacher after exposure to this technology at school.

Tablets. Dixon, Verenikina, Costley, and Pryor (2015) mentioned that tablets can also be used effectively with ASD students in the home setting for educational purposes including but not limited to developing literacy skills, working with numeracy activities, and developing musical play skills. Dixon et al. (2015) mentioned that "families had downloaded a range of apps aimed at developing their child's skills in writing, reading, comprehension, and sentence building. Digital tablets were also used in the home for music education" (p.197). Another purpose of using tablets with ASD individuals at home setting is to reduce their anxiety. In fact, one of the most significant uses of the tablet is supporting children with ASD behaviors at home (Dixon et al., 2015). Parents of individuals with ASD valued the use of tablets in assisting with their children's behaviors. They mentioned that the use of tablets decreased the unacceptable behaviors of their child. In essence, the researcher mentioned that "digital tablets were also being used in the home setting to reduce children's anxiety levels" (Dixon et al., 2015, p. 196).

It has already been established by numerous studies that iPads and tablets are effective teaching tools for those with and without ASD. The guidelines for creating applications for all of these uses are now being created with a number of techniques included in the design suggestions. One area of design includes the implementation of immersive virtual reality technologies. Parents are the backbone of interventions and education for individuals with ASD. Parents/families are essentially part of the educational process of individuals with ASD since they are the person most aware of their child's disabilities (Zager, 2005). With the parents involved in the education process, individuals with ASD will have more opportunities to receive support in the home setting. This will result in more transferring of the intervention to real-world scenarios, especially if the parents are trained to teach and implement the intervention (Zager, 2005).

Technology intervention with adults and their parents

Young adult with ASD have been involving in technology intervention research regarding the lack of social and communication, vocational, and independent. Such deficits could affect their engaging with the community and their everyday life. The following studies used technology with adults including young adults with ASD along with their parents in some cases.

Attitude, anxiety, and social-vocational skills of adults with ASD

A study conducted by Hillier, Greher, Queenan, Marshall, and Kopec (2016) aimed to investigate the impact of technology-based music (SoudScape) on adolescents and adults with ASD to improve social interactions as well as individual responses to the technology interface, iPad. Also, the study investigated the level of stress and anxiety of the participants after the intervention. Parents' perceptions were explored to determine the efficacy of the model. The findings showed that more than half of the participants had less stress and anxiety after the

intervention and improved socially by making friends. In addition, parents expressed the advantages of the iPad to develop social skills, “Like everybody has said, there’s the social, there’s also the collaboration part, thanks to the iPad. It’s just a different way for him, you know, to enjoy and participate in making music…” (Hillier et al., 2016, p. 275). In fact, they suggested the iPad implementation for learners on the autism spectrum specifically to reduce stress and anxiety.

Burke, Andersen, Bowen, Howard, and Allen (2010) conducted a study to evaluate the effectiveness of vocational training program using tablets to teach social-vocational skills for ASD adults. The results of this first study revealed that all participants had performance improvements after interacting with behavior skill training (BST). Also, the results showed that there is a high percentage of completing home tasks individually (no parent interaction) by the participants between the baseline phase and the end of the program. Moreover, the survey showed that there is a high level of satisfaction among parents regarding the program as evidenced by the fact that they would highly recommend it to other adults with ASD. Burckley, Tincani, & Fisher (2015) investigated the iPad with application intervention to aid shopping skills for young adult with ASD at the community setting. Specifically, the study focused on the participant’s independence on using shopping list at grocery store. The participant had to go through nine steps that start from going to the store and ends with getting in line for checkout. The results of this multiple-probe design suggested that visual cues and video prompting can increase independent shopping of young adult with ASD. The study also revealed that the acquired skills can be generalized, as the independent percentage of the participant were high in two different locations. Parent of the individual was involved in the study to complete a survey in regards of social validity. Parent expressed the important of the aimed skills and the

effectiveness of the iPad intervention for the young adults with ASD. Parent also mentioned the ease of using the iPad and the intend of applying this intervention to acquire additional community skills.

Similarly, a study by Cakmak and Cakmak (2014) claimed that the use of iPad as a teaching tool could be effectively develop the daily life skills of individuals with intellectual disability and autistic. In the study, multiple-probe design cross subjects were used in this study to measure the level of shopping skills performance at a supermarket for 3 age between 17-19 years old. The results showed the effective of the animation practices that presented through the iPad to the participants even after five or ten days of the instruction. Parents of the participants expressed that their individuals could be more in independent and social relation.

Jones and Bucholz (2014) investigated the iPad intervention with young adult who diagnosed with ASD in a vocational setting to increase their independence. The study investigated the iPad intervention to improve work-related behavior in a local chain restaurant. The participant had to identify three behaviors independently such as, workstation's setting up, time management, and coworkers' identification. Data were collected through observations on jobsite by one staff trainer of the Transition Academy Program which the participant is associated to. The program aims to acquire vocational skills for young adult with ASD through on-job training on sites. The results showed the important of the iPad intervention for adults with ASD. The participant independence was statically improved in setting up the works station. Also, the participant was able to manage time as he had zero minutes of lateness, which was 8 minutes on the baseline phase. Lastly, the percentage of identifying faces and the names of coworkers increased after the intervention. Another technology intervention with young adults with ASD is to reduce the reliance on people's support. Genty, Kriner, Sima, McDonough, & Wehman (2015)

investigated the use of an iPod Touch as a personal digital assistant to reduce the need of personal support on the job site. Young adult with ASD may need a personal support to facilitate tasks implementation, training, supervising, or transportation planning specially in some vocational settings. Serval measures were used including Supports Intensity Scale (SIS) that was specifically designed for individuals with intellectual disabilities including ASD to identify aspects of personal support required. The results of this study suggested that the iPod Touch intervention with young adults can significantly reduce the need of personal support as they needed less hours of support on job coaching than the group who did not received the intervention.

Morgan, Leatzow, Clark and Siller, (2014), conducted a pilot study to evaluate the intervention of Interview Skills Curriculum (ISC) that was delivered to young adults with ASD by numerous formats including video feedback. The aim of the pilot randomized controlled trial was to increase social and pragmatic skills that may essentially result to successful job interview. It is good to mentioned due to lack of social communication of individuals with ASD; non-verbal communication, emotional regulatory strategies and self-advocacy topics have been imbedded to the curriculum. Video-recorded of Mock Job Interviews was the primary source of data collection along with parents-report measures to measure the final outcomes. The results of this study showed the efficacy of the ISC for young adults with ASD. It is shown that social and pragmatic skills of adults with ASD in the experimental group were largely gained than the control group.

Kandalaft, Didehbani, Krawczyk, Allen, & Chapman (2013), conducted study is to investigate the effectiveness of using computer-based Virtual Reality Social Cognition Training (VR-SCT) interventions to aid social and communication skills in adults with high functioning

autism (HFA). The virtual reality platform *Second Life* was used in this study. Each participant will meet the coach virtually, and the coach will provide the participant with instructions on how to engage in social scenarios. The constructed scenarios were designed to imitate real-world social experiences such as applying for a job, meeting people, and interacting with a roommate. A pre-test was conducted in two of the interventions for each participant. Each individual with ASD completed ten sessions of VR-SCT. Participants had the chance to familiarize themselves with navigating by using a computer keyboard. Then a post-test was conducted within two weeks. After six months, the research conducted a follow-up (phone call) to have feedbacks regarding the intervention. SPSS where used to analysis the collected data. The findings showed statistical evidence of improvements in verbal and non-verbal recognition, Triangles Intentionality, conversational skills. The findings also reported the ease of navigating inside the VR environment, enjoyment of sessions, and confidence in engaging in everyday social situations.

Similarly, Smith, Ginger, Wright, Wright, Taylor, Humm, Olsen, Bell & Fleming (2014) investigated the use of a computer-based virtual reality training program that designed eight different positions of employment to improve the job interview performance for adults with ASD. The participants performance before and after the program intervention was measured (interview role-play, self-report of the job interview, and self-confidence). The participants in this study expressed the ease of use and enjoyment the VR intervention and being ready for a future job interview. Moreover, the participants' role-play performance of the job interview has been improved after the intervention.

Immersive Technology with Children with ASD and their Parents

Virtual Reality (VR) has shown potential to promote the acquisition of adaptive skills for autistic individuals (Beach & Wendt, 2014; Bozgeyikli, Raij, Katkoori, & Algasemi, 2018; Cheng, Huang, & Yang 2015; Ke & Moon, 2018; Yu-Ju et al., 2018). Accordingly, the following section includes studies of immersion technologies that were used to develop skills of children with ASD, such as social, communication, and emotions recognition.

Social and communication skills

The characteristic symptoms of individuals with autism involve difficulties in social understanding and language growth, repetitive behavior, and absence of imagination (American Psychiatric Association, 2000). As a result of these problems, they struggle in social understanding, use of accurate gestures and social skills, conservation of friendship, and contribution in social play (Machintosh & Dissanayake, 2006), which leads to social interaction deficits (Chung, Mosconi, Drewry, Matthews, & Tasse, 2007). The intervention of 3D immersive virtual environment with a head-mounted display (HMD), as it is the current focus display technology, improved the development of social interactions of children with ASD (Cheng et al., 2015). Learners with ASD were able to slightly reduce inappropriate behaviors and better concentration when questions presented and provided more acceptable answers. It is good to mention that teachers could provide prompts to ASD learners when needed to enhance the social responses of these individuals (Odom & Strain, 1986).

In addition, social awareness and sensory engagement can be effectively improved after the VR intervention and applied in a real-world setting (Beach and Wendt, 2014). Individuals with ASD can get involved in conversations with sustainability and describe experiences from the virtual world and how they felt it was like a real environment with less stress, especially

when interacting with someone in real-life after the intervention. While social awareness is the awareness of incapability to involve and maintain a conversation with peers, sensory engagement is experiencing of the individuals in the simulator and using the HMD (Beach and Wendt, 2014).

The implementation of VR intervention as a game-based intervention can improve social interaction performance of children with ASD. It is shown that chess and sports games can improve collaboration, identity development, and flexibility in play. While role-play provided improvements in a variety of social skills, such as response, initiation, interpersonal negotiation, positive self-identify expression, and cognitive flexibility (Ke & Moon, 2018). The VR game-based learning intervention allows individuals with ASD to interact more, especially when they are exposed to tasks that suit their interests.

Another effective VR intervention is to improve linguistic communication skills of students with mental disabilities and ASD. Yu-Ju et al. (2018) mentioned that children with ASD were able to provide more words and sentences at home after learning and playing in the 3D virtual context. Additionally, the study revealed the ease of using the VR game-based learning platforms, such as kitchen and dining room in a house, playground, health center at school, zoo, shopping mall, traditional market to enhance the learner's language along with motivations.

Emotions and recognition

Chen, Lee, and Lin (2016) showed that Augmented Reality (AR) could improve the ability of children with ASD to recognize, recall, and mimic nonverbal social cues by using the designed AR along with Video Modeling (VM). The social cues focused on included 6 basic emotions and their corresponding facial expressions, such as fear, happiness, anger, disgust, surprise, and sadness. The combination of AR and VM technology can help children with ASD

focus on the subject being taught (social cues in this instance) without the typical response of being drawn to other objects not relevant to the subject.

Lorenzo et al. (2016) mentioned that "the user is completely immersed in a computer-generated world, giving them the impression that they have 'stepped inside' a synthetic world. These systems offer a controlled and safe three-dimensional representation of real environments that can be used repeatedly" (p. 193). In the study, the immersive virtual reality system along with a robotic camera is used to coach, create and aid the emotional skills of ASD children. Regardless of the individual's position, the robotic camera is capturing their facial expressions to teach social cues and determine if the child is reacting appropriately. The "real world" feel of the IVRS program will include avatars that react to the children's facial expressions and provide feedback to their response to the social situation. The study showed that using IVRS technology had significantly higher results that were maintained after the sessions than using VR only. These results also translated to real-world scenarios with the students that used the IVRS system having more appropriate reactions than the control group.

Immersive Technology with Adults with ASD and their Parents

Through the past decade, very few research studies have used immersive VR among adults with ASD. These research studies focused on using immersive VR technology regarding the acceptance of HMD with VR (Newbutt, Sung, Kuo, Leahy, Lin, & Tong, 2016), anxiety (Ross, Cox, Reeve, Brown, Moncrief, Schmitt, and Gaffney 2018), driving abilities (Patrick, 2016), social interaction skills (Beach & Wendt, 2015), and public transportation (Schmidt, Schmidt, Glaser, Beck, Lim, Palmer, 2019). The following section includes studies of immersive VR technologies that were used to develop skills of adult and young adults with ASD.

Newbutt et al., 2016 investigated the use of Head-mounted displays (HMDs) among adult individuals with ASD to examine the acceptance of virtual reality and HMD. Two phases were designed in his study. The first phase included three short scenarios (10 min) that adults with ASD will navigate through the HMD Oculus Rift and controller. The participants were asked after the first phase if they were willing to return for phase two, in which the participants would engage in two longer scenarios (25 min) and more intensive. Survey and observation were used to collect the data in this study. Newbutt et al., (2016) suggested that most of the participants accepted the HMD and intend to complete the tasks in all scenarios. In addition, some participants reported a high level of presence and engagement with the VR environment. Newbutt et al., (2016) concluded that this is a very important factor as the participants expressed the presence as "real" through the HMD, in which this could be a way of improving real-life skills of individuals with ASD and generalizing of the acquired skills. Parents/caregivers of some adults with ASD who are under guardianship in his study were involving along with their individuals to understand the goal of the study and to consent of being part of the study.

Several studies mentioned that young adults with ASD may have high level of risk regarding anxiety (Van Steensel et al., 2011; Vasa and Mazurek, 2015). As a result, anxiety may affect some of their daily life activities (MacNeil et al., 2009) like driving. Ross et al, (2018) examined the effectiveness of virtual reality driving system for ASD individuals. The study focused on exploring parents' perceptions of their ASD individuals' attitude toward driving after the intervention. ASD individuals age between 16 and 25. To investigate the two hypotheses of this study, *first,* 50 driving scale completed by parents who participated to this study with their ASD drivers. A group of 23 randomized participants with ASD used Routine Training RT, trained on-road in real world situation with parents supervising. Then group of 46 randomized

participant will receive addition treatment (8-12) sessions to train individually by high-fidelity virtual reality driving system. It is good to mentioned that 19 participants were crossed over from the routine training group for large sample manner. *Second*, 186 completed scale by parents of neuro-typical drivers to compare them with parents of drivers with ASD. To investigate the second hypotheses, parents of individuals who undergo the virtual reality driving system completed the scale after three months for the second time. To analyze the collected data, ANOVA was used to compare the two groups. Another ANOVA was conducted to examine ASD beginning drivers' improvement toward draining after the VR training. The finding in this study statistically revealed that there was a difference between parents of individuals with ASD and parents of neurotypical controls on the DAS-PR scale. Specifically, parents of individuals with ASD expressed that their individuals' attitudes toward driving was negative. The results also revealed the VRDS training enhanced the driving skills of individuals with ASD.

Similarly, Patrick (2016) explored factors that are associated with driving abilities of individuals with ASD when using virtual reality driving simulator. The driving environment where using three monitors to provide more level of immersion along with steering wheel and foot pedals. The study focused on different aspects of driving performance like social functioning, speed, attention, and executive function. The findings revealed that speed and lane control is significantly difficult for young adults with ASD comparing to the typical development group. Patrick (2016) mentioned that both groups have difficulties when engaging in an additional task while driving. Specifically, when turning the radio, individuals with ASD have more difficulties than the control group with speed control. Individuals with ASD performed poorly because of the lack of switching between two tasks that require attention or executive

functions. Moreover, individuals with ASD could not maintain speed when engaging in a social conversation due to the lack of social communication.

Beach and Wendt (2015) used virtual reality with HMD with individuals with ASD including a participant who recently graduated from high school to aid social interaction skills. In addition, the study examined if the participant able to apply the acquired skills (eye contact and starting conversation) from the virtual environment to the real-world scenarios. The participant engaged in three scenarios in the virtual environment like asking a person for directions at the park, applying for a job at a hospital, asking the librarian to help finding a book. Two themes were revealed after the intervention. First, sensory engagement. The participant describes the virtual environment as a realistic and being part of it. Second, social awareness. The participant was able to walk and engage within the scenarios authentically. Beach and Wendt (2015) mentioned that the participant was able to maintain eye contact in almost all scenarios and during real-life situation, and able to initiate conversation after the intervention.

Schmidt et al. (2019) used a 360 video-based VR and mobile application that designed to support adaptive skills of young adults with ASD. The study focused on examine the SVVR mobile application usage with adults with ASD using head-mounted display and evaluating the SVVR public transportation model intervention by experts. Although the mild symptoms of cybersickness of two participants, the findings suggested the ease of use by all participants with ASD along with positivity when experiencing the SVVR model. Experts and participants expressed the feasibility of the SVVR app including the immersive video interface and agreed especially, google cardboard. Experts also expressed the feasibility and relevance of the intervention.

Summary and Conclusions

The current studies show the potential use of immersive virtual reality environment intervention to improve social and vocational skills for young adults with ASD. After exploring the literature review, it is clear that using technologies with an emphasis on immersion technologies can impact ASD individuals positively. However, the review of the literature reveals existing gap regarding parent's involvement in immersive VR intervention for their individuals with ASD and factors that may influence parents of adults with ASD on the adoption of immersive VR technology. The majority of VR interventions in the past two decades were focused mostly on children with ASD. Therefore, the current study aims to fill this gap by exploring factors that may affect parents of adults with ASD decision regarding the adoption of SVVR mobile application.

CHAPTER 3: Research Method

Introduction

The purpose of this qualitative study was to determine the factors that may influence the adoption of the SVVR mobile application by parents of ASD adults enrolled in the EMPOWER program at the University of Arkansas. A phenomenological research approach was used to understand how parents of individuals with ASD perceive the SVVR mobile application in terms of its potential for home use. The goal of the phenomenological approach was to understand and describe the experiences of participants who used the SVVR. Rogers' Diffusion of Innovation (2003) theory was used in this study as a lens to determine factors that may affect SVVR adoption among parents. In this chapter, the researcher will describe (a) the research design and rationale, (b) the research questions, (c) the participants, (d) the instruments used, (e) the data collection procedures, (f) the data analysis, (g), issues of trustworthiness, (h) and the ethical procedures.

Research Design and Rationale

This qualitative study attempted to explore, decode, and describe the following research questions: (a) What factors prevent parents of associates in the EMPOWER program from adopting the SVVR mobile application for home use? (b) What do parents of the associates in the EMPOWER program think might increase adoption of the SVVR mobile application among parents of ASD individuals, and (c) What skills do parents of the associates at the EMPOWER program think VR technology could address to support individuals with ASD in the future?

In this study, a qualitative approach was used to acquire in-depth information that allowed the researcher to understand how the participants experienced and perceived the SVVR

mobile application. A quantitative approach that focuses on providing statistical information was not suitable for this research study. According to Creswell (2013), qualitative research can be done using five different approaches: phenomenological, narrative, ethnographic, grounded theory, and case studies. This study used the phenomenological approach. Brinkmann and Kvale (2015) state that phenomenology refers to "… understanding social phenomena from the actors' own perspective and describing the world as experienced by the subject, with the assumption that the important reality is what people perceive it to be" (p. 30). The phenomenological approach allowed the researcher to understand the essence of the factors that might influence the participants' decision on whether or not adopt the SVVR application. In this study, parents of individuals with ASD were examined.

Research questions

1. What factors impact the adoption of SVVR mobile application by the parents of students in the EMPOWER program?
2. How might changes to the EMPOWER program increase adoption of the SVVR mobile application among parents of individuals with ASD?
3. What are the perceptions of parents of students with ASD in regard to the potential for other skills that might be addressed using VR technology?

Role of the Researcher

In this study, the researcher acted as an observer and was responsible for collecting data through interviews and observation, and follow-up and analysis of the data (including transcription, coding, and generating themes). There was no relationship between the researcher and the EMPOWER program that could influence the participants.

To avoid research bias, the researcher used member checking, peer debriefing, and triangulation. Member checking was conducted after the data collection, and the researcher ensured that his interpretations matched the participants' answers. The participants had an opportunity to check the researchers' interpretations and evaluate the final report to determine the accuracy of the research findings. This process provided an opportunity for a follow-up interview with the participants in which they were able comment on the results (Creswell, 2014). Peer debriefing was conducted by another researcher (a committee member/doctoral student) who reviewed the study to check the accuracy of the findings (Creswell, 2014). Triangulation involves acquiring different data sources that will be summarized in themes. In this study, the researcher used interviews, observation, field notes, video recordings, and follow-up interviews.

Methodology

Participant selection logic

The participants in this study are parents of adults diagnosed with autism spectrum disorder who are enrolled in the EMPOWER program at the University of Arkansas. The aim of this study was to analyze the parents' perceptions around adopting SVVR technology. Understanding their perspective is important to an evaluation of the technology's use and adoption. The interviews and focus group allowed the researcher to capture different points of view from individuals who share the same interest, during and after their use of the technology (Brinkmann & Kvale, 2015). The researcher led the session by introducing discussion topics and facilitating the dialogue among the participants (Brinkmann & Kvale, 2015). The gathered data were themed according to the participants' perceptions of SVVR.

In this qualitative research study, purposeful sampling was applied to recruit the participants. The sampling was suitable for phenomenological design due to the nature of the

participants, as they are all parents of adults with ASD who are associates in the EMPOWER program. Purposeful sampling involves samples selected intentionally to provide relevant information on the questions and goals of a research study, where the information might not be acquired from a different source (Maxwell, 2013). In a phenomenological study, no specific number of participants represents the sample. Some researchers recommend three to ten participants in a phenomenological study (Dukes, 1984), but others recommend in-depth interviews with ten participants who have shared the same experience (Creswell, 2013). Accordingly, the number of participants of this phenomenological study was six parents.

Instrumentation

The data for this study were gathered through interviews, observation, and follow-up. The researcher used a modified version of interview questions developed by Curran (2017) to address the first and second research questions.

Interview. The researcher conducted a face-to-face interview with each participant to understand their current skills and knowledge about technology in general and advanced technology, and particularly VR. The researcher asked questions developed by Curran (2017). The researcher met the participants for one hour in a lab at the EMPOWER program at the University of Arkansas. All interviews were recorded using an audio recorder and a laptop computer.

Focus group. After the interviews, the researcher conducted a focus group with six participating parents. Generally, a focus group contains between six and eight participants (Creswell, 2014). The focus group was divided into two groups of three participants each. The focus group format was designed so that each group would receive a demonstration of the SVVR mobile application by the researcher, followed by a try-out of the HMD Google Daydream and

mobile application. The and group interview (using open-ended and semi-structured questions) allowed the researcher to gather information to answer the three main study questions.

Observation. During the focus groups, the researcher took field notes. Data collected through observation of participants allows a researcher to explore and capture topics or attitudes that participants may not intend to share or discuss (Creswell, 2014). The researcher used a video camera and laptop to record the focus group interviews.

Follow-up. The final step in the data collection process consisted of follow-up interviews (phone) conducted by the researcher to identify or clarify any confusion. These ensured that the findings and themes were accurate.

Equipment

The researcher used different types of equipment. For hardware, the researcher used three Google Daydreams (2nd generation), two Samsung Galaxy S8s, one Samsung Galaxy S9 Plus, three Cyber Acoustics Lightweight headsets, a Samsung Gear 360 (2nd generation) 4k Camera, and a selfie stick tripod. Software used included the VR platform Veer and Veer VR, the screen recording application Vysor, and the Samsung Gear 360 application for stitching the recorded videos together. All software applications were available in Google Play.

Data collection

The data collection process involved three different phases. The first phase included completing the administrative work associated with the study. To illustrate, the researcher first submitted an Institutional Review Board (IRB) (Appendix D) application to gain approval to conduct this study. Second, after receiving the IRB approval, the researcher contacted parents/guardians through the EMPOWER program at University of Arkansas to get their permission to participate in the study. Participants were required to sign a consent form, which

included a description of the research, its risks and benefits, a statement of their right to withdraw from the research, and a guarantee that the collected information would remain confidential. In the third phase, the researcher interviewed the parents. The interviews consisted of open-ended, semi-structured questions. Semi-structured questions are less structured and more open-ended to elicit participants' perceptions. In other words, the researcher used not only the listed questions, but also other questions that he generated during the interview (Merriam & Tisdell, 2016).

The purpose of the focus group interview was to explore the factors that may affect the participants' decisions in regard to the adoption of the SVVR transportation model. Moreover, the focus group interview sought suggestions on how to increase SVVR adoption among other parents of ASD individuals. The focus group also explored the participants' perceptions regarding skills that might be addressed using the VR technology.

Participants were asked questions such as:

1- What is your opinion about the SVVR 360 environment?
2- Does the SVVR and mobile app look easy to use? Why/Why not?
3- Do you think the words on the screen are easy to read and understandable? Why/why not?
4- Do you think the SVVR and mobile app is easy to learn? Why/Why not?
5- Do you think what is being taught (the curriculum) of the SVVR and mobile app is clear? Why/Why not?
6- Do you think the SVVR and mobile app is visually appealing? Why/Why not?
7- Do you think the SVVR and mobile app will make it easy to navigate the bus tasks? Please explain.

Data analysis

After the data were collected, the researcher started the analysis process to answer the research questions. The researcher transcribed the recordings, then started the analysis process by going through each line and assigning codes (first-cycle coding). The researcher grouped codes with similar meanings and assign them to one category (second-cycle coding). These categories were generalized as themes. Conclusions were formed based on the common themes arising from the interviews. The researcher used a web-based word and phrase frequency application (dedoose.com) to help organize the data.

Issues of trustworthiness

The researcher verified the validity of the study findings in terms of the following:

Credibility

The researcher used triangulation on the collected data by using member checks, peer debriefings, interviews, observation, video recordings, and field notes.

Transferability

The small sample size limited the ability to generalize the study findings. Thus, the researcher described details of the setting to allow the reader to feel that they were sharing the experience. Thus, the readers would be more knowledgeable about what occurred and how it occurred. This added realism to the results and made them richer. Ultimately, it also added validity to the results (Creswell, 2014).

Dependability

A committee member/doctoral student reviewed the results of the triangulated of data to add validity to the study.

Confirmability

The personal information of all participants was not be made public to ensure honest replies. The research started the interviews by welcoming the participants and then explaining the process that would be used in the session.

Ethical Procedures

The researcher applied to the university institutional review board of the University of Arkansas before starting the research. An informed consent form was sent to all participants to inform them about the overall goals of the study and their right to drop out of the research study at any time (Brinkmann & Kvale, 2015). Participants had to sign the consent form to be part of the research study.

Summary

In this chapter, the researcher covered the process that were used to determine the factors that may influence the adoption of SVVR by parents of associates in the EMPOWER program. The sample size of this qualitative study was six. To avoid researcher bias and add validity to the study, the researcher conducted member checks, peer debriefings, and triangulation. The researcher employed interviews, focus groups, observation, and follow-up interviews to collect data.

CHAPTER 4: Results

Introduction

The purpose of this qualitative study was to determine the factors that may affect the adoption of VR and applications among parents of the adults at the EMPOWER program who diagnosed with ASD. Moreover, the study considered ways to increase the adoption of VR among other parents as well as other future skills that needed to be addressed through the VR technology. A phenomenological approach was used and consisted of six parents of adults at the EMPOWER program at the University of Arkansas. The researcher conducted an individual interview with each participant followed by focus groups. This study was guided by the following research questions:

4- What factors impact the adoption of SVVR mobile application by the parents of students in the EMPOWER program?

5- How might changes to the EMPOWER program increase adoption of the SVVR mobile application adoption among parents of individuals with ASD?

6- What are the perceptions of parents of students with ASD in regard to the potential for other skills that might be addressed using VR technology?

In this section, the researcher describes the setting of the participants in this study. The data collection section includes how the data was collected from the participants. The data analysis section presents how the researcher analyzed the data. After that, the researcher discussed the evidence of trustworthiness. The final section represents the study results which contain the discussion of the collected data.

The Study Setting

The EMPOWER program is a part of the College of Education and Health Professions at the University of Arkansas in the United States. The college provides a comprehensive training program to young adults between the ages of 18 and 26 with intellectual disabilities, some of which also have autism spectrum disorder. The students that attend the EMPOWER program are offered a four-year, non-degree college experience at the university. The program's goal is “to improve independent living skills of participants. As a result, emphasis will be placed on independent living skills throughout the entire program. Students are encouraged to live in university housing to facilitate the development and reinforcement of these skills. Students, however, are allowed to live off campus with family members if preferred.” (“EMPOWER and Life,” n.d.). Another key of the program is “to enhance the employability of EMPOWER students. As a result, emphasis will be placed on career exploration, pre-job skills, and on- and off-campus internships. Students will be placed in internships beginning with their sophomore year, culminating in a full-time internship their final semester. While not limited, students will be encouraged to focus on childcare, culinary, health care, hospitality, recreation and agricultural employment in order to take advantage of opportunities in these areas on campus.” (“EMPOWER and Support,” n.d.). In this phenomenological study, individual interviews, focus groups, and observation were the sources of data with the parents of the EMPOWER program students diagnosed with autism spectrum disorder. At the time of the study, the researcher did not find any personal or organizational conditions that influenced the parents or their experience. Also, during the study, the researcher did not find evidence of personal or organizational changes that would affect the interpretation of the final outcomes.

Demographics

The interviewed sample that was used in this research consisted of the six participants. All participants were parent(s) of the adults with ASD who are enrolled at the EMPOWER program at the University of Arkansas. For confidentiality, pseudonyms were assigned to each participant parent. Three mothers, Amanda, Lara, and Carla participated, as well as three fathers, Alan, Ben, and Tyler participated (see Table 1).

Table 1: Participants demographics.

Participant Name	Age	Parent used VR before	Purpose of using VR
Amanda	49	Yes	Gaming
Alan	49	Yes	Gaming
Lara	58	Yes	Gaming
Ben	53	No	-
Carla	46	Yes	Training/Gaming
Tyler	48	Yes	Gaming

Amanda and Alan:

Amanda is a special education teacher and a mother of two children. Stephanie, her daughter, is nineteen and was diagnosed with autism spectrum disorder at age three. Amanda's other child is named John and is twenty-one years old. Amanda is married to Alan, who is also a participant in this study, and they live in Texas. Amanda described her family as a normal family who "… enjoy traveling together, swimming in the pool together, and spending a lot of time with the grandparents on both sides of the family." She mentioned that Stephanie and her brother "… have been heavily involved in music. Stephanie has been very involved, performing a lot," and "she's been in choir since third grade and my son was in band and he's still in collegiate band.

Amanda continued: “Stephanie’s going to be in the Women’s University Chorus here.” Amanda concluded that their “… activities have been around either his performances or her performances, and then both of them did swim team for 10 years, so we did a whole lot of swim meets.”

Alan is Stephanie’s father. Alan described Stephanie as non-athletic, “As a family, three of the four of us like sports. Stephanie’s not a big sports fan.” Alan added, “Stephanie’s more of a movie person, a pet person, and a dog person. So, if there’s anything involving animals, she’s a big fan of it.” He described that recently “She’s gotten into scary movies, not scary like super horror, but like suspense. So, we watch a lot of suspense or even somewhat scary movies. I don’t know where that came from the last two years?”

Lara and Ben:

Lara lives in a suburb of Dallas, Texas. She currently works part-time from home after retiring from her job as a nurse. Lara left nursing as soon as she had her only child, Bryson, who is currently nineteen years old and has been diagnosed with autism spectrum disorder. Lara is married to Ben, who is participating in this study. Lara and her family love the beach, “we love to go to the beach, so we do that every summer. We go to Florida. We all love the beach, the ocean.” She added that her husband and her son “love to go on long bike rides” every weekend.

Ben is Bryson’s father. He works as a director of sales for a medical products company. He is married to Lara for twenty-one years. Ben and Bryson like to go biking together, and as a family, they like to play “tennis when the weather is not too hot or too cold”. On holidays, Ben and his family like to go to sports events. This will help his son “with his focus and being able to still be involved in athletics.”

Tyler:

Tyler works as a manager at a networking company. He and his family live in Dallas, Texas. Tyler and his wife have three kids and one of them, Dan, who has been diagnosed with autism spectrum disorder. Dan is twenty-one years old and his two sisters are sixteen and thirteen years old.

Tyler mentioned that his son loves to play video games, especially when playing together, “if he can convince me to play a game with him, that’s going to be his favorite. Tough for me, because he’s way better than me and he always makes short order of defeating me in whatever.” Tyler added “Another thing we enjoy doing is we like the superhero movies. So, we usually watch when there’s a new one that comes out, ‘Spiderman’ or ‘X-Men’ or ‘Avengers,’ he and I will go do that together. That’s something we enjoy.” Tyler mentioned that they do outdoor activities, but his son does not enjoy it “We did Boy Scouts together. Cub Scouts and Boy Scouts all the way through in fact and Dan was able to achieve his Eagle Scout rank.” He added “So, a lot of camping, a lot of outdoor activities there. We also have a boat, so we enjoy going boating, water skiing, too, that kind of stuff. But Dan is not a real big sports guy. He doesn’t really enjoy playing. I’ll go out and do stuff with him, but he usually is counting the number of times he has to throw the ball or how many minutes before he can go in. Tyler concluded that “Dan doesn’t really enjoy the outdoors as much as I would have hoped.”

Carla:

Carla is not the biological parent of Howard. She works as a director for one of the largest grocery company in the US. Carla is the only participant who live locally. She has a nephew who is on the autism spectrum, Howard. Howard is 18 years old and has lived with her since he was 5 years old.

Carla and Howard like to watch movies together “we actually watch a lot of movies, and we hang out at the house a lot. So we like to watch football games, kind of tailgate and have people over, entertain, and just, kind of spend time together.” She added, “he loves going to arcades. He loves video games, then movies is normally what he wants to do, but we occasionally get out, go bowling.” Carla gave some examples of places they enjoy together, “He loves Dave & Buster’s, but we still do other stuff, like we’ll go to Fun City, things of that nature.”

Howard does not like to do outside activities. Carla said “he’ll go outside if I force him, and I’ve learned over the years that Howard is a creature of habit.” She explained, “that comes back from having a very structured environment and schedule. So, in order for him to try new things, sometimes I just kind of have to force him, and I’m like, “No, we’re going to do it. You’ll have fun! He’ll, nine times out of ten, enjoy it.”

She provided an example of last summer “I took him kayaking and paddle boarding for the first time. Initially, I thought that he would really enjoy kayaking, but he actually thoroughly enjoyed paddle boarding. He went up and down the lake on his own with a paddle board and was just fine.”

Data Collection

In this qualitative study, the data collection process consisted of individual interviews, focus groups, and observations which were conducted on different days. In other words, the data collection procedures included two different phases. First, six participants were interviewed. All participants were parents of individuals with autism who attended the EMPOWER program in the Fall semester 2019 at the University of Arkansas. After acquiring the names from the director of the program, each parent received an email invitation to the study. All parents who agreed to

be part of this study then received an email that contained a link to doodle.com to set up the date of the interview to fit their schedule. Due to the lack of time and the geographic location, as five of the six participants live in Texas, it was difficult to have all the participants on the same day. All parents agreed to have their first interviews on their child's move-in dates at the University of Arkansas which was August 19th, 2019. The face-to-face interviews, with each participant, were conducted in a conference room at the EMPOWER program building at the university. All participants were asked the same questions in the interviews and each session lasted for 30-40 minutes. The interviews were video recorded using a laptop and an audio Sony digital recorder. All data from the interviews were transcribed manually.

In the second phase of data collection (after the interviews), each parent received another email that consisted of a doodle.com link to set up the date of the focus group. Due to the lack of time and geographic location as well as the lack of the quantity of VR equipment, the researcher had to divide the participants randomly into two groups, three participants in each group. All parents agreed to have the focus group interviews at the Family Weekend event that was held between the 20th and 22nd of September 2019. The focus groups were held at two different locations at the university, the Graduate building and the Mullins Library. The first focus group was held at the Graduate building and it lasted for 50 minutes. The second focus group was held in a conference room at Mullins Library and it lasted for 55 minutes. The focus groups data were recorded using two Sony digital audio recorders, a Logitech digital camera, and a laptop. All data from the focus groups were transcribed using the manual technique.

During the second stage, the researcher used observation and field notes in the data collection process. This data collection method helped the researcher observe the participants' experiences and behaviors when interacting with the VR technology. The observations also

allowed the researcher to explore and capture topics or attitudes of the participants toward the SVVR model. During the try-out, the researcher used a digital camera and audio recorder. Both focus groups were video recorded and transcribed manually. Also, field notes were taken by the researcher while observing the participants. The researcher used handwriting notes that will reflect the participant's engagement with the SVVR. Specifically, the researcher focused on the participant's interaction with and within the SVVR and their responses that could be used for analysis.

It is worth mentioning that all participants signed the consent form (Appendix C) and agreed to participate in both interviews that were recorded and stored in a locked hard drive.

Data Analysis

The first step in analyzing the data was to upload all data to an online platform (dedoose.com) that can be used for qualitative data analysis. The researcher created a project in Dedoose called Final Project that contained all data from the interviews and focus groups. Then, the researcher started the analysis process by going through each line and assigning codes using In Vivo and descriptive coding (first cycle coding). In-Vivo coding is to write the exact word or phrase from the participants interview, which reflect the voice of the participants and describe their perspectives authentically. Saldana (2015) stated, "In Vivo Codes use the direct language of participants as codes rather than researcher-generated words and phrases." (p. 149). Descriptive coding refers to assigning codes by describing and summarizing the data to a word or phrase (Saldana, 2015). After that, the researcher grouped the codes that have similar meaning using pattern coding and put them in one category (second cycle coding), which generalized as themes to answer the research questions. Pattern Coding method is, "grouping those summaries into a smaller number of sets, themes, or constructs" (Miles & Huberman, 1994, p. 69). Themes and

sub-themes were described in Table 2. (see Table 2). Themes and sub-themes were organized based on the three stages of the innovation-decision process that presented in Rogers' theory: knowledge, persuasion, and decision (Figure 1).

Table 2: Themes and sub-themes description.

Themes and subthemes	Description
Awareness of VR learning applications	Parents' lack of knowledge about educational purposes of VR and its applications
Availability	Parent's perceptions about the lack of availability of VR technology their individuals with ASD
SVVR transportation model: Disadvantages	Negative factors that may lead to rejection the VR
Expense	Parents' concerns about the cost of the VR system.
Sensory issues	Parents' concerns about students with sensory issues at educational setting that may affect the learning process
Issues related to the SVVR model	Issues related to the SVVR transportation model that may negatively affect the adoption.
The amount of VR exposure	Parents' concerns about different symptoms of cybersickness of using the VR
Discomfort	Participant felt discomfort and took off the HMD for few seconds.
SVVR transportation model: Advantages	Positive factors that may lead to adopt the VR
Immersion	Participants' perceptions about virtual surroundings the SVVR transportation model that resulted in the feeling of presence.
Realism	Participants' perceptions about the SVVR transportation model as it reflects the real-world environment and the feeling of actually walking on campus.

Table 2 (Cont.)

Themes and subthemes	Description
Ease-of-use	Participants' perceptions about SVVR model being used by them.
Videogame	Participants' perceptions about ease-of-use the SVVR model by their individuals because it has a videogame feature.
Enjoyment	Participant perception about the SVVR model in which to bring joy and fun to their individuals with ASD
Motivation	Participant perception about the SVVR model in which to motivate their individuals with ASD to engage in outdoor activities.
Understanding the VR technology	Initiate and increase the awareness of VR among parents of individuals with ASD.
VR exposure at schools	Participants see schools as the main source for their individuals with ASD to be exposed to the Technology.
Home setting	Participants' perceptions about using the VR technology at home settings
Improving the SVVR model	Participants' suggestion in regard to the 360-video, lack of visual information, and other suggestion include adding a reverse scenario, and information about how to download the app.
Preparing teachers	Parents' conference about teachers in regard to buy-in and implementing a new technology
Training	Participants' perceptions about training teachers when using new technology at schools.
Buy-in	Participant perception about the important of believing the new technology when using new technology by teachers.
Potential skills	Future skills needed by parents of individuals with ASD that could be addressed through VR technology.

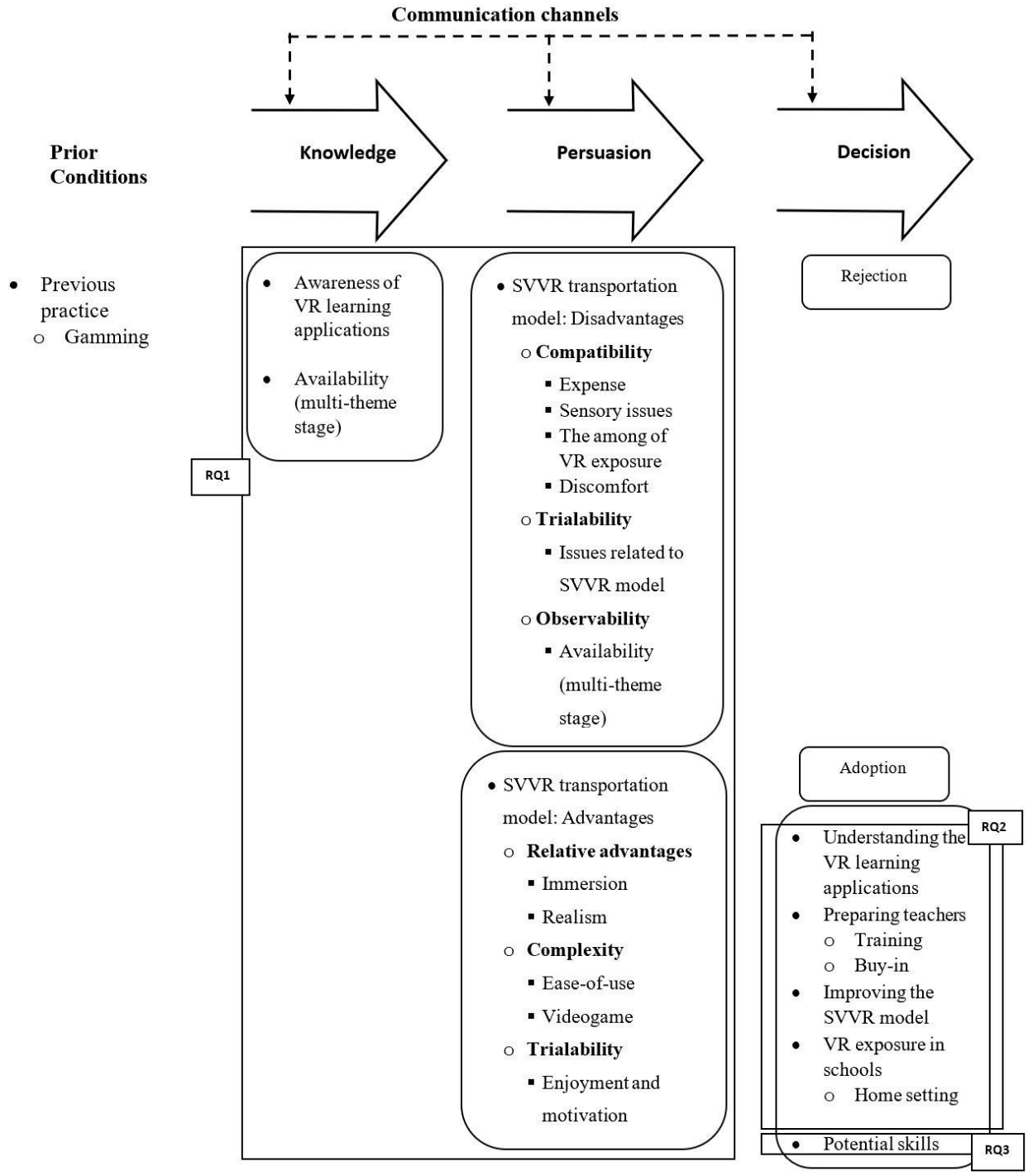

Figure 1. Themes Cross-Referenced to Stages of the Innovation-Decision Process.

Evidence of Trustworthiness

Creswell (2014), indicated that qualitative validity is when the researcher "checks for the accuracy of the findings by employing certain procedures" (p. 201). In this study, the researcher established trustworthiness by using different strategies. This will ensure validity of the outcomes.

Credibility

The researcher ensured credibility and quality of the research via triangulation. The researcher collected data from interviews, focus groups, observations and field notes. This will ensure validity of all the interview data. In addition, a doctoral student reviewed the data interpretation and the final outcomes of the study. This evaluation will ensure the accuracy and validity of the study outcomes.

Transferability

The purposeful sampling of this study resulted in a small size sample that will limit the generalization. Therefore, the researcher provided rich, thick, and more information about the setting, participants, and their adults with ASD; enabling future researchers to feel the experiences that may apply in similar research scenarios. The researcher described in detail the setting of all interviews. Also, detailed description of all participants and their individuals was presented in Table 1 and the Biographic section.

Dependability

The researcher gathered more in-depth data through interviews, focus groups, observations and field notes to ensure dependability. This will help future researchers to have more information about the participants use with technology that can be used as therapy for individuals with ASD. Also, member checks were conducted as all participants reviewed the

outcomes before publishing. In addition, peer debriefing was conducted with a doctoral student who l reviewed the study report and checked the accuracy of the findings (Creswell, 2014). Expert audit review will be used by local research support to ensure accuracy and validity.

Confirmability

To ensure confirmability, the researcher described and clarified the step by step process of analyzing the data. In addition, a local expert audit was used to confirm the outcomes of the study. The expert audit examined the analysis of the collected data and to confirm the researcher work, in which to be free of researcher bias.

Results

Interviews

In this stage, the researcher individually asked each participant several questions that aimed to understand their thoughts as being a parent of an individual with ASD (Appendix A). This helps the researcher to understand each participant's condition and how do they adapt to their individual's needs. Also, the researcher aimed to elicit information about resources that parents were aware of when their individuals first diagnosed. This helped the researcher to identify resources that parents were experienced as a therapy for their individuals. Lastly, the researcher sought to understand the participants' experience with technology as well as their individuals. This helped the researcher to understand the participants' current skills and knowledge about technology in general and advanced technology, particularly, VR.

In case of Amanda and Alan.

Amanda describes her feelings as a parent of an adult with ASD as it is "… hard. It's scary" explaining "… because she's very pretty, and we are always worried that she's going to be assaulted or be easily manipulated or taken advantage of in some way because she is

immature for her age and very gullible and naïve. So, I would say that is our number one fear for her." Amanda continued: "she hasn't been an adult for very long but getting her through childhood certainly had plenty of bumps along the way." Amanda believes that "… in some respects it's made her more resilient and she's been able to persevere more than she realizes, because she's never had it easy. Never!"

Amanda uses technology in her everyday job. She believes it could help her performance in her class with her students. Stephanie used an iPad that was supported by her school, but it was not easy for her "They supplied all the students with an iPad, and so you'd turn your homework in. She struggled with them, quite honestly. In addition to her autism, she had some learning disabilities, but, you know, she can use them."

Amanda believes assistive technology "can mean anything from the virtual reality to an FM device for somebody with auditory impairment." In her school, assistive technology was used to help students with difficulties in speech or math. As she mentioned," We use all kinds of assistive technology on iPads for some of our students [with learning disability] that may need some additional type of accommodation like text-to-speech or a calculator."

Amanda also believes assistive technology is "fantastic. It's leveling the playing field. It's helping those kids who have some kind of disability or deficit, get them up to where their peers are and being able to function or be academically successful."

Amada has a little exposure of the VR "I've only done like where you put the goggles on and like you're on a rollercoaster kind of thing."

Alan described his feeling as a parent of an adult with ASD, as "Painful!". He began by stating that "all the way through, I always want to see her do things that make her happy, and sometimes you project your own, like when I was a kid. But children are always a little bit

different than their parents, and with children with autism, it's even more different." He stated that "As Stephani got older, she is not as socially adapt as others. One of the challenges is watching her slowly get excluded from that." Alan believes that it is "always tough because that happened to everybody. So, there's always, probably, if you're like me have a lot of friends. You did a lot of great things. But there were times where you were left out. That was always painful. When you see that happen to your kids, it's ten times as painful." He added "So, trying to find things for her to be included in, things that she was good at is challenging. And so, when she struggles at stuff" he concluded "when you struggle as a person, it always is frustrating, but it's ten times more painful when it's your child."

Alan has a little exposure to the VR, as he described "it was like in a demo at a trade show, so very little. I'm somewhat familiar with it.". He continued to say it, "was more of a gaming thing at a trade show, and it was literally just walking on a ledge. It was fascinating". VR was also a part of Alan's work, but he did not directly involve with "My business is sports marketing, and so those tools are starting to get into athletic training like literally put on a headset, teach a quarterback. I didn't participate with that. I've seen it on a much more basic level."

In case of Lara and Ben.

Lara was very upset and concerned when she found out that her son was diagnosed with autism spectrum disorder. "I remember when all that was going on in kindergarten, thinking, 'Oh my gosh, oh my gosh!' So yeah, very upset, very concerned." She continued by saying "but the school system we were in was a great school system." Lara explained that the place they live in has its own independent school district "so, great schools, great support, great Special Ed programs, all kinds of services". She added that the school is "very inclusive though". She

explained that “because Bryson, even all the way through school, any kind of elective that he took, he was with regular kids, so he was never in Special Ed all the time. It was just only parts of the day, really just for academic, the major academic classes.”

Lara mentioned that Bryson has “never been a difficult child at all. He never was as a baby or anything like that.” Lara and her husband think that Bryson had a speech delay only, and “then once he started talking, that was when things kind of got better.” She added, “But, he does have a learning disability” and she thinks “some of that has to do with Bryson having attention deficit disorder. Lara believes that “the learning is probably why he had to be in Special Ed classes in school and stuff.”. Bryson love to run and he “was a cross country runner from seventh grade through senior year of high school”. She added, “But, I think it’s just having one child, I tend to kind of helicopter a little bit. Obviously, whether he probably was on the spectrum or not, I’d probably be that way, because he’s it. So, just, I guess it’s always just anticipating what might happen, what might go wrong, and thinking how can we make sure that he’s set up for success.” She concluded “I feel like I’m always thinking that. But, like I said, he’s a pretty easy kid. He’s an easy kid when he’s at home and just likes to hang out.”

Technology is a part in Lara’s everyday life. She uses her iPhone and laptop for her part time job. Bryson used an iPad for his school. He started using the iPad in middle school all through high school.

Lara and her son Bryson have tried VR. She recalled the use of VR was for gaming proposes “I remember we got this for Bryson, but it was one of those virtual reality headsets and you downloaded an app on your phone, and then it had a place for your phone to stick in there, and then you could, whatever you downloaded, whether it was a concert or dinosaurs or something. So, he had a little bit exposure to it and I’ve had a little bit of exposure to it.” When asked what it

is like to be a parent of an individuals who diagnosed with ASD, Ben believes it was “difficult” because of the nature of his job that allowed him to not involved in his son’s life as he wishes “I travel in my job, so I haven’t been at home as much as I probably would like to be. So, a lot of the responsibilities to finding the resource, different at job support groups has been through my wife. But then I was there for the weekends and some of the sporting events”.

Technology has also been involved in Ben’s life. He mostly uses iPad, iPhone, and laptop for his everyday work for video and call conferencing.

Ben believes assistive technology is “being another vehicle for expressing content or providing feedback to other content.” Ben and Lara mentioned that assistive technology was not involved in Bryson’s life.

In case of Tyler.

Tyler described what it is like to be a parent of an adult with autism as “shocking!” He explained, “We knew that something was a little different. It wasn’t until he was in fourth grade, the school did an official battery of tests, and a diagnostician diagnosed him. So, that parts shocking when you kind of get that diagnosis” He added “we didn’t know that much about it. So, of course, we worked on gathering information, trying to figure out what’s the best treatment.”

One of the things that Tyler and his wife are struggling with, as a parent of an adult with autism, is balancing the adaptation of Dan with his situation. He started with saying “Dan, he has a very strong will, and he doesn’t always want to listen to what his mom and I recommend or suggest or flat-out tell him to do. So, that’s kind of the hardest part.” Then he continued by saying,

> “we’ve become aware that he sees the world as very black and white. And the gray things are the things that depend on the situation and what he struggles with. So, that’s been

hard for us to learn to kind of get him to adapt and then us adapt to his way of seeing things."

Tyler concluded that "at the end of the day, we always say, "We want to figure out how to make his world or his life happy." Whatever that is, whatever that looks like for him. And we're not there. It's a journey."

Tyler mentioned that his son "can work a computer, he can teach me how to work a computer." Tyler also mentioned his son used technology through school "where he was allowed to type instead of write. His handwriting or fine motor skills are not very good. So, he has accommodations, and he's always had a laptop to be able to type, to take notes".

Tyler believes assistive technology is "stuff that's going to help people with whatever their challenges are." But assistive technology was not used with his son Dan "as far as specifically addressing his autism, no."

In case of Carla.

Carla has a different perspective about her feelings as being a parent of an individual with autism because she is not the biological parent. She said, "It can be stressful," and she explained by saying "my journey is a little bit different because I'm not Howard's biological parent." Carla added "the situation is a little different because I oftentimes am trying to balance my role in Howard's life being the primary caregiver, but at the same time too, ensuring that both his mom and dad feel somewhat a part of the process, and that hasn't always been easy. So for me, I'm kind of in the space now where I'm like my main focus has to be Howard, and I can't necessarily worry about the other factors."

Another reason Carla is stressed is “the transition from high school to college is already a huge transition for anyone.” She added with “the complexity of someone that has a special need or a disability, it makes it a little bit more complex.”

Carla continued sharing her feelings “I’m so happy that Howard is able to move in early into the dorm” But she has some concerns. She asked, “What do you do because you don’t have a schedule, or the schedule hasn’t kicked in yet?” The concern is, “what if you get him to adapt to the alter/current schedule,” She provided the cafeteria as an example, “even for the cafeteria this week, it’s having to go back and retrain next week so that way he knows what to expect for the next couple of months.”

As for Howard being in college, Carla exclaimed that “It’s exciting!” She never thought that college could be part of Howard’s life, and she believes that other parents have the same thought. “I think I can probably echo maybe some of the other parents, not knowing that college was an option for him, especially when I think about where he was at the age of five and kind of where he was on the journey and on the spectrum from an autism perspective.” Carla stated, “So it’s exciting to actually have this option be available to him.”

Carla believes that being very close to campus would make her less stressed, “I probably would be a little bit more nervous if I wasn’t local. She explained the “fact that I can literally be down on campus in a matter of 10 to 15 minutes should I need to be, puts me extremely at ease” She offered an example “I texted Howard today. I was like, ‘Hey, I got a meeting down at the U of A. Do you want me to stop by and see you?’ He’s like, ‘No. Come on Friday.’ Like, Cool!”

To conclude her feelings about being a guardian of an individual with autism, Carla stated “it is as much stress or adversity that we’ve probably overcome in our journey. It is, by far, the most rewarding experience I’ve ever had, and I’d do it again in a heartbeat.”

Carla and Howard were heavily involved in technology in their everyday lives “we actually are pretty tech savvy. Of course, smart TVs, alarm system at home. Howard knows how to operate all of that. I’ve had computers for the most part. He has a cell phone”. Howard uses his phone to help his search on things that interest him “He can Google stuff. He can research stuff with the best of them that I would take, that is stuff that he’s going to be interested in, yeah. Not just random stuff.”

Carla and Howard have used VR for gaming “we’ve done virtual reality before from a gaming perspective. So, Howard’s accustomed to that from a gaming perspective, we do a lot of arcades, and they have a lot of virtual reality-type games. Carla also has tried VR from training proposes at her work “we actually had some virtual reality training where it was the associates could come up and actually select one of the four modules that we had, and it walked them through the training that way.” She continued, “They put a VDR headset on, and then it was outdoor tent, it was a way for them to actually kind of experience training customized for this particular audience.” Carla thinks about VR that “It’s great. I think it’s fantastic, and I think if it’s a way to help, especially with students that are on the spectrum. If it’s a way to help them learn better, then I’m all for it.”

Summary of the interviews

Participants indicated that being parent of individual with ASD is painful, difficult, and scary. In addition, participants implied that schools and therapists are the main resources of therapy for their individuals. Moreover, all parents indicated the use of technology in everyday bases. The findings also showed that five of six participants have experienced VR before conducting the study. The purpose of using the VR of the five participants was for gaming.

Focus group

In this phase, the researcher asked several questions that aimed to answer the research questions (Appendix B).

Research Question 1

What factors impact the adoption of the SVVR mobile application by the parents of students in the EMPOWER program?

Several themes emerged in the answers to the first research question. The themes were organized to align with three of Rogers' Stages of the Innovation-Decision Process: knowledge, persuasion, and decision.

The Knowledge Stage. Knowledge was considered not only as knowledge of VR technology in general, but also awareness of the learning applications. Two themes were identified in this stage: awareness of VR learning applications and availability.

Awareness of VR learning applications. Lack of awareness was a factor among all parents of individuals with ASD. Participants expressed a lack of knowledge of VR applications that can be used for learning purposes. For example, Amanda expressed her lack of knowledge about VR applications. When asked about SVVR mobile applications, she answered:

> I don't know of any apps that we could download on our own, that we could have done on our own, outside of therapy. Maybe there's software now that's out there that's available to families, but we've not been aware of that, especially when Stephanie was younger.

This sentiment was echoed by Lara, who pointed out that she did not know of any applications that can be used for educational purposes. She said:

> I don't know that there are specific apps that would help provide the education and awareness.

Ben also expressed his lack of knowledge about the applications as a resource for individuals with ASD:

> I don't know that I have considered it a resource as it pertains to providing education and awareness because I haven't heard of apps, or applications like the one you're developing, that we could leverage for our individual personal use.

Carla also agreed, stating:

> I don't know that there are specific apps that would help provide the education and awareness.

Tyler explained that the lack of knowledge about the VR technology that could be used as a learning tool reflects the poor understanding of the VR applications that could actually deliver the educational content. He said,

> From my perspective, it's the application that actually delivers the content, and if that is not developed, I don't know how they would actually even consider it, from a learning perspective.

Similarly, Ben mentioned:

> I mean, probably just not having the resources [applications]. I mean, I just haven't really looked into it.

Participants in this study expressed a lack of knowledge about VR apps that could deliver education. This could be due to the limited number of research studies that have used VR in educational settings, specifically with students with ASD. In fact, it has been reported that VR has been used in many different ways other than education. Molnar (2019) reported that VR was involved heavily in gaming (54%) and health and medical devices (43%), leaving the education field in the third place (36%). Military use of VR stood at 28%.

***Availability*.** The absence of VR technology in schools was a factor mentioned by some participants. Parents indicated that VR was never offered to them or their child as an option. Particularly, four participants indicated that VR technology was not offered as an option at either their child's school or by their therapist. For instance, Amanda stated:

> This has never been offered to us as an option. It was never offered at the school district.

This was echoed by Alan:

> This is not something that was ever offered in either route for us.

His statement indicated that his daughter had never been offered the VR technology at school nor at physical and occupational therapy.

Tyler said:

> That was not something that was ever even mentioned as an option.

Lara agreed, saying:

> Yeah, I don't think it was in the curriculum. In our ISD they never presented it as an option.

Interestingly, Amanda indicated that the adoption of VR technology by schools could be controlled by state requirements. She believes that if the state requires VR technology as a learning tool for students diagnosed with ASD, schools will then try to adopt it. She also suggested applying VR at an early age. As she said:

> In our state, part of their IEP, their Individual Education Plan, there's an autism supplement that's part of what the state requires, like a checklist of things that are being addressed regarding an autism diagnosis. And so if this fell under social skills or part of their IEP, then to his point, if schools could get a grant or something so that they could buy the equipment and use it for social skills classes, that would be something that would be super effective, starting with the little kids. They started PPCD [Preschool Programs for Children with Disabilities]at three. When they're – that's the earliest age that they can be in the public-school district. The absence of VR technology in schools could be due to the cost, time, and train

teachers (Gleason, 2017). Schools' directors cited the lack of time when acquiring a new technology due to fact of trying and testing the technology and training teachers (Gleason, 2017).

Persuasion stage. For the persuasion stage, Rogers (2003) has identified five characteristics of an innovation that help participants form a negative or positive attitude towards

the SVVR mobile applications: relative advantage, compatibility, complexity, trialability, and observability.

Two themes were identified under the Persuasion stage: SVVR transportation model: disadvantages and SVVR transportation model: Advantages

SVVR transportation model: disadvantages identified factors that are negatively impacted the decision of the VR adoption included the elements of compatibility, trialability, and observability. Factors that appeared to prohibit (*rejection*) parents from the adopting VR included expense, sensory issues, the amount of VR exposure, discomfort, issues related to the SVVR model, and availability.

Compatibility. Rogers (2003) identified compatibility as "the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.". Two themes were attributes to the element of compatibility: expense, sensory issues, the amount of VR exposure, and discomfort.

*Expense***.** All participants perceived the cost of VR as a factor that might prevented them from acquiring VR technology. "Cost" includes the cost of the VR system (hardware and software). For instance, Alan believes that cost may be a barrier to the adoption of VR. He indicated that software and hardware could be expensive: "Well, it could be cost. As I understand it, you would need to buy the software. It'd have to be a machine; I assume the Dells in front of us are tied to the app?"

This was echoed by another participant, Amanda, who agreed that cost is an important factor. She believes it would make sense for her to use VR if the cost is low and being used in schools.

> I guess it's like any other technology. If it becomes less cost-prohibitive and it's something that schools and staff can start using, that they can afford the equipment for it, then it would make sense to use it.

Another reason that Amanda thinks cost is an obstacle to VR use is the production equipment. As she mentioned, "If you have a camera that's not going to jiggle, it's more expensive for you to produce it."

Cost was also mentioned by Tyler, who believes that VR technology is overpriced for him:

> How much is this going to cost me? We bought these simple $100-$200 goggles that we could use with our smartphone, but if you've got to buy thousands of dollars of stuff, then it's going to be a barrier to entry.

Lara seemed to agree on the overpricing aspect of VR:

> "Yeah, I don't know how much it cost, but advanced technology could cost more."

Carla indicated that that the cost of VR may vary based on its purpose and capabilities:

> It would depend. I mean, there are tiers to the VR. So, there's some that are inexpensive that a lot of kids have gotten for gaming purposes. If you need a specialty one to deliver the application because traditional VRs don't come with a remote and things of that nature, based on that put your phone in there and it's a game, and you could be on a rollercoaster. So, it just depends on how high-tech the actual VR capability needs to be able to deliver the application.

Ben agreed and further explained by stating:

> Yeah, I think I think when it comes to people factoring the cost in, depending on what type of capability the VR has to have to deliver, the actual app on the phone will determine that. I mean, they do a lot [VR] on Friday, that are like 25 bucks, so fairly inexpensive, but if the capability of that one isn't high enough to be able to really, truly deliver what you're trying to get with the app, then that's when maybe you could actually say that could be an impeding factor from a cost perspective.

Ultimately, all participants agreed that cost is one of the most important factors preventing them from using VR technology devices and applications.

Sensory issues. Two participants parents indicated that students with sensory issues could a barrier to the adoption of VR technology in school settings. Specifically, Amanda believes that students with sensory issues could be a crucial factor in the learning process. She stated:

> With getting disoriented, like if you have kids that are not used to it and they have some sensory issues, you might have to do a lot of starting and stopping … So if you were doing the lessons with the goggles and then you stop and you have some discussion, and you take the goggles off and let them kind of get reoriented and see what sensory issues you might have within that group of kids.

Alan agreed, and addressed how students with sensory issues could be a critical factor when using VR in classes:

> Once you hit a certain button or threshold on some with sensory issues, then you're done. You're not going, "Okay, let's start over." If I was someone with severe sensory issues, at a certain age, I'd be like "I don't ever want to see those things again."

He explained saying,

> Some people don't want things on their head, don't want things in their ears. There are some people that just can't use it, so you can't make it perfect. The themes attributed to the element of *capability* were "expense" and "sensory issues".

The gathered data indicated that the cost of VR technology (including software and hardware) is a barrier to adoption. The participants' responses were consistent with the study by Curran (2017) who reported that parents of individuals with ASD perceive the cost of technological intervention as an obstacle to its adoption. The gathered data also indicated the participants' concerns about the capability of VR to help students with sensory issues. Research cited different symptoms of cybersickness among ASD user of VR technology (Schmidet et al., 2019).

The amount of VR exposure. Five participants expressed their concern about the VR dosage. Particularly the among of time that may cause different symptoms. Some parents

considered these symptoms as an obstacle to using VR on individuals with sensory issues. After the try-out, Ben said:

> At first, I was a little dizzy. After a while, my eyes adjusted. It's pretty engaging. Now, how long could I watch that with the shaking? I don't know. That might bother me after some amount of time.

Lara agreed:

> I know, me too. You just have to get used to it… If I were doing that for a long time, I'd probably start to feel a little nauseous, just watching it."

Tyler also agreed that the amount of VR exposure could be a barrier:

> If you say you've got to watch two hours of videos. Then, that's a time crunch, it's got to be reasonable… I wonder with some of the kids that have sensitivity, if that's going to bother them or distract them.

Alan felt disoriented after 10 minutes of the VR exposure and expressed his concern about VR dosage among individuals with sensory issues:

> I was a little disoriented after five or ten minutes. I could see somebody, especially with special needs, they might have sensory issues and get a little overloaded. They could feel more disoriented than I was.

Amanda agreed:

> Yeah. I could see some folks who have sensory issues, whether they're on the spectrum or not, shutting down because it was too much.

Discomfort. Physical discomfort was observed, as one parent had to take off the Google Daydream for thirteen seconds after she felt hot while interacting with the SVVR model.

It was noted that participants experienced of different symptoms of cybersickness during and after the try-out. This consistent with a study by Laviola (2000) that cited symptoms of cybersickness along participants exposed to a virtual environment. The symptoms arising from technology use could negatively impact both individuals with ASD and their families (MacMullin et al., 2016).

Trialability. Some findings that were attributed to the element of trialability addressed the participants' experienced SVVR model.

Issues related to the SVVR model. Some factors related to the SVVR transportation model – including the 360-video and lack of visual information – may negatively influence VR adoption.

360-video. For instance, the stability and sound of the 360-video seemed to be an issue for three participants. Tyler and Alan indicated that the 360-video was not stable; they felt it was shaky. Tyler said, "I realize this is a part of the video, but there's quite a bit of shaking." Another factor related to the 360-video was the sound. Carla had a concern about the sound of the 360-video that may be an issue for individuals in the "hard of hearing" spectrum.

Lack of visual information. Many participants indicated that the absence of visual information may be critical for individuals with ASD – particularly, information about how long it would take for the bus to arrive at the bus stop, as well as information about the bus number. For example, Tyler said,

> Doesn't exactly tell you how long it's going to be before it gets there…If they don't know how long they're going to be there, I can see some kids that may get uncomfortable if it's been five or 10 minutes or 15 and the bus hasn't shown up, right?

Tyler shared his son's experience at the bus stop:

> He didn't like it. He had to wait a long time, and, yeah, and some of these kids aren't going to like being crowded.

Tyler also had a concern about the bus number:

> Something confusing is you see the number on the bus, but then there's also a number being flashed up on the moving, kind of, information screen on the bus.

His statement indicated that more time is needed to identify the bus number, and that there is confusion between the bus and route number.

Alan was also confused about the visual appearance of the bus number and needed more time to see the bus information. He said:

> You say you're looking for Bus 3, but I couldn't. We looked at the screen just for a second, so I didn't know. And then there's a route number on the bus and then a number on the bus.

Amanda agreed that more time is needed to present not only the bus information, but also the map that shows where the bus stop is. She said:

> I didn't really see the map. It kind of popped up, which is nice. I was trying to figure it out, and then we left, we walked, and then you had said, "Wonderful looking for Bus 3," but I never saw it on the screen.

Lara also had difficulties on locating the bus number:

> I didn't see the bus number on the bus. All I saw was Route 48, and that's what I was looking for.

The participating parents indicated areas for improvement in some aspects of the SVVR transportation model, in regard to the 360-video and lack of visual information.

Observability. Findings attributed to the element of observability addressed the degree to which the SVVR model was visible to others (Rogers, 2003). The theme of *availability* (i.e., the multi-theme stage, which appeared in the "Knowledge stage" was treated as the absence of VR technology at schools that resulted in the participants' individuals with ASD not seeing and experiencing VR technology. The absence of VR technology at schools was reported due to cost, time, and train teachers (Gleason, 2017).

SVVR transportation model: advantages identified factors that are positively impacted the decision of the VR adoption included the elements of relative advantage, complexity, and trialability. Factors that appeared to increase the rate of adoption of VR included immersion, realism, ease-of-use, videogame, enjoyment and motivation.

Other themes were identified that positively impacted the adoption decision. These included relative advantage, complexity, and trialability. Factors that seemed to not prohibit parents from adopting VR included immersion, realism, ease-of-use, enjoyment, and motivation.

Relative advantage. Two themes address unique features of the SVVR model that may affect the decision to adopt VR technology:

Immersion. Two parents expressed their feelings about the immersive nature of the SVVR transportation model. Alan believes the 360 environment is immersive and helps him to navigate:

> It's certainly under the definition of immersive. You're in the exact environment that you live in in Maple, which Stephanie does, and you're trying to get a feel for where things are and how to walk around. That's as realistic as it gets, because it's real.

This was echoed by Amanda, who also believes the 360 environment is immersive because of the embedded sound that reflects the real world.

> It's cool. The sound is really good. Like it sounds like the street noises and stuff, was really good.

Realism. Two participants indicated the realism of the SVVR environment. Tyler felt the 360 environment is real, and different than what he had seen before:

> It's way cooler than a lot of other things I've seen. Definitely a real application, a real-world kind of thing.

Carla believed she was actually walking on campus while trying the VR. She also believes 360 environments could be a new way to connect with individuals with ASD. She stated:

> I felt like I was actually walking on campus. I think it's a creative way to connect with them.

She also provided an example to address how the SVVR could simulate real-world scenarios that could be taught by parents. Carla stated:

> When I think about my teaching methods with him just as a parent, a lot of the stuff that you're doing in the videos, what I would do anyway, when I think about just even getting him acclimated to the campus, it was, "Who's actually going to walk him to his classes?" They did that the first week. Now he pretty much knows where he needs to go. So, I think it's perfect for that particular aspect of it.

The immersion and realism of the virtual environment were cited as unique features of SVVR transportation model which simulate real-world situations. Research has reported the authenticity of experiencing a virtual environment, as it simulates and mirrors real-world situations (Parsons, 2016).

Complexity. This element addresses the difficulty of using the SVVR transportation model (Rogers, 2003). Participants' parents liked the ease-of-use of the SVVR transportation model and believed that their individuals with ASD would, too. Moreover, observational data indicated that all participants parents had no difficulties in wearing the HMD.

Ease-of-use. All parents believed that the SVVR transportation model was easy to use. For example, Tyler believed that the SVVR mobile application delivered through the Google Daydream was very easy:

> It's super easy… and obviously the joystick seems pretty easy.

Amanda also agreed:

> Oh yeah, it's definitely easy to use.

Ben believed the SVVR model was extremely easy to use and consider it to be at a basic level:

> It almost seemed too basic. I would call it "entry level" virtual reality.

Lara said:

> I don't think it was difficult.

Participating parents further believed that the SVVR transportation model would be easy to be use by their individuals with ASD, as they would perceive it as a video game.

Video game. Participating parents agreed that the "video gaming" aspect of the SVVR model was game-changing factor. They believed the SVVR model would be easy to use for their individuals with ASD. For example, Carla said:

> Howard learns through repetition. He watches a lot of TV. For him, this would almost be like playing in a game and actually connecting with him differently, versus actually feeling like he has to sit down and hear a lecture.

Her statement indicated that the SVVR model would not only be easy for Howard to use because it's like a video game, but that it would provide be a new way to teach him.

Tyler said:

> I think he would watch the first couple of videos, and go, "I know all this already."

His statement indicates that his son Dan could easily learn by watching the SVVR model.

Alan also believed the SVVR mobile application was not only easy for his daughter to use, but fun:

> We think Stephanie would be able to use it and enjoy it because she likes gaming. I assume if this was a game, you'd just open the app, hit Run, put the equipment and go.

Amanda agreed:

> Yeah, it's like a videogame, essentially.

The participants' responses are consistent with the study by Schmidt et al. (2019) that reported the ease of use of an SVVR model (Google Cardboard and Google Daydream) that was designed to help improve the adaptive skills of adults with ASD. Research also indicated the effectiveness of the potential use of gaming VR with individuals with ASD to support skills development (Kandalaft et al., 2013; Ke & Moon, 2018; Noor et al., 2012).

Trialability. Findings attributed to the element of trialability were found to address participants' experience of the SVVR transportation model. Parents saw the SVVR model as a video game which could bring fun and motivation to individuals on the autism spectrum.

Enjoyment and motivation. Two participants indicated that the SVVR could motivate individuals with ASD, as it brings fun and motivation to outdoor scenarios.

Tyler believes the SVVR could motivate individuals with ASD who don't like to go outside:

> Motivate them into being willing to get out in the world and do some things. Because they understand what they're going to see and feel. For that individual who's scared to get outside or unsure.

Lara believes the 360 environment brings fun to learning:

> I think it's a fun way for Bryson to learn because they probably all would love this virtual reality.

A few participants reported that the SVVR mobile application could provide fun and motivation to their adults with ASD. This supports prior research on using VR technology to improve skills of individuals with ASD (Kandalaft, 2013; Smith et al., 2014; Yu-Ju et al. 2018).

Summary for Research Question 1

Seven factors seemed to negatively affect the adoption of VR: awareness of VR learning applications, availability, expense, sensory issues, issues related to the SVVR model, the amount of VR exposure, and discomfort. First, the participants described their lack of knowledge of VR applications that can be used for educational and independent functioning purposes. Second, some participants indicated that VR technology was not mentioned as an option for their individuals with ASD for learning purposes. The theme of availability was considered to be a multi-theme stage, as it appeared in both the knowledge and persuasion stages. Third, all participants indicated that cost was a barrier to introducing VR technology into their students'

lives. Also, several participants described how different levels of VR capability can be reflected in its cost. Fourth, a few participants expressed their concerns about using VR technology with students with sensory issues that may hinder their learning process. Fifth, there were issues relating to the SVVR model, including the 360-video and a lack of certain visual information. Sixth, some participants experienced symptoms of cybersickness (including dizziness and disorientation) after being exposed to VR. Seventh, it was observed that one participant took off Google Daydream for thirteen seconds when she felt hot while interacting with the SVVR model.

Decision stage. The decision stage consisted of themes that may affect the decision-making process regarding the adoption of the SVVR mobile application. Factors identified that negatively impacted the decision (rejection) were awareness of VR learning applications, availability, expense, sensory issues, issues related to the SVVR model, the amount of VR exposure, and discomfort. While factors identified that positively impacted the decision (adoption) were immersion, realism, ease-of-use, videogame, enjoyment, and motivation.

Research Question 2

How might changes to the EMPOWER program increase adoption of the SVVR mobile application among parents of individuals with ASD?

The data analyzed for the second research questions were gathered from the focus group questions. Findings of the second research questions were also attributed to the Decision stage. Four themes were emerged to answer the second research question. Themes were identified that positively impact the decision to adopt VR were understanding of VR technology, VR exposure in school-home, improving the SVVR model, and preparing teachers. The following section will present the unpacked details of each theme.

Understanding of VR technology: Participants indicated the importance of understanding VR technology, including the purpose of VR as a learning tool, how it works, the potential of VR learning applications and what has been done, time and effort, and experiencing the VR. Some sources were suggested for parents of individuals with ASD to help them learn more about the technology. Ben suggested that informing parents about the potential of VR as a learning tool may increase the VR adoption rate. When asked what should be done to help increase the adoption of the SVVR mobile application among other parents, he replied:

> Just raise the awareness. I mean, just like, "Here's a potential learning application that your son or daughter could participate in, and you as parents will need to be involved as well." I mean, like anything, just raise the awareness and people will increase the adoption if it hits their messaging.

Likewise, Carla suggested that parents of individuals with ASD should be aware of VR applications specifically designed for educational purposes. She first asked,

> Are there other applications out there that we should be aware of? I think because people aren't aware of the actual application, it's hard to think, "Oh, I can leverage VR to actually have a different form of providing education and awareness."

She further explained,

> So if people aren't aware that there are applications out there, then your mind doesn't go to think through this, as far as being able to provide the service, whether it's with the school, whether it's at home, whether it's through EMPOWER, or any other entity.

This was echoed by Alan, who also emphasized the importance of finding other training applications designed to be applied not only in Arkansas, but also anywhere. Alan stated, "Well, just awareness. I didn't know it was being used from a training perspective. If this is something that is widespread, obviously this is specific to Arkansas, but if there's an overall tool." Amanda agreed, and suggested that parents could become aware of VR technology by actually seeing and engaging with it:

> Yeah, awareness is the first. I mean, I had read some articles a few years ago that this was being researched, but I haven't seen it in a mainstream setting.

Tyler wants to be aware of the time and effort that parents must spend on VR as a learning tool:

> Yah, but also why should I spend my time? Because time is always a constraint for any parent that's got kids, especially that has challenges, because it requires more time and effort. So, tell me why it's going to help? How is it going to help me?

Tyler added:

> Here's some challenges that have been identified for kids similar to yours and how this technology might address them.

Tyler's statement indicated that parents should be also aware of the challenges that have been addressed and how to overcome these challenges when VR technology is used with children with ASD.

Lara agreed that parents should be aware of different aspects of VR technology. Specifically, she wants to be aware of the importance of the technology and how its content has been used:

> Yeah, just the emergence of the technology and the content that's there.

Interestingly, two participants voluntarily suggested some methods that could help parents of individuals with ASD become aware of VR technology. Lara suggested that stories about individuals with autism who have successfully adopted VR technology as a therapy will not only help parents to become aware of the technology, but also help them consider it as a good resource and save them time. She stated, "If there's success stories related to it, outcomes, things that would show that it'd be a good resource to invest in, time-wise."

Tyler also suggested other ways for parents to become aware of VR as a learning tool. This includes findings from support groups, therapists, internet, and videos related to VR technology. As he mentioned,

> Well, I know there's the autism speaks, and there's various support groups. So, getting into their websites or whatever activity they have going on. Therapists that specialize in counseling kids with autism, if they're aware. And then general information that's available on the Internet. Some of those, while it's not VR, you could still have a similar video, so they could show what it would be like even though it's not the VR experience.

Participating parents indicated the importance of understanding the potential of educational VR technology designed for individuals with ASD. They noted that understanding it required time, effort, and exposure to the technology. Research reported that parents of individuals with ASD sometimes felt frustrated and overwhelmed when they were exposed to a new technology intervention (Brosnan, 2016; Curran, 2017).

VR exposure in schools. Some participants provided suggestions about the *availability* of VR technology. Particularly, parents indicated that schools and therapists could offer VR technology to their individuals with ASD. Therefore, participants suggested urging the adoption of the technology in these settings. For instance, Tyler suggested schools as one place to offer VR technology as a learning tool for individuals with ASD. He stated, "Through the school would be great, but it's going to be through the special ed program at the schools." The idea of offering the VR technology in schools was mentioned by another participant, Amanda, who also suggested schools could offer VR to individuals with ASD at an early age to get them accustomed to the technology. "Yah, the easiest way to get exposure would be to work with public school special ed departments and get grants or adoption, so it starts trials for some kids in school."

Home setting. Two participants suggested using VR mobile applications at home as a continuance learning tools, but only when the cost of VR goes down or if the learner has prior of VR exposure at school. Amanda said:

> As the cost of the goggles and stuff comes down, that might be something that they would have the option to continue like some in-home training.

Alan said:

> Because yes, there are some parents that might say, "We're going to buy this and try it," without a doubt, but it probably would be more mainstream if they had a little experiment with it at school, they liked it, now we'll do something with it at home as well.

His statement indicated that trying VR in schools might not only increase the adoption of VR as a learning tool, but that it could also motivate parents to use it at home. Alan added: "Therapists that specialize in counseling kids with autism [could use it], if they're aware.

The gathered data revealed that schools are considered to be the main source of VR for the participating parents. The absence of VR technology in schools is considered to be a barrier to adoption for many participants. A few participants indicated that they would like to use VR technology at home. Research cited the effectiveness of parenting when technology intervention is used in the home setting (Brown and Woods, 2015; Dixon et al., 2015; Yikmis, 2017)

Improving the SVVR model. Suggestions were provided regarding issues with the SVVR model. Some participants suggested improvements to the SVVR transportation model relating to the 360-video and lack of visual information.

Alan and Amanda recommended incorporating video stabilization to prevent shaking. Carla suggested adding captions, as the sound of the 360-video may be a distraction for individuals with ASD, especially those with low mobility. She said:

> Is there a way to add closed captioning? And even for Howard, he just likes to watch closed captioning on anything. So that could be something that could help.

In regard to the *lack of visual information,* Tyler suggested providing information about how long it will take individuals with ASD to arrive at the bus stop, as well as how long it will take for the bus to arrive:

> Well, the whole idea is to set the expectation. So, if they have an expectation of, "Okay, it's going to take approximately five minutes to walk to the bus, and the bus is going to be there in about 10, then you need to allow extra time or that amount of time to get there.". It gives you an idea of approximately how long you're going to be there.

Carla embraced the idea of the researcher being a play-role in the virtual environment as Howard may not able to read and acknowledge that map. She said,

> I don't know that Howard would actually go see the map. I think actually having the video of you walking to the bus stop would be helpful for him, because I don't know that he would comprehend reading a map and knowing where to go.

Some participants suggested calling out and highlighting objects of the virtual environment. Carla believes this will help users understand the real world when they recall a place they have seen in the app:

> Maybe actually call out certain things or have it kind of written on there? So Reid Hall is the actual name of the dorm that is right next door, or even as you're getting up on the bus stop, actually have it maybe in red or something that flashes and says, "This is a bus stop."

Lara added:

> Be able to call out. "That's where the numbers are". "They're up on the top".

Ben also suggested calling out the bus stop when it is seen from a distance will help individuals with ASD become familiar with it:

> If all the bus stops at the U of A are these green little awnings, maybe just say that "You're looking for a green." Because when I saw that in the distance, I thought, "Well, that's where we're going. That's a bus stop." But they would know that. Because if they're like that at every stop on campus, they can quickly recognize it.

Other suggestions for improvement to the SVVR transportation model included adding a reverse scenario in case of arriving the unwanted bus, and instructions on how to download the app.

Participants suggested incorporating video stabilization and closed captioning to the SVVR model, as their individuals with ASD are more likely to watch visual information with closed captioning. With the support of captions, individuals with intellectual disabilities are better able to learn academic content delivered through video (Evmenova, Graff, and Behrmann, 2017). Participants also suggested calling out and highlighting objects in the virtual environment when it is seen from a distance to help individuals with ASD become familiar with them. Other suggested adding a reverse scenario in which the wrong bus arrives, as well as instructions on how to download the app.

Preparing teachers. Suggestions were provided in regard to the *Sensory issues* factor. Two participants suggested that training teachers is very important when using VR technology in school settings. This will help teachers overcome obstacles that may occur when teaching students with sensory issues. In addition, interestingly, one participant noted the importance of teachers believing in the new technology before they are trained in it.

Training. Amanda mentioned the idea of training teachers at schools when adopting new technology. She stated, "Teachers had the training for it, that would be something that at least you could start as a baseline there."

Alan agreed:

> Yeah, you'd have to train the teachers. If you just put this out there, I think, you'd get 10 percent would be fantastic; most of your middle would do okay; and then there'd be some that wouldn't know how to do it. So, it would have to involve the teachers and faculty, so they knew how to use the tool to the most.

Alan's statement indicates the importance of training teachers, as well as involving faculty member in schools. This will help them fully understand the potential of VR technology to meet each individual's needs.

Buy-in. Alan raised an important point, which is belief in the VR technology. He suggested that teachers have to believe in the VR technology before they are trained:

> I would think if the teachers didn't buy into it, it wouldn't get any use. If they bought into it but didn't know how to use it, it would be a detriment. I would think the buy-in, and then training.

Amanda concluded that teachers need to be flexible when it comes to technology with individuals with special needs:

> I think it's a tricky balance, as it has to be a pretty structured lesson, but also they're going to come into a training with very specific examples of their students in mind and, "How is this going to work with this particular student?" So there also has to be some flexibility there of how that's going to work and how they're going to ease those students into using this kind of technology. So, it's that balance.

Participants' responses indicted the importance of training teachers to use the new technology, as well as getting their buy-in in order to achieve effective outcomes. It was reported that fear and intimidation are related to old teachers when using new technology at schools (Ruthven, Hennessy, & Brindley, 2004).

Summary of Research Question 2

Four themes seemed to positively impact the adoption of the VR technology: understanding of VR technology, VR exposure in school-home, improving the SVVR model, and preparing teachers. First, parents indicated the importance of understanding the potential of VR technology and raising awareness among parents of individuals of ASD. Second, a few participants suggested urging the adoption of the VR technology by schools, which are considered to be the main source of VR for parents of individuals with ASD. This may enable continued use of VR technology at home, according to some parents who also indicated they might use VR at home setting if the cost is low. Third, participants suggested improvements to the quality of the 360-video and certain visual information. Fourth, it was noted that training

teachers and getting buy-in to the new technology is very important to the learning process with individuals with sensory issues.

Research question 3

What are the perceptions of parents of students with ASD in regard to the potential for other skills that might be addressed using VR technology?

Findings of the third research questions were also attributed to the Decision stage. The *potential skills* theme addressed the potential of other skills that could be learned using VR technology.

Potential skills. Participants cited future skills that could help their individuals with ASD learn or be more aware of the surroundings. These included social skills, safety, personal care, school roles, and navigation. The following section unpacked the details of each potential skill.

Safety. Amanda would like to have SVVR models about safety for her daughter. Specifically, she wants a model that could provide step-by-step direction on how to react in an unsafe or uncomfortable situation on campus. She stated:

> I would say a lot of safety issues. Like she's already run into a scenario where it was dark and she was on the opposite side of campus, and she was texting me because she didn't remember how to ask for the safe walk. So like walking through a scenario where you can get yourself help if you need it, and depending on what degree of help it is. Is it an emergency? Is it just being cautious, and keeping yourself safe if you're on campus alone at night? Or how you're going to get from A to B. And if you do find yourself in a situation that you feel is unsafe, what steps do you need to take?

Alan agreed and suggested safety models that could help younger individuals with ASD to be aware in public places:

> Certainly, safety, strangers, going up to strangers, going up to pets, if it's in a park, to do it properly. What to do if you get lost, how to find help. Again, I'm thinking younger, essentially prompted that. How to ask for help if you get lost. How to approach people, approach, you know, aid.

Amanda agreed and indicated that the safety model could also be used with not only younger individuals with ASD, but also adults. She wants a model that could help them be aware of surroundings, rather than focusing on one thing. Amanda provided an example of her daughter in a public place, petting a dog and not paying attention to things around her that could be dangerous:

> But even now, that's a problem. If Stephani sees a stranger with a dog, she's automatically going to go up and ask to pet the dog, and she will not be aware of her surroundings because she'll be focused in on the dog. So, she can put herself at risk safety-wise if she's not paying attention to who has the dog, and what else is going on around her. She'll just zero in and focus too tightly on that one thing.

Personal care. Amanda and Alan want to have models for individuals with ASD at an early age. In particular, Amanda wants a model that could help her daughter learn skills that could be applied in the real world, without prompting. Amanda recalled how she struggled to prepare her daughter for school, even in high school. Amanda stated:

> I kind of recall the routine being, well, it's been important all along, but like going through the steps of getting ready for school, like being able to put on your clothes and brush your teeth and wake yourself up using an alarm clock. Brushing your hair. Using buttons. Using a zipper. Some of that, you can't do the dexterity stuff with this, but just what the expectations are. What is the next thing you should be doing without prompting? Because they need … they can't do multi-step directions.

Alan further explained**:**

> So, can they prompt themselves: "Okay, if I just put my pants on, should I put on my shirt next? Should I brush my teeth next? What on that checklist of things to get ready for school have I not done yet that I can get done without a prompt from my mom?" "Can I find both of my shoes?" "Should I eat breakfast? Should I take my medicine?" That took a long time, and still a lot of prompting even in high school. Like, "You haven't brushed your teeth yet. We're not leaving until you brush your teeth. We're not leaving until you eat your breakfast. We're not leaving till you take your medicine."

Lara and Carla want to have SSVR models that can help individuals with ASD learn to clean their room and bathroom at the dorm. She said:

> Well, What about things inside the dorm, like cleaning? I mean, they're all pretty good. They seem to all kind of do a good job of taking care of themselves, but it's taking care of the room.

Lara concluded by saying:

> The dorm, cleaning, and those kinds of things … cleaning the bathroom.

School rules. Amanda wants to see SVVR models for individuals with ASD that can simulate school. Specifically, she wants to have scenarios to help them be aware of rules such as, speaking with the teacher in a good way, getting in line, waiting in line in the cafeteria, and models that can aid their in-class behavior. She stated:

> I mean, any of those – properly speaking to a teacher, understanding how to wait in line, understanding what the rules are in the cafeteria when you're in elementary school – it can be, in elementary school, very rigid, and a lot of the kids with autism don't pick up some of the unwritten rules.

Amada added:

> Like getting up out of your seat and going to talk to the teacher when they're in the middle of instruction. That happens in kindergarten, and I have students that do it that are 17. Because they'll start stimming, and then they'll want to ask a question, and the teacher's in the middle of instruction, and they'll get up and disrupt this class and start walking in circles and want to get into the personal space of the teacher and interrupt to ask a question, and it's very disruptive to the momentum of the class. So, they don't understand just what appropriate behavior in the classroom is.

Navigation. Ben and Lara want to have an SVVR model that will help their son be more aware of things and other places on campus that they are not aware of and how to go there. Ben stated:

> Maybe like other things that they're not participating in on campus because they just don't even know about it. I think about the Health Center.

Lara agreed:

> Oh yeah, going to the Health Center.

Ben also believes his son would actually go to the Health Center if he knew where it was:

> I think Bryson would probably, once he finds out there's a Health Center and he can actually walk or run on a center, track or just do light weights, I mean, he'll probably do it every other day, but he's not even doing it because he probably doesn't know it's there. So, showing him where it is.

Lora ended by saying:

> That's true, yeah. Maybe making use of other, like you said, things on campus. Opportunities.

Social skills. Carla believes that SVVR could be used to teach social skills to individuals with ASD. She wants to have an SVVR model that could teach learners social cues, how to interact with new people, navigation, and personal space:

> I do think that you could probably leverage this tool to maybe focus on more in-depth issues as it pertains to teaching these particular students that are on the spectrum, meaning social cues, how to interact more. So, the things that I probably struggle with as a parent in helping him understand [relate to] how you interact and navigate; how does he understand personal space; how does he understand the context when someone may not necessarily be his friend but he's assuming that they are his friends because maybe they're his mentors.

Carla further suggested a model that could help Howard overcome his nervousness with females:

> Knowing when to decipher when he's coming across maybe a little too pushy or aggressive as it pertains to females; and a lot of this is coming from just what's been happening on campus already anyway, not necessarily with the EMPOWER students, but just across the board with all of the students. I know there's been a couple of incidents of assault and things of that nature.

Tyler also believes it would be valuable for him to have a model that simulates a real-world social scenario. Specifically, a scenario when his son may need to avoid aggressive people by asking for help. Tyler stated:

> I think if you could expand to some other real-world applications in the social world, because that's an area that these kids really struggle with. Somebody confronts you, maybe they're angry with you, they feel like you cut them off, how do you diffuse that situation? How do you get yourself away, or how do you ask for help? Something like that would be really valuable.

Natural disaster awareness. Tyler also suggested a model that helps individuals with ASD know how to react to dangerous situations like a thunderstorm or flood:

> A thunderstorm or flooding warning or situation or something that might require you to take some sort of action.

Other skills. Tyler ended by suggesting some models such as driving, what to do in an accident situation, at the airport, and in an Uber share. He stated:

> Assisting with certain situations on driving, but there's a lot. What do you do if you find yourself in car wreck. Or an accident situation. Airport. Just the simple aspects of, okay, you got to go through security, and you got to go check your gate number, and then walk to a gate, and "By the way, here's a police officer or a gate agent that you could get help from." Uber, use of ride sharing.

The participating parents identified certain skills that need to be addressed through the SVVR mobile application. These skills include safety, personal care, school rules, navigation, social skills, natural disaster awareness, and other skills that are needed to deal with situations such as car accidents, visiting the airport, and using an Uber for ride-sharing. Research cited that social and emotional skills are the most targeted skills in VR technology that designed for individuals with ASD (Larenzo et al., 2019).

Summary of research question 3

Some parents suggested future models to support skills including social skills, safety, personal care, natural awareness, school roles, and navigation. Two parents suggested safety models that will help individuals with ASD be aware of dangerous or uncomfortable situations. Two parents suggested social interaction models to help their individuals communicate and be understood by others. A personal care model was suggested by one participant as a way to help her daughter get ready for school. One parent suggested an awareness model that could help individuals learn how to react to natural dangerous situations. A "school rules" model was suggested by one parent to help individuals behave properly in class and in the cafeteria. A

few parents suggested models on cleaning and navigating on campus. Driving, airport, and Uber car-sharing were other suggested models.

Summary

In this chapter, the discussion started with the EMPOWER program at the University of Arkansas and the demographics of the participating parents. The following section described how the data were collected from the parents through interviews, focus groups, and observations from six parents of students at the EMPOWER program. The section also discussed the data analysis process. The themes that emerged from the answers to the first research question were: awareness of VR learning applications, availability, expense, sensory issues, issues related to the SVVR model, ease of use, enjoyment and motivation, symptoms, and discomfort. Four themes emerged in the answers to the second research question, including understanding of VR technology, VR exposure in schools-home, improving the SVVR model, and preparing teachers. In their answers to the third research question, participants suggested that ASD individuals might enhance certain skills – including social skills, safety, personal care, school roles, and natural disaster awareness, and navigation – by using VR technology. The next chapter will interpret the results.

CHAPTER 5: Discussion, Implications, and Conclusions

Introduction

The purpose of this qualitative study was to determine the factors that may affect the adoption of SVVR mobile application among parents of the adults diagnosed with ASD at the EMPOWER program. Moreover, the study sought to reveal ways to increase the adoption of VR among parents, as well as skills that need to be addressed through the VR technology. The researcher's goal was to understand the essence of the shared experience among the participants in using the SVVR mobile application and to determine factors that may affect their decision adoption toward the technology. This will help teachers, specialists, and designers provide better service, content and design at earlier stage when using VR technology with individuals with ASD. In this study, a phenomenological approach was used to understand how parents of individuals with ASD perceive the SVVR mobile application. This approach allowed the researcher to understand the factors that may influence the participants' decisions regarding the adoption of the technology. The researcher conducted an interview with each parent. Focus groups were also conducted to experience the SVVR mobile application by parents and to determine the factors that may contribute to resistance to VR. The first research question aimed to indicated factors that may affect the decision-process of the adoption toward the VR technology. The second research question was to explore suggestions that parents of ASD adults believe it could increase the adoption of the VR technology among other parents. The third research question sought for potential future skills that the participants believe it could address thought the VR technology.

In this chapter, the researcher will present an interpretation of the findings associated with the data collected through interviews, focus groups, and observation. The limitations of the study will also be discussed, followed by the study's recommendations. After that, the researcher will discuss the implications of the study. The final section will contain the researcher's final thoughts about the study.

Interpretation of the Findings

Rogers (2003) has identified five stages associated with the adoption of an innovation: knowledge, persuasion, decision, implementation, and confirmation. Rogers (2003) also highlighted the important of the Prior conditions of the participants in regard to previous practice, innovativeness, and norms of social system.

In this study, the researcher focused on the first three stages only, as well as the prior condition of each participant and his/her ASD adult in regard to the use of technology, including VR technology.

Responses from the individual interviews indicated that the technology is integrated into the everyday life of the participants who are aged between 46 and 58 years old and considered to be well-educated. Educational level and parental age are reported to be factors that affect the effectiveness of using technology with special-needs students (Stahmer, Schreibman, & Cunningham, 2011). Although research has reported that parents are often overwhelmed when using technology interventions with special need students (Brosnan, Parson, Good, & Yuill, 2016), the parents in the current study seemed to be familiar with technology. They use their smartphones, laptops, and iPads for everyday work such as sending and checking emails, web conferencing, and communicating with their ASD individuals. It was apparent to the researcher

that the participants showed indications of their passion for technology. This was clearly thought the participant's' eagerness and motivation to try the new technology that has the potential for use for their adults with ASD.

Responses from the individual interviews also revealed that five of the six participants have experienced VR technology before conducting the study. Participants parents indicated the prior VR exposure was for gaming purposes.

Participants also indicated that technology was a routine part of their ASD individual's everyday life. It was noted that participants' individuals have been using iPhones, iPads, and laptops for entertainment and doing homework. It was also noted that participants' individuals often engaged with their smartphones and tablets for communication, gaming, and watching videos. This strong relationship between individuals with ASD and technology was expected by the researcher. Parents of individuals with ASD reported the allure of visually based media such as TVs and videos to their individuals with ASD (Nally, Houlton, & Ralph, 2000).

Research question 1

The first research question was: What factors prevent the parents of the students in the EMPOWER program from adopting the SVVR mobile application?

Knowledge stage

According to Rogers' theory (2003), the knowledge stage occurs when "an individual (or other decision-making unit) is exposed to an innovation's existence and gains an understanding of how it functions". (p. 169). Knowledge was considered not only as knowledge of VR technology in general, but also awareness of the learning applications. Two themes were

identified: awareness of VR learning applications and availability. Themes appeared to be negatively affecting the decision process of the adoption.

Awareness of VR learning applications. Parents indicated that they were not aware of the VR technology that could deliver learning content. Although almost all participants parents had been exposed to VR through gaming before this study was conducted, none of the participants had exposed to applications that specifically designed for educational purposes, particularly for individuals with ASD. This could be due to the limited number of research studies that have used VR in educational settings, specifically with students with ASD.

Parents in this study have engaged and interacted with the SVVR transportation model to gain an understanding about VR technology and its potential as a learning tool for individuals with ASD (the "knowledge" stage).

***Availability*.** Four participants indicated that VR was not offered as a therapeutic option to their individuals in school. Research indicates that schools' directors cited the lack of time as the most challenging aspect of acquiring new technologies to help students with ASD. Gleason (2017) reported that school directors have to spend much time to find new technology, which in some cases involves parents and teachers recommending what will best meet their ASD students' needs. School directors also explained that acquiring new technology is time-consuming, as the new technology must be tried and tested with students with ASD, and staff must buy into the new technology Gleason (2017).

Persuasion stage

Rogers (2003) indicated that the persuasion stage occurs when "an individual (or other decision-making unit) forms a favorable or an unfavorable attitude towards the innovation.". (p.

169). The two sub-themes “disadvantages” and “advantages” of the main themes “SVVR transportation model” related to the stage of persuasion. The sub theme “disadvantages” including the factors expense, the amount of VR exposure, sensory issues, issues related to the SVVR model, and availability fall under the elements of compatibility, trialability, and observability.

Compatibility. Rogers (2003) identified compatibility as “the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.” (p. 240). Two factors were attributes to the element of compatibility: expense and sensory issues.

VR *expense* emerged as a factor that may affect the adoption of VR. Parents indicated the cost of a VR system – including hardware and software (application) – could be an obstacle to the adoption of VR for their individuals with ASD as a therapy. The participants’ responses consistent with the study by Curran (2017) who reported that parents of individuals with ASD perceive the cost of technological like VR intervention as an obstacle to its adoption. Studies have indicated that individuals with special needs may not capable of making decisions in their everyday life (e.g. Cavet & Sloper, 2004; Franklin & Sloper, 2009; Mitchell, Malone, & Doebbeling, 2009). In this case, parents’ role in overcoming the affordability hurdles of technology become more crucial, as they usually seek out whatever means will help their ASD individuals. However, in the past few years, the cost of VR technologies has rapidly decreased. For instance, a spherical, video-based virtual reality (SVVR) system could offer a controllable immersive environment for learning purposes in a low-cost and easy-to-develop manner (Newbutt, Sung, Kuo & Leahy, 2017; Schmidt et. al, 2019; Sun, Pan, Wan, Wu, 2018; Wallgrün et al., 2019; & Xu, 2016). This has resulted in more research into the potential of SVVR in

educational settings (Sun & Looi, 2017; Zhang et al., 2018). In a study by Schmidt et. al. (2019), the use of SVVR as a learning tool – specifically, using Google Cardboard and Google Daydream with a mobile application – was examined to teach adaptive skills to adults diagnosed with ASD. The price of Google Cardboard is less than $10, and Google Daydream costs less than $50. The reason for using the SVVR mobile application as a learning tools was due to (a) the low-cost of the SVVR hardware, (b) less time and effort was required to develop the SVVR software, (c) it was less complex and user-friendly, (d) it reduced cybersickness, and (e) it offered a realistic learning environment (see Schmidt et. al. 2019).

Many participants expressed concern about *the amount of VR exposure* (i.e., their dosage) because after using it they felt disoriented, dizzy, and nauseous. Research cites different cybersickness symptoms – such as eye strain, headache, and sweating – in users during and after exposure to virtual environments (VE) (Laviola, 2000). Cobb, Nichols, Ramsey, and Wilson (1999) reported that most participants in their study experienced cybersickness in different degrees after ten minutes of using a head-mounted display (HMD). Similar research cited cybersickness (including nausea and disorientation) among 61 undergraduate students after nine and half minutes of VR exposure (Kim et al., 2005). Participants in studies that reviewed the side effects of VR technology were typically developing users. Therefore, the amount of research that has investigated the side effects of VR with ASD individuals remains limited. This could be due to the minimal verbal expression among the autistic population, which means in this case that the role of parents was vital to mediate to understand and reflect what was happening to their individuals with ASD when cybersickness symptoms occurred. To the best of the researcher's knowledge, only one study has cited mild symptoms of cybersickness ("disoriented" and "dizzy") among adults with ASD after they experienced the SVVR mobile application (Schmidt

et al., 2019). Participants in this study were asked to complete tasks that took maximum of 20 minutes. These symptoms could negatively impact the use of VR technology by individuals with ASD and their families (MacMullin et al., 2016). Such findings may leave parents of individuals with ASD – not to mention educational institutions – with a negative impression of VR technology.

Another factor that may prevent parents from adopting VR is ASD learners who have *sensory issues*. A few parents believed that through the learning process, students with ASD may need a lot of "starting" and "stopping" points as they get disoriented; in some cases, they dislike having wearable devices on their head or ears. The acceptance of wearable technology (VR-HMD) among individuals with ASD has been investigated over the past decade. Peli (1998) reported no negative short-term effects from using the HMD (Peli, 1998). In a similar study (Strickland et al., 2007) reported the acceptance of the HMD by children with ASD. Moreover, Newbutt et al., (2017) reported not only acceptance of the VR-HMD among adults with ASD, but also motivation.

In regard to the use of VR in the learning process with students with sensory issues, Cole (2011) highlighted the importance of understanding students with ASD and their difficulties with technology – specifically, over-stimulation among ASD students with sensory issues. Research found that school directors express concern that using VR with ASD students with sensory issues may result in adverse reactions such as stimming and flapping (Gleason, 2017). Stimming and flapping are compensatory strategies that children with ASD often use in response to states of sensual arousal (Boyd, McDonough, & Bodfish, 2012).

The observational findings included another factor that may negatively affect the VR adoption rate: *discomfort*. Although physical discomfort was cited by only one participant, the

researcher did not consider discomfort as a major factor. The participant had to take off the Google Daydream for 13 seconds because she felt "hot" while interacting with the SVVR model. This seemed to be a minor factor regarding VR adoption.

Trialability. Two factors attributed to the element of trialability. Factors were related to the sub-theme *issues related to the SVVR model*. First were the stability and sound of the 360-video. A few participants indicated that the 360-video was not stable and "shaking". The rapid rotation of the camera was reported in Schmidt et al. (2019) as experts expressed their overwhelming regarding the video shaking of the SVVR app. This could result in motion sickness, as well as an inability in ASD users to maintain focus on a targeted object (Schmidt et al., 2019). Another factor related to the 360-video was its sound. One parent expressed her concern about sound for ASD individuals who are hard of hearing. Although VR can be adjusted to suit individuals with sensory issues (Bradley and Newbutt, 2018), research on the VR and ASD individuals with low mobility still remains to be done. The second factor was lack of visual information. Parents said it would be useful to indicate how long their ASD individual would have to wait at the bus stop. Parents also indicated that the appearance of the bus number and route number were confusing to them. The public transportation bus at the university campus has a bus number and a route number on the screen. This is a critical issue, because the on-screen route number may change at any time to show a new route.

Observability. The theme of *availability* emerged at the knowledge stage is considered to be a multi-theme stage, as it also appeared in this stage. Parents indicated the absence of VR at schools, which were the main source of technology interventions for their individuals with ASD.

Although this study's main research questions focused on factors that may negatively affect the adoption of VR, participants also reported positive factors that may increase VR

adoption. The sub theme "advantages" including immersion, realism, ease of use, fun, motivation fall under the elements of relative advantage, complexity and trialability.

***Relative advantage*.** Many participants commended the *immersion* and *realism* of the SVVR model. Parents indicated that immersion in the 360-video allows the user to be fully surrounded by the virtual world through HMD (Bozgeyikli et al., 2018) and "street noises". The controllable immersive VR environment, therefore, will open up an opportunity for ASD users to engage in a realistic experience that simulates a real-world scenario. Participants parents in this study reported feeling like they were actually walking on campus. The realism of the virtual environment can simulate and mirror real-world situations and offer authentic experiences (Parsons, 2016). In addition, Parsons, Rizzo, Rogers, and York (2009) indicate that VR technology can be highly appealing to students with ASD because of its realism, visual performance, and controllable environment. Other unique advantages of VR were cited in regard to rehabilitation in the ASD population; these advantages included safety, repetitiveness, and the flexibility of the virtual environment (Georgescu et al., 2014; Kandalaft et al., 2013; Newbutt, 2013; & Parsons & Leonard, 2004).

***Complexity*.** factor attribute to the element of complexity and that may positively affect the adoption of SVVR mobile application among the participants is its *ease of use*. Although parents expressed concerns about using VR with individuals with sensory issues, parents indicated that SVVR would be easy for their individuals with ASD to use because it has aspects of gaming. Research has shown that the ease of use and effectiveness of VR and gaming can help develop social skills in individuals with ASD (Kandalaft et al., 2013; Ke & Moon, 2018; Noor et al., 2012). Also, experts and adults with ASD indicated the ease of use of an SVVR model

(Google Cardboard and Google Daydream) designed to help ASD individuals improve their adaptive skills (Schmidt et al., 2019).

Research notes not only the ease of using VR technology, but that it is fun and motivational.

Trialability. The final factors that emerged that can positively affect the adoption of VR technology were "fun" and "motivation". These factors were attributed to the element of trialability. A few participants reported that the SVVR mobile application could provide *fun* and *motivation* to their adults with ASD. Prior research has reported that VR interventions using can not only motivate students with ASD to improve their adaptive skills (Kandalaft, 2013; Smith et al., 2014; Yu-Ju et al. 2018) but also give them a bit of fun (Newbutt et al., 2017). Most of the research in this area has targeted children with ASD. Research on adults with ASD is limited.

Decision stage

According to Rogers (2003), the decision "take place when an individual engages in activities that led to a choice to adopt or reject the innovation" (p. 177).

Rejection. Factors emerge from the first research question that considered to be affecting the decision-making process negatively (Rejection) among both stages, knowledge and persuasion were: awareness of VR learning applications, availability, expense, the amount of VR exposure, sensory issues, and discomfort, and issues related to the SVVR model.

Adoption. Factors emerge from the first research question that considered to be affecting the decision-making process positively (Adoption) were in which to be found at the persuasion stage were: immersion, realism, ease-of-use, enjoyment and motivation.

Ultimately, according to Rogers (2003), the most important elements affecting the adoption of VR are its relative advantages, compatibility, and complexity. In the present study, factors such as expense, sensory issues, and the amount of VR exposure seemed to be the most negative factors that affect the parents' decision to adopt of VR technology. Positive factors included VR's immersive, realism, its preparing teachers, its ease of use, and the skills that might be addressed using VR technology seemed to be affecting the parents' decision toward the adoption.

Research Question 2

The second research question was: What procedures do the parents of the students in the EMPOWER program suggest will increase the adoption of the SVVR mobile application among parents of individuals with ASD?

Four themes emerged from the data to answer the second research question, which related to the decision stage, to increase the decision-making process toward the adoption: understanding the VR technology, VR exposure in schools-home, preparing teachers, and improving the SVVR model. Themes were related to the decision stage as

Rogers (2003) defines communication channels as "the process by which participants create and share information with one another in order to reach a mutual understanding" (Rogers, 2003, p. 18). In this study, communication channels can be seen as the suggestions by parents of individuals with ASD.

Understanding of VR technology. Although prior knowledge of VR gaming technology existed among almost all participants, none of them was aware of its potential for presenting educational or awareness content to their individuals with ASD. Therefore, all participants

indicated the need to raise awareness about VR and its educational potential and functionality among parents of individuals with ASD. One parent suggested that time and effort are the biggest constraints for parents of individuals with disabilities who are considering using new interventions. Therefore, information about the time and effort associated with using VR technology with ASD is important to highlight. This need could be attributed to the parents' frustrations with technology (Curran, 2017) when using interventions to target multiple skills (Stahmer, Schreibman, and Cunningham, 2010). These obstacles may cause stress, especially to those trying to access and use services and technologies (Moreso, Boshoff, Gibbs, Phillips, Wiles, and Porter, 2016). Parents also like to learn about innovations through communication channels such as successful stories, autism speaks, support groups, the internet, therapists, and videos of the technology and its functionality.

***VR exposure in schools-home*.** Schools were found to be the main source of VR technology for many participants. Although VR has proven to promote the acquisition of adaptive skills in children with ASD over the past few years (Beach & Wendt, 2014; Bozgeyikli, Raij, Katkoori, & Algasemi, 2018; Cheng, Huang, & Yang 2015; Ke & Moon, 2018; Yu-Ju et al., 2018) as well as adults (Newbutt, Sung, Kuo, Leahy, Lin, & Tong, 2016; Ross, Cox, Reeve, Brown, Moncrief, Schmitt, and Gaffney 2018; Schmidt, Schmidt, Glaser, Beck, Lim, Palmer, 2019), the number of studies that provide evidence of the impact of VR technology among individuals with ASD is limited. Another challenge for schools offering VR technology for students with ASD is time. School directors reported that it can be time-consuming to acquire new technology (VR), a process which in some cases involves parents and teachers to discover what will best suit their ASD students' needs. Parents also said they liked the idea of using VR technology at home with their individuals with ASD as a carry-on therapy after school. Research

has cited the effectiveness of parents' use of technological interventions in the home setting (Brown and Woods, 2015; Dixon et al., 2015; Yikmis, 2017)

***Preparing teachers*.** The theme "preparing teachers" emerged when participating parents were asked for suggestions about what might increase the adoption of VR technology. Many participants indicated that schools are their main source of technology for their ASD individuals. However, two parents indicated the importance of preparing teachers (in terms of VR training) and their belief in VR technology (buy-in). It was reported that school directors believed in the importance of training teachers and providing professional development when using new technology like VR in special educational settings (Gleason, 2017). However, directors also reported fear and resistance to change among teachers when introducing a new technology. When training teachers to overcome their fear of using a new technology, resistance to change was the biggest factor that affected the adoption of new technology like VR in schools. There is a need for more trained teachers who will not be overwhelmed by the broad variety of technology in classrooms (Shepard, Fowler, McCormick, Wilson, & Morgan, 2016) or more youthful teachers who are less likely to be intimidated by new technology (Ruthven, Hennessy, & Brindley, 2004). Teachers must be flexible and patient when teaching individuals with ASD (Curran, 2017).

Improving the SVVR model. Other factors that may affect the adoption of VR technology by parents of individuals with ASD could be relevant to the SVVR transportation model. Parents provided suggestions in regard to improvement in some aspects of the experienced SVVR model, including the 360-video, visual details, and the calling and highlighting details.

Participants suggested incorporating video stabilization and closed captioning to the SVVR model, as their individuals with ASD are more likely to watch visual information with closed captioning. With the support of captions, individuals with intellectual disabilities are better able to learn academic content delivered through video (Evmenova, Graff, & Behrmann, 2017).

Participants also suggested calling out and highlighting objects in the virtual environment when it is seen from a distance to help individuals with ASD become familiar with them. Research indicated the use of verbal instructions and highlighting (flashing) subjects in red could positively impact people with learning disabilities when using VR technology for training purposes (Brown, Neale, Cobb and Reynolds, 1999). This suggestion consisted with Schmidt et al. (2019) who emphasized the important of improving the play back of the spherical video in which to be used with ASD population. It was advised to use a design cues such as arrows and highlighting in order to maintain focus on relevant objects (Schmidt et al., 2019).

One suggested adding a reverse scenario in which the wrong bus arrives. This could help ASD users on how to react in such situation. Other parent suggested instructions on how to download the app.

Research Question 3

Relative advantage is defined as "the degree to which an innovation is perceived as being better than the idea it supersedes". The researcher in this study sees relative advantage in how significant new outcomes are needed for comparison to the current situation, which are identified by the members of the social system (participant parents). It was suggested that future models could support skills including safety, personal care, school roles, navigation, social, natural disaster awareness, and other skills.

One participant said that social and communication skills can be addressed through VR, as these are the area that parents struggle with the most. School directors reported that social and life skills such as riding a bus, navigation, and shopping are valuable content that can be offered through VR (Gleason, 2017). Individuals with ASD usually struggle with different aspects of the social domain, including social understanding, use of accurate gestures and social skills, maintaining friendships, and contributing to social play (Machintosh & Dissanayake, 2006). These struggles can lead to social interaction deficits (Chung, Mosconi, Drewry, Matthews, & Tasse, 2007). Research has proven the effectiveness of using VR with ASD individuals to boost social and communication skills (Beach and Wendt, 2014; Bozgeyikili, Raij, Katkoori, & Algasemi, 2018; Cheng, Huang, & Yang 2015; Ke & Moon, 2018; Yu-Ju, Hsiao, & Mei-Feng 2018).

Other future skills were offered to be learn/train through the VR technology are safety, personal care, natural disaster awareness, and school roles. Although there is limited research about VR and ASD that focuses on social skills and navigation, a very limited amount, if any, research targets skills such as safety, personal care, natural disaster awareness, and school roles. This an important finding, as it bridges the gap in the literature about other skills that are important to parents. A virtual environment model that could provide step-by-step guidance on how to react in an unsafe/uncomfortable situation on campus or awareness of dangerous surroundings would be appreciated by some of the participating parents. Also, useful would be a VE program that could help younger individuals improve their personal care and help them get ready for school without parent prompting. Moreover, a VE that could simulate a natural disaster – like a severe thunderstorm or flooding – could help decrease anxiety in individuals with ASD

and show them how to react in such situations. Lastly, a VE that helps children with ASD reduce unwelcomed behavior in class would also be welcomed.

Limitations of study

The findings of this study offer a distinctive contribution to the literature on the vital role that parents of individuals with ASD can play in immersive technology intervention. The study offers a unique view of how to increase the adoption rate among adults with ASD of the SVVR mobile application in both educational and home settings. However, this study has several limitations. First, the perceptions of only six parents of individuals diagnosed with ASD were explored. Because of this small sample size, generalizing the findings will be of limited accuracy and will not necessarily represent all parents of individuals with ASD. To alleviate this concern, the researcher provided rich information about the setting, the participants and their individuals with ASD, as well as detailed descriptions of the settings of all the interviews. The second limitation of the findings is related to the study population. Only one participant was a local (Arkansas) resident. The other five participants were from a different state (Texas). The findings of this study may have differed based on where the participants live. Also, the demographic characteristics of the participants may limit generalization of the findings. Participants in this study were aged between 46 and 58 and considered to be well-educated. The third limitation of relates to the data collected during the individual interviews. It is possible that some answers were misrepresented due to the nature of the interview questions, which sometimes evoked emotional memories. To reduce this concern, the researcher provided comprehensive information to the interviewees about the research, confidentiality, and the right to withdraw from the interview at any time. Fourth, the amount of exposure to VR in this study was limited. That is, participants parents engaged with the SVVR mobile application for only 10 to 15 minutes. This

brief exposure was chosen by the researcher due to factors including, but not limited to the display and technology, characteristics of the individuals with ASD (Laviola, 2000), and sensory issues that may arise within individuals with ASD. The relationship between the duration of exposure to VR and different forms of VR technology are still not fully understood. Symptoms of cybersickness could manifest between 10 minutes (Cobb et al., 1999) and 5 hours (Regan and Ramsey, 1994) after exposure to VR. Lastly, this study did not include parents of low-functioning ASD individuals. All participants at the EMPOWER program were students diagnosed with high-functioning ASD. VR intervention with individuals with low-functioning ASD is still open for investigation. More research will help expand the literature of technology intervention in the ASD population, especially interventions with individuals with low mobility.

Recommendations

This study was able to identify factors that restrict the adoption of VR among parents of individuals with ASD. This study also provided suggestions to increase the adoption among parents of individuals with ASD and identifies important skills that need to be addressed through the VR technology. However, the findings of this study raise future research questions that should include more participants. The small sample size of the current study – six parents – will limit the generalizations from this study. With a larger sample, additional factors that negatively affect the adoption rate of VR may emerge and help us develop solution to overcome these obstacles. In relation to educational settings, it would be useful to study how adopting a new technology at schools may affect training teachers – particularly a study that focuses on the relationship between factors that restrict the adoption of VR and the demographic profiles of teachers and/or parents of individuals with ASD. This could help us understand the obstacles related to school resources, state requirements, or teachers' and/ or parents' beliefs. Another

limiting factor that may prevent the VR adoption in the education setting is cost. Future research should focus on the economics of the infrastructure, tools, equipment, and applications of VR technology in different schools. School budgets can be affected by many socioeconomic factors. Such studies could provide vital information about how various levels of VR technology may influence its adoption by both schools and teachers from one setting to another. A very important study could be conducted to investigate the different symptoms of cybersickness that may affect individuals with sensory issues. The side-effects of VR exposure through the HMD are not fully understood (Newbutt et al., 2016). A very interesting future study could include both parents and their individuals with ASD to explore more factors that may restrict the adoption of VR and examine the authenticity of parents' perceptions that may not match those of their ASD child. Future research could also focus on parents and their ASD child to examine the different levels of immersion that may be more complex for individuals with ASD to use.

The current SVVR transportation model offers an infrastructure platform (https://veer.tv/discover) that the EMPOWER program can use to research the efficacy of using VR technology with adults with ASD. Specifically, a study that aims to examine the acceptance, ease-of-use, and the transferable skills of the model among the EMPOWER program students. This would shed light on how EMPOWER students interact with wearable devices and the complexity of the model. The study could also examine the efficacy of the transferable learned skills, which are designed to help ASD individuals supervise themselves and interact with people independently in their everyday lives.

Implications

This study will provide positive change in society at the individual, organizational and societal level.

At the Individual Level

Teachers. The results of this study may help special-needs teachers make decisions about using a new technology and raise their expectations regarding the implementation of VR technology. Additionally, the results may encourage teachers to adopt SVVR as a learning tool to enhance the academic, social, and life skills of individuals with ASD. This type of learning tool is inexpensive and easy to use (Schmidt et. al, 2019; Sun, Pan, Wan, Wu, 2018; & Xu, 2016). The findings of this study are vital to special-needs teachers, because parents indicated their intention to continue VR therapy in home settings. Collaboration between parents and teachers is essential if an innovation is to be effective (Brown & Woods, 2015; Crane-Mitchell, and Stafford 2017; Meadan, Snodgrass, Meyer, Fisher, Chung, & Halle 2016; Stump, 2017). Partnering with teachers in all aspects of the design process will not only help determine what best meets the individual with ASD's needs, but also integrate game-changing aspects of VR treatment that can be continued in the home setting. This would also open up an opportunity for parents to verify their ability to use VR at their home with their individuals with ASD.

Designers. Another aspect of the findings could be vital to designers who produce the virtual environment – specifically, the 360-degree video. The study results indicate the important of highlighting visual objects. For example, from the perspective of parents of the EMPOWER program, providing a map in the transportation model that shows the location of the bus stop was not enough. Participants indicated the importance of highlighting the bus stop while walking to it (e.g. flashing red lights above the bus stop). Another recommendation was to add closed

captions. As indicated, the participants' ASD individuals are more likely to lean toward visuals with closed captioning, which could also be beneficial for individuals with hard hearing.

Directors. This study will raise awareness of VR technology and encourage school directors to initiate the adoption of VR. Time and cost were reported as the main concern of school directors (Gleason, 2017). The SVVR mobile application could eliminate these factors due to the low-cost of the HMD (Google Daydream or Google Cardboard) and its ease of use.

Parents/caregivers. This will encourage parents/caregivers of individuals with ASD to better understand the potential of VR technology, and particularly the SVVR mobile application. Parents play a vital role in implementing technological interventions with their ASD individuals (Brown & Woods, 2015; Crane-Mitchell, and Stafford 2017; Meadan, Snodgrass, Meyer, Fisher, Chung, & Halle 2016; Stump, 2017). The findings of this study will also help reduce parents' stress and increasing their confidence, as they usually seek to use best available technology for their individuals with disabilities (Curran, 2017).

At the Organization Level

Service providers. The findings of this study could encourage service providers to identify and address unmet demands. The dearth of information about the potential use of using VR technology for parents may encourage service providers to align with current trends in technology interventions among individuals with disabilities. Parents of individuals with ASD reported a need for not only technology that can support them and their individuals, but also a need for training (Murphy and Tierney, 2006). Parent training programs may also open up the opportunity for parents to meet other parents with similar interests and needs. It was reported that parents consider other parents of individuals with ASD as a prime source of information, as their experiences may be similar (Rhoades, Scarpa, & Salley 2007; Murphy & Tierney 2006).

Conferences. The study findings encourage the collaboration and communication between conferences related to autism spectrum disorder and parents/caregivers. Parents/caregivers reported that they enjoyed receiving information through conferences including workshops (Rhoades, Scarpa, and Salley, 2007) and being more involved in training workshops (Murphy and Tierney, 2006). These help them stay abreast of current trends in technology and educational practices for the ASD population and to gain access to seminars/workshops on a variety of topics.

Societal Level

It was predicted that over the next decade, almost half a million youth with ASD will enter adulthood (Roux, Shattuck, Rast, Rava, and Anderson, 2015). When transitioning to adulthood and being more independent, individuals with ASD may have challenges due to social communication deficits, an overreliance on family, and their ability to adapt to change (Simonoff, Pickles, Charman, Chandler, Loucas, & Baird 2008). These challenges are more likely to result in poor outcomes for this population (Roux, Shattuck, Rast, Rava, and Anderson, 2017) in terms of socializing, learning, and vocations (Taylor and Mailick 2014). Specifically, young adults with ASD are mostly unemployed or absent from college attendance (Newman, Wagner, Cameto, Knokey, & Shaver 2010; Wei, Wagner, Hudson, Yu, & Shattuck 2015). This is related to their frequent lack of social skills, including adaptive skills that enable young adults with ASD to manage themselves in everyday situations and interact with people independently (Schmidt, Schmidt, Glaser, Beck, Lim, & Palmer, 2019). This study has shown that parents of individuals with ASD are likely to use VR technology that has the potential to overcome their individuals' struggles with engaging with and being active in society.

Educational practice. This study has shown the potential use of a SVVR mobile application that is designed to help improve the life skills of adults with ASD. Parents of adults with ASD report that the transportation model would offer a realistic immersive experience, ease of use, joy, and motivation for their individuals. The SVVR transportation model will help adults with ASD to deal with real-world scenarios by practicing doing it in a safe environment. This could eliminate the physical danger of applying the learned skills in a real-world situation (Standen & Brown, 2005). Moreover, the findings of this study also indicated that VR technology is a preferred carry-over therapy for home settings. In fact, parents appreciated the value of using VR technology at home to reinforce use of the application at school. Use of VR at home will also open up opportunities for teachers and parents to collaborate to design a VR learning environment that supports everyday skills development.

Conclusion

Parents know their individuals with ASD best and tend to look for interventions that best meet their individuals' needs. This helps explain the rapid increase in technological development in the autism domain. This is why it is important to define the factors that limit the adoption of VR technology in educational and non-educational settings and describe how to overcome them. This study explored the use of the SVVR transportation model, which is designed to improve certain life skills in adults with ASD and sought to identify factors that inhibit adoption of the model. The findings indicated that there was a lack knowledge about VR learning applications among all the parents who participated in the study. The findings also indicated that neither schools nor therapists had offered VR technology as a therapeutic option for the participants' individuals with ASD. Other factors that inhibited adoption included cost, sensory issues, cybersickness, and design issues in the SVVR model. The study also explored what changes

could be done to overcome these issues. Accordingly, the findings include suggestions such as understanding of VR technology and its potential for use with individuals with ASD; using VR technology in schools, which are the main source of this technology for all participants; improving the SVVR transportation model; and training teachers to use the technology. The study also identified life skills that parents thought VR technology should address, including safety, personal care, understanding school rules. Ultimately, the study findings could lead more parents to use VR at home to support their individuals with ASD. They might also benefit teachers who use VR with their ASD students, because it could open up opportunities for home-school collaboration.

References

Acar, C., Tekin-Iftar, E., & Yikmis, A. (2017). Effects of mother-delivered social stories and video modeling in teaching social skills to children with autism Spectrum disorders. *The Journal of Special Education*, *50*(4), 215-226.

Agarwal, R., & Prasad, J. (1997). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision sciences*, *28*(3), 557-582.

Akman, Ö., & Koçoglu, E. (2017). Examining Technology Perception of Social Studies Teachers with Rogers' Diffusion Model. *International Education Studies*, *10*(1), 39-46.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

American Speech-Language-Hearing Association. (2008). *Roles and responsibilities of speech-language pathologists in early intervention: Position statement*. Available from www.asha.

American Speech-Language-Hearing Association. (2008). Roles and responsibilities of speech-language pathologists in early intervention: Position statement.

APA. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Washington, DC: *autism* (pp. 91-110). Springer, Boston, MA.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition*, *21*(1), 37.

Beach, J., & Wendt, J. (2014). Social Interaction Development through Immersive Virtual Environments. *International Association for Development of the Information Society*, 10. Retrieved from http://0-search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=eric&AN=ED557325&site=ehost-live&scope=site

Beach, J., & Wendt, J. (2017). Using Virtual Reality to Help Students with Social Interaction Skills. *Editorial Staff*, 26.

Boshoff, K., Gibbs, D., Phillips, R. L., Wiles, L., & Porter, L. (2016). Parents' voices: ‘why and how we advocate’. A meta-synthesis of parents' experiences of advocating for their child with autism spectrum disorder. Child: Care, Health and Development, 42(6), 784-797.

Boyd, B. A., McDonough, S. G., & Bodfish, J. W. (2012). Evidence-based behavioral

Boyd, B. A., Odom, S. L., Humphreys, B. P., & Sam, A. M. (2010). Infants and toddlers with autism spectrum disorder: Early identification and early intervention. *Journal of Early Intervention, 32*(2), 75-98.

Bozgeyikli, L., Raij, A., Katkoori, S., & Alqasemi, R. (2018). A survey on virtual reality for individuals with autism spectrum disorder: Design considerations. *IEEE Transactions on Learning Technologies, 11*(2), 133-151. doi:10.1109/TLT.2017.2739747

Bradley, R., & Newbutt, N. (2018). Autism and virtual reality head-mounted displays: A state of the art systematic review. Journal of Enabling Technologies, 12(3), 101-113. doi:10.1108/JET-01-2018-0004

Brinkmann, S., & Kvale, S. (2015). *Interviews: Learning the craft of qualitative research interviewing*. Los Angeles, Calif: Sage.

Brookman-Frazee, L., Stahmer, A., Baker-Ericzen, M. J., & Tsai, K. (2006). Parenting interventions for children with autism spectrum and disruptive behavior disorders: Opportunities for cross-fertilization. *Clinical Child and Family Psychology Review, 9*(3-4), 181-200.

Brosnan, M., Parsons, S., Good, J., & Yuill, N. (2016). How can participatory design inform the design and development of innovative technologies for autistic communities?. *Journal of Assistive Technologies, 10*(2), 115-120.

Brown DJ, Neale H, Cobb SV, Reynolds H (1999) The development and evaluation of the virtual city. Int J Virtual Reality 4(1):28–41

Brown, J. A., & Woods, J. J. (2016). Parent-Implemented Communication Intervention: Sequential Analysis of Triadic Relationships. *Topics in Early Childhood Special Education, 36*(2), 115–124. Retrieved from http://0-search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=eric&AN=EJ1105672&site=ehost-live&scope=site

Burckley, E., Tincani, M., & Guld Fisher, A. (2015). An iPad™-based picture and video activity schedule increases community shopping skills of a young adult with autism spectrum disorder and intellectual disability. *Developmental neurorehabilitation, 18*(2), 131-136.

Burke, R. V., Andersen, M. N., Bowen, S. L., Howard, M. R., & Allen, K. D. (2010). Evaluation of two instruction methods to increase employment options for young adults with autism spectrum disorders. *Research in developmental disabilities, 31*(6), 1223-1233.

Cakmak, S., & Cakmak, S. (2015). Teaching to Intellectual Disability Individuals the Shopping Skill through iPad. *European Journal of Educational Research, 4*(4), 177-183.

Cannella-Malone, H. I., Tullis, C. A., & Kazee, A. R. (2011). Using Antecedent Exercise to Decrease Challenging Behavior in Boys with Developmental Disabilities and an Emotional Disorder. *Journal of Positive Behavior Interventions, 13*(4), 230–239.

Retrieved from http://0-search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=eric&AN=EJ939984&site=ehost-live&scope=site

Cano, A. R., Fernández-Manjón, B., & García-Tejedor, Á. J. (2018). Using game learning analytics for validating the design of a learning game for adults with intellectual disabilities. *British Journal of Educational Technology*, *49*(4), 659-672.

Cardon, T. A. (2012). Teaching caregivers to implement video modeling imitation training via iPad for their children with autism. *Research in Autism Spectrum Disorders*, *6*(4), 1389-1400.

Carter, E. W., Lane, K. L., Cooney, M., Weir, K., Moss, C. K., & Machalicek, W. (2013). Self-determination among transition-age youth with autism or intellectual disability: Parent perspectives. *Research and Practice for Persons with Severe Disabilities*, *38*(3), 129-138.

Centers of Disease (2014). Autism and Developmental Disabilities Monitoring (ADDM) Network. Retrieved from: https://www.cdc.gov/ncbddd/autism/addm.html

Chen, C., Lee, I., & Lin, L. (2016). Augmented reality-based video-modeling storybook of nonverbal facial cues for children with autism spectrum disorder to improve their perceptions and judgments of facial expressions and emotions. *Computers in Human Behavior*, *55*, 477-485. doi:10.1016/j.chb.2015.09.033

Chen, X. (2009). Students Who Study Science, Technology, Engineering, and Mathematics (STEM) in Postsecondary Education. Stats in Brief. NCES 2009-161. *National Center for Education Statistics*.

Cheng, Y., Huang, C. L., & Yang, C. S. (2015). Using a 3D immersive virtual environment system to enhance social understanding and social skills for children with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities*, *30*(4), 222-236.

Chung, K. M., Reavis, S., Mosconi, M., Drewry, J., Matthews, T., & Tassé, M. J. (2007). Peer-mediated social skills training program for young children with high-functioning autism. *Research in developmental disabilities*, *28*(4), 423-436.

Cobb, S. V. G. (2007). Virtual Environments Supporting Learning and Communication in Special Needs Education. *Topics in Language Disorders, 27*, 3, 211. https://www.researchgate.net/publication/232239978_Virtual_Environments_Supporting_Learning_and_Communication_in_Special_Needs_Education.

Cobb, S. V. G., Nichols, S., Ramsey, A., & Wilson, J. R. (1999). Virtual reality-induced symptoms and effects (VRISE). Presence: Teleoperators & Virtual Environments, 8(2), 169-186. doi:10.1162/105474699566152

Constantino, J. N., & Gruber, C. P. (2007). *Social responsiveness scale (SRS)*: Western Psychological Services Los Angeles, CA.

Cox, A. W. (2013) *Modeling fact sheet.* Chapel Hill: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

Cox, A. W. (2013). Exercise (ECE) fact sheet. Chapel Hill: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

Crane-Mitchell, L., & Stafford, L. (2017, March). Enhancing Learning Outcomes for Students with Autism through the Use of Assistive Technology: Effect of Parent-Teacher Collaboration. In *Society for Information Technology & Teacher Education International Conference* (pp. 2225-2235). Association for the Advancement of Computing in Education (AACE).

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, California: SAGE Publications.

Curran, D. (2017). *Parents of Autistic Children and Their Experiences With Assistive Technology* (Doctoral dissertation, Northeastern University).

December 4, 2014, from http://www.edutopia.org/autism-school-special-needs

Desai, T., Chow, K., Mumford, L., Hotze, F., & Chau, T. (2014). Implementing an iPad-based alternative communication device for a student with cerebral palsy and autism in the classroom via an access technology delivery protocol. *Computers & Education, 79,* 148-158. doi:10.1016/j.compedu.2014.07.009

Disorders, 42(6), 1236–1248. http://doi.org/10.1007/s10803-011-1284-z

Dixon, R. M., Verenikina, I., Costley, D., & Pryor, S. (2015). The use of iPADs in the home setting for students with autism spectrum disorders. *Journal of Special Education Technology, 30*(4), 193-206. doi:10.1177/0162643415623023

Dukes, S. (1984). Phenomenological methodology in the human sciences. *Journal of Religion and Health, 23(*3, 197-203.)

Dunn, L. M., & Dunn, D. M. (2007). *PPVT-4: Peabody picture vocabulary test*: Pearson Assessments.

Ekas, N. V., Lickenbrock, D. M., & Whitman, T. L. (2010). Optimism, social support, and well-being in mothers of children with autism spectrum disorder. *Journal of autism and developmental disorders, 40*(10), 1274-1284.

Ennis-Cole, D. (2011). Teaching students with autism spectrum disorders: Technology, curriculum, and common sense. *I-Manager's Journal on Educational Psychology*, *5*(3), 52.

Ennis-Cole, D., & Parkman, C. (2012). The Parenting Challenge: Selecting Technology and Non-Technology Interventions for Children with Autism Spectrum Disorders. *Journal on Educational Psychology*, *6*(1), 1-10.

Evmenova, A. S., Graff, H. J., & Behrmann, M. M. (2017). Providing access to academic content for high-school students with significant intellectual disability through interactive videos. *Focus on Autism and Other Developmental Disabilities, 32*(1), 18-30. doi:10.1177/1088357615609307

Fleury, V. P. (2013). Scripting (SC) fact sheet. Chapel Hill: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

Freuler, A. C., Baranek, G. T., Tashjian, C., Watson, L. R., Crais, E. R., & Turner-Brown, L. M. (2013). Parent reflections of experiences of participating in a randomized controlled trial of a behavioral intervention for infants at risk of autism spectrum disorders. *Autism*, 1362361313483928.

Friedman, N. D., Warfield, M. E., & Parish, S. L. (2013). Transition to adulthood for individuals with autism spectrum disorder: Current issues and future perspectives. *Neuropsychiatry, 3*(2), 181-192. doi:10.2217/npy.13.13

Fullan, M. (2001). Leading in a culture of change. San Francisco: Jossey-Bass.

Gantman, A., Kapp, S. K., Orenski, K., & Laugeson, E. A. (2012). Social skills training for young adults with high-functioning autism spectrum disorders: A randomized controlled pilot study. *Journal of Autism and Developmental Disorders*, *42*(6), 1094-1103. doi:10.1007/s10803-011-1350-6

Gentry, T., Kriner, R., Sima, A., McDonough, J., & Wehman, P. (2015). Reducing the need for personal supports among workers with autism using an iPod touch as an assistive technology: Delayed randomized control trial. *Journal of Autism and Developmental Disorders, 45*(3), 669-684. doi:10.1007/s10803-014-2221-8

Georgescu, A. L., Kuzmanovic, B., Roth, D., Bente, G., & Vogeley, K. (2014). The use of virtual characters to assess and train non-verbal communication in high-functioning autism. *Frontiers in human neuroscience*, *8*, 807.

Girli, A., & Dogmaz, S. (2018). Ability of Children with Learning Disabilities and Children with Autism Spectrum Disorder to Recognize Feelings from Facial Expressions and Body Language. *World Journal of Education, 8*(2), 10-26.

Gleason, L. (2017). Virtual Reality Technologies and Autism Spectrum Disorder: Directors of Special Services' Perceptions.

Griffin, W., & AFIRM Team. (2015). *Exercise*. Chapel Hill, NC: National Professional Development Center on Autism Spectrum Disorder, FPG Child Development Center, University of North Carolina. Retrieved from http://afirm.fpg.unc.edu/exercise

Hedges, S., & AFIRM Team. (2017). *Technology-aided instruction and intervention*. Chapel Hill, NC: National Professional Development Center on Autism Spectrum Disorder, FPG Child Development Center, University of North Carolina. Retrieved from http://afirm.fpg.unc.edu/technology-aided-instruction-and-intervention

Hillier, A., Greher, G., Queenan, A., Marshall, S., & Kopec, J. (2016). Music, technology and adolescents with autism spectrum disorders: The effectiveness of the touch screen interface. *Music Education Research, 18*(3), 269-282. doi:10.1080/14613808.2015.1077802

Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. Journal of Child Psychology and Psychiatry, 45(2), 212-229. doi:10.1111/j.1469-7610.2004.00215.x

Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 45*(2), 212–229.

Jones, S., & Bucholz, J. L. (2014). The utilization of an iPad for increasing work-related behaviors in adults with disabilities. *TechTrends*, *58*(6), 84-89.

Kandalaft, M. R., Didehbani, N., Krawczyk, D. C., Allen, T. T., & Chapman, S. B. (2013). Virtual reality social cognition training for young adults with high-functioning autism. *Journal of Autism and Developmental Disorders, 43*(1), 34-44. doi:10.1007/s10803-012-1544-6

Ke, F., & Im, T. (2013). Virtual-reality-based social interaction training for children with high-functioning autism. *The Journal of Educational Research, 106*(6), 441-461. doi:10.1080/00220671.2013.832999

Ke, F., & Moon, J. (2018). Virtual collaborative gaming as social skills training for high-functioning autistic children. *British Journal of Educational Technology, 49*(4), 728-741. doi:10.1111/bjet.12626

Kim, Y. Y., Kim, H. J., Kim, E. N., Ko, H. D., & Kim, H. T. (2005). Characteristic changes in the physiological components of cybersickness. Psychophysiology, 42(5), 616–625. https://0-doi-org.library.uark.edu/10.1111/j.1469-8986.2005.00349.x

Laugeson, E. A., Gantman, A., Kapp, S. K., Orenski, K., & Ellingsen, R. (2015). A randomized controlled trial to improve social skills in young adults with autism spectrum disorder:

The UCLA PEERS® program. *Journal of Autism and Developmental Disorders, 45*(12), 3978-3989. doi:10.1007/s10803-015-2504-8

LaViola, J. J. (2000). A discussion of cybersickness in virtual environments. *ACM SIGCHI Bulletin, 32*(1), 47-56. doi:10.1145/333329.333344

Lee, L., Harrington, R., Louie, B., & Newschaffer, C. (2008). Children with autism: Quality of life and parental concerns. *Journal of Autism and Developmental disorders, 38(6),1147-1160.*

Life on Campus: EMPOWER: University of Arkansas. (n.d.). Retrieved December 12, 2019, from https://empower.uark.edu/campus-life.php

Lin, C. (2018). The Effect of ICT Acceptance on Kindergarten Parents' Empowerment: Deliberative Belief as the Mediator. *Journal of Education and Learning, 7*(6), 37–44. Retrieved from http://0-search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=eric&AN=EJ1191194&site=ehost-live&scope=site

Lorenzo, G., Lledó, A., Arráez-Vera, G., & Lorenzo-Lledó, A. (2019). The application of immersive virtual reality for students with ASD: A review between 1990–2017. Education and Information Technologies, 24(1), 127. doi:http://dx.doi.org/10.1007/s10639-018-9766-7

Lorenzo, G., Lledó, A., Pomares, J., & Roig, R. (2016). Design and application of an immersive virtual reality system to enhance emotional skills for children with autism spectrum disorders. *Computers & Education, 98*, 192-205. doi:10.1016/j.compedu.2016.03.018

Lostan, C. R. (2018). *Defining and measuring autism awareness: Scale development and pilot study* (Order No. 10868224). Available from ProQuest Dissertations & Theses Global. (2057208359). Retrieved from http://0-search.proquest.com.library.uark.edu/docview/2057208359?accountid=8361

Lu, A., Chan, S., Cai, Y., Huang, L., Nay, Z. T., & Goei, S. L. (2018). Learning through VR gaming with virtual pink dolphins for children with ASD. *Interactive Learning Environments, 26*(6), 718-729.

Macintosh, K., & Dissanayake, C. (2006). Social skills and problem behaviours in school aged children with high-functioning autism and Asperger's disorder. *Journal of autism and developmental disorders, 36*(8), 1065-1076.

MacMullin, J. A., Lunsky, Y., & Weiss, J. A. (2016). Plugged in: Electronics use in youth and young adults with autism spectrum disorder. *Autism, 20*(1), 45-54.

MacNeil, B. M., Lopes, V. A., & Minnes, P. M. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Research in Autism Spectrum Disorders, 3*(1), 1-21.

McConachie, H., & Diggle, T. (2007). Parent implemented early intervention for young children with autism spectrum disorder: A systematic review. *Journal of evaluation in clinical practice*, *13*(1), 120-129.

Meadan, H., Snodgrass, M. R., Meyer, L. E., Fisher, K. W., Chung, M. Y., & Halle, J. W. (2016). Internet-based parent-implemented intervention for young children with autism: A pilot study. *Journal of Early Intervention*, *38*(1), 3-23.

Medlin, B. D. (2001). *The factors that may influence a faculty member's decision to adopt electronic technologies in instruction* (Doctoral dissertation, Virginia Polytechnic Institute and State University

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (Fourth ed.). San Francisco, CA: Jossey-Bass, a Wiley brand.

Miller, H. L., & Bugnariu, N. L. (2016). Level of immersion in virtual environments impacts the ability to assess and teach social skills in autism spectrum disorder. *Cyberpsychology, Behavior, and Social Networking*, *19*(4), 246-256.

Mintz, J., Branch, C., March, C., & Lerman, S. (2012). Key factors mediating the use of a mobile technology tool designed to develop social and life skills in children with Autistic Spectrum Disorders. *Computers & Education*, *58*(1), 53-62.

Molnar, M. (2019, April 16). Education Seen as Strong Market for VR and AR By Industry Insiders. Retrieved January 30, 2020, from https://marketbrief.edweek.org/marketplace-k-12/education-seen-strong-market-vr-ar-industry-insiders/?cmp=soc-edit-tw

Morgan, L., Leatzow, A., Clark, S., & Siller, M. (2014). Interview skills for adults with autism spectrum disorder: A pilot randomized controlled trial. *Journal of Autism and Developmental Disorders*, *44*(9), 2290-2300.

Murphy, T., & Tierney, K. (2006). Parents of children with Autistic Spectrum Disorders (ASD): A survey of information needs. *National Council for Special Education Special Education Research Initiative*.

Newbutt, N. A. (2013). *Exploring communication and representation of the self in a virtual world by young people with autism*. University College Dublin (Ireland).

Newbutt, N., Sung, C., Kuo, H. J., & Leahy, M. J. (2017). The acceptance, challenges, and future applications of wearable technology and virtual reality to support people with autism spectrum disorders. In Recent Advances in Technologies for Inclusive Well-Being (pp. 221-241). Springer, Cham.

Newbutt, N., Sung, C., Kuo, H. J., Leahy, M. J., Lin, C. C., & Tong, B. (2016). Brief report: A pilot study of the use of a virtual reality headset in autism populations. *Journal of autism and developmental disorders*, *46*(9), 3166-3176.

Newbutt, N., Sung, C., Kuo, H.-J., Leahy, M. J., Lin, C.-C., & Tong, B. (2016). Brief report: A pilot study of the use of a virtual reality headset in autism populations. *Journal of Autism and Developmental Disorders, 46*(9), 3166–3176.

Newman, L., Wagner, M., Cameto, R., Knokey, A. M., & Shaver, D. (2010). Comparisons across Time of the Outcomes of Youth with Disabilities up to 4 Years after High School. A Report of Findings from the National Longitudinal Transition Study (NLTS) and the National Longitudinal Transition Study-2 (NLTS2). NCSER 2010-3008. *National Center for Special Education Research*.

Nicholson, H., Kehle, T. J., Bray, M. A., & Van Heest, J. (2011). The Effects of Antecedent Physical Activity on the Academic Engagement of Children with Autism Spectrum Disorder. *Psychology in the Schools, 48*(2), 198–213. Retrieved from http://0-search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=eric&AN=EJ921339&site=ehost-live&scope=site

Noor, H. A. M., Shahbodin, F., & Pee, N. C. (2012). Serious game for autism children: review of literature. *World Academy of Science, Engineering and Technology*, *64*(124), 647-652.

Odom, S. L. (2013). *Structured play groups (SPG) fact sheet*. Chapel Hill: The University of North Carolina, Frank Porter Graham Child Development Institute, The National Professional Development Center on Autism Spectrum Disorders.

Odom, S. L., & Strain, P. S. (1986). A comparison of peer-initiation and teacher-antecedent interventions for promoting reciprocal social interaction of autistic preschoolers. *Journal of Applied Behavior Analysis*, *19*, 59–71.

Odom, S. L., Boyd, B., Hall, L., & Hume, K. (2014). Comprehensive treatment models for children and youth with autism spectrum disorders. In F. Volkmar, S. Rogers, K. Pelphrey, & R. Paul (Eds.), Handbook of autism and pervasive developmental disorders (Vol. 2, pp. 770–778). Hoboken, NJ: Wiley.

Olçay-Gül, S., & Tekin-Iftar, E. (2016). Family generated and delivered social story intervention: Acquisition, maintenance, and generalization of social skills in youths with ASD. *Education and Training in Autism and Developmental Disabilities*, *51*(1), 67-78.

Oswald, T. M., Winder-Patel, B., Ruder, S., Xing, G., Stahmer, A., & Solomon, M. (2018). A pilot randomized controlled trial of the ACCESS program: a group intervention to improve social, adaptive functioning, stress coping, and self-determination outcomes in young adults with autism spectrum disorder. *Journal of autism and developmental disorders*, 1-19.

Özen, A. (2015). Effectiveness of Siblings-Delivered iPad Game Activities in Teaching Social Interaction Skills to Children with Autism Spectrum Disorders. Educational Sciences*: Theory and Practice*, *15*(5), 1287–1303. Retrieved from http://0

search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=eric&AN=EJ1101294&site=ehost-live&scope=site

Palmen, A., Didden, R., & Lang, R. (2012). A systematic review of behavioral intervention research on adaptive skill building in high-functioning young adults with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *6*(2), 602-617.

Parisot, A. H. (1995). *Technology and teaching: The adoption and diffusion of technological innovations by a community college faculty* (Doctoral dissertation, Montana State University).

Parsons, S. (2016). Authenticity in Virtual Reality for assessment and intervention in autism: A conceptual review. *Educational Research Review*, *19,* 138-157. review", Educational Research Review, Vol. 19, pp. 138-57.

Parsons, S., Mitchell, P., & Leonard, A. (2004). The use and understanding of virtual environments by adolescents with autistic spectrum disorders. *Journal of Autism and Developmental disorders*, *34*(4), 449-466.

Patrick, K. E. (2016). *Factors Related to Driving Abilities of Young Adults with Autism Spectrum Disorders*. Drexel University.

Pickard, K. E., Kilgore, A. N., & Ingersoll, B. R. (2016). Using community partnerships to better understand the barriers to using an evidence-based, parent-mediated intervention for Autism Spectrum Disorder in a Medicaid system. *American journal of community psychology*, *57*(3-4), 391-403.

Pottie, C. G., & Ingram, K. M. (2008). Daily stress, coping, and well-being in parents of children with autism: A multilevel modeling approach. *Journal of family psychology*, *22*(6), 855.

Raman, R., Vachharajani, H., & Achuthan, K. (2018). Students motivation for adopting programming contests: Innovation-diffusion perspective. *Education and Information Technologies, 23*(5), 1919-1932. doi:10.1007/s10639-018-9697-3

Regan, E. C., & Ramsey, A. D. (1994). Some side-effects of immersion virtual-reality: The results of four immersions (Technical Report 94R012), Army Personal Research Establishment, Farnborough, Hampshire.

Rhoades, R. A., Scarpa, A., & Salley, B. (2007). The importance of physician knowledge of autism spectrum disorder: Results of a parent survey. *BMC Pediatrics, 7*(1), 37-37. doi:10.1186/1471-2431-7-37

Rigsby-Eldredge, M., & McLaughlin, T. F. (1992). The effects of modeling and praise on self-initiated behavior across settings with two adolescent students with autism. *Journal of Developmental and Physical Disabilities*, *4*(3), 205-218.

Rogers, E. M. (1971). *Communication of innovations*. New York, NY: The Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: The Free Press.

Ross, V., Cox, D. J., Reeve, R., Brown, T., Moncrief, M., Schmitt, R., & Gaffney, G. (2018). Measuring the Attitudes of Novice Drivers with Autism Spectrum Disorder as an Indication of Apprehensive Driving: Going beyond Basic Abilities. *Autism: The International Journal of Research and Practice, 22*(1), 62–69. Retrieved from http://0 search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=eric&AN=EJ1167392 &site=ehost-live&scope=site

Roux, A., Shattuck, P., Rast, J., & Anderson, K. (2017). National autism indicators report: Developmental disability services and outcomes in adulthood. AJ Drexel Autism Institute, Drexel University, Philadelphia, PA.

Roux, A., Shattuck, P., Rast, J., Rava, J., & Anderson, K. (2015). National Autism Indicators Report: Transition into young adulthood. *Philadelphia, PA: Life Course Outcomes Research Progra, AJ Drexel Autism Institute, Drexel University.*

Ruthven, K., Hennessy, S., & Brindley, S. (2004). Teacher representations of the successful use of computer-based tools and resources in secondary-school English, Mathematics and Science. *Teaching and Teacher Education, 20*(3), 259-275.

Sahin, I., & Thompson, A. (2006). Using Rogers' Theory to Interpret Instructional Computer Use by COE Faculty. *Journal of Research on Technology in Education, 39*(1).

Saldaña, J. (2015). *The coding manual for qualitative researchers* (3E [Third]. ed.). London;Los Angeles, Calif;: SAGE.

Sam, A., Kucharczyk, S., Waters, V., & AFIRM Team. (2018). *Structured play groups*. Chapel Hill, NC: National Professional Development Center on Autism Spectrum Disorder, FPG Child Development Center, University of North Carolina. Retrieved from http://afirm.fpg.unc.edu/structured-play-groups

Sani-Bozkurt, S., & Ozen, A. (2015). Effectiveness and efficiency of peer and adult models used in video modeling in teaching pretend play skills to children with autism spectrum disorder. *Education and Training in Autism and Developmental Disabilities, 50*(1), 71-83

Schmidt, M., Schmidt, C., Glaser, N., Beck, D., Lim, M., & Palmer, H. (2019). Evaluation of a spherical video-based virtual reality intervention designed to teach adaptive skills for adults with autism: a preliminary report. *Interactive Learning Environments*, 1-20.

Schohl, K. A., Van Hecke, A. V., Carson, A. M., Dolan, B., Karst, J., & Stevens, S. (2014). A replication and extension of the PEERS intervention: Examining effects on social skills and social anxiety in adolescents with autism spectrum disorders. *Journal of autism and developmental disorders*, *44*(3), 532-545.

Seltzer, M. M., Shattuck, P., Abbeduto, L., & Greenberg, J. S. (2004). Trajectory of development in adolescents and adults with autism. *Mental Retardation and Developmental Disabilities Research Reviews, 10*(4), 234–247.

Shepherd, K. G., Fowler, S., McCormick, J., Wilson, C. L., & Morgan, D. (2016). The Search for Role Clarity Challenges and Implications for Special Education Teacher Preparation. Teacher Education and Special Education: The Journal of the Teacher Children, 39(2), 83-97. Education Division of the Council for Exceptional

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *47*(8), 921-929.

Smith, F. (2009). Educators deal with the growing problem of autism. (n.d.). Retrieved

Smith, M. J., Fleming, M. F., Wright, M. A., Losh, M., Humm, L. B., Olsen, D., & Bell, M. D. (2015). Brief report: Vocational outcomes for young adults with autism spectrum disorders at six months after virtual reality job interview training. *Journal of Autism and Developmental Disorders, 45*(10), 3364-3369. doi:10.1007/s10803-015-2470-1

Smith, M. J., Ginger, E. J., Wright, K., Wright, M. A., Taylor, J. L., Humm, L. B., ... & Fleming, M. F. (2014). Virtual reality job interview training in adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *44*(10), 2450-2463.

Sofronoff, K., Attwood, T., Hinton, S., & Levin, I. (2007). A randomized controlled trial of a cognitive behavioural intervention for anger management in children diagnosed with Asperger syndrome. *Journal of autism and developmental disorders*, *37*(7), 1203-1214.

Stahmer, A. C., & Pellecchia, M. (2015). Moving towards a more ecologically valid model of parent-implemented interventions in autism.

Stahmer, A. C., Schreibman, L., & Cunningham, A. B. (2010;2011;). Toward a technology of treatment individualization for young children with autism spectrum disorders. *Brain Research, 1380*, 229-239. doi:10.1016/j.brainres.2010.09.043

Standen, P. J., & Brown, D. J. (2005). Virtual reality in the rehabilitation of people with intellectual disabilities: Review. *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society, 8*(3), 272

Strickland, D. C., McAllister, D., Coles, C. D., & Osborne, S. (2007). An Evolution of Virtual Reality Training Designs for Children with Autism and Fetal Alcohol Spectrum Disorders. Topics in Language Disorders, 27(3), 226.

Stump, K. C. (2017). *Children with autism wearing action cameras: Changing parent/child interactions using point-of-view video modeling* (Order No. 10256113). Available from

ProQuest Dissertations & Theses Global. (1867025189). Retrieved from http://0-search.proquest.com.library.uark.edu/docview/1867025189?accountid=8361

Stump, K. C., Dunn, W., & Tomchek, S. D. (2016). *Using point-of-view video to facilitate social interaction between a parent and their child with an autism spectrum disorder: A feasibility study*. Manuscript submitted for publication.

Sun, F. R., Pan, L. F., Wan, R. G., Li, H., & Wu, S. J. (2018). Detecting the effect of student engagement in an SVVR school-based course on higher level competence development in elementary schools by SEM. *Interactive Learning Environments*, 1-14.

Support: EMPOWER: University of Arkansas. (n.d.). Retrieved December 12, 2019, from https://empower.uark.edu/support.php

Taylor, J. L., & Mailick, M. R. (2014). A longitudinal examination of 10-year change in vocational and educational activities for adults with autism spectrum disorders. *Developmental psychology*, *50*(3), 699.

Van Manen, M. (1990). *Researching lived experience: Human science for an action sensitive pedagogy*. Albany, N.Y.: State University of New York Press.

Van Steensel, F. J. A., Bögels, S. M., & Perrin, S. (2011). Anxiety disorders in children and adolescents with autistic spectrum disorders: A meta-analysis. *Clinical Child and Family Psychology Review, 14*(3), 302-317. doi:10.1007/s10567-011-0097-0

Vasa RA and Mazurek MO (2015) An update on anxiety in youth with autism spectrum disorders. *Current Opinion in Psychiatry* 28: 83–90.

Wallgrün, J. O., Zhao, J., Sajjadi, P., Oprean, D., Murphy, T. B., Baka, J., & Klippel, A. (2019, October). For the Many, Not the One: Designing Low-Cost Joint VR Experiences for Place-Based Learning. In *International Conference on Virtual Reality and Augmented Reality* (pp. 126-148). Springer, Cham.

Wei, X., Wagner, M., Hudson, L., Yu, J. W., & Shattuck, P. (2015). Transition to adulthood: Employment, education, and disengagement in individuals with autism spectrum disorders. *Emerging Adulthood*, *3*(1), 37-45.

Wing, L. (1988). The continuum of autistic characteristics. In *Diagnosis and assessment in autism* (pp. 91-110). Springer, Boston, MA.

Wong, C., Odom, S. L., Hume, K. A., Cox, A. W., Fettig, A., Kucharczyk, S., ... & Schultz, T. R. (2015). Evidence-based practices for children, youth, and young adults with autism spectrum disorder: A comprehensive review. *Journal of autism and developmental disorders*, *45*(7), 1951-1966.

Yu-Ju Lan, Hsiao, I. Y. T., & Mei-Feng Shih. (2018). Effective Learning Design of Game-Based 3D Virtual Language Learning Environments for Special Education

Students. *Journal of Educational Technology & Society, 21*(3), 213–227. Retrieved from http://0-search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=a9h&AN=130867686&site=ehost-live&scope=site

Zhu, S., Yang, H. H., MacLeod, J., Shi, Y., & Wu, D. (2018). Parents' and Students' Attitudes toward Tablet Integration in Schools. *International Review of Research in Open and Distributed Learning, 19*(4), 222–241. Retrieved from http://0-search.ebscohost.com.library.uark.edu/login.aspx?direct=true&db=eric&AN=EJ1192325&site=ehost-live&scope=site

Zlomke, K. R., Jeter, K., & Murphy, J. (2017). Open-trial pilot of parent-child interaction therapy for children with autism spectrum disorder. *Child & Family Behavior Therapy, 39*(1), 1-18.

Appendix

Appendix A: Interview Protocol

1- Basic introduction: Facilitator and the participant. Thank you for coming this interview and participating in this study.

2- Purpose: The goal of today's face-to-face interview is to know and understand your background of using technology in general, and using technology with ASD individuals, in particular. I will be asking specific questions to guide our conversation.

3- Informed Consent: I am passing out what is called informed consent. Signing this means that you are giving me permission to use what you say in this interview for this research. Please read it over and sign if you agree to participate in this research study. If you have any questions, please let us know.

4- Before we start, I would like to remind you that this session will be audio recorded. It is good to mention that only the members of this project will have access to this data and will not share any of your personal information to the public.

Interview questions:

1. Can you describe to me your family?

2. Can you tell me a story that describes your family?

3. What do you enjoy doing together as a family?

4. Can you describe to me a story that exemplifies something your family enjoys?

5. Can you tell me what it is like to be a parent of an Autistic adult?

    a. How old was your adult when he/she was diagnosed?

b. How did you feel when your adult was diagnosed?

c. After the diagnoses, what resources were you made aware of to support your adult?

6. What do you think of when I say the words parental involvement?

a. Can you tell me a story about what parental involvement means to you?

7. What do you think of when I say the word technology?

a. Can you tell me a story about what technology means to you?

b. What or who do you think influenced your use of technology and how do you feel about that?

c. How would you describe your experiences using technologies?

8. What do you think of when I say the word assistive technology?

a. Can you tell me a story about how you have used assistive technology in your everyday life?

b. What or who influenced your use of assistive technology and how do you feel about that?

c. Tell me how you feel about using assistive technology?

9. How would you describe how your family uses technology?

a. Can you tell me a story about how your family uses technology?

b. What or who do you think influenced your family's use of technology and how do you feel about that?

c. How would you describe your family's experiences using technologies?

10. What do you think of when I say the word Virtual reality?

If the participant used VR before:

11. What or who influenced your use of the VR and how do you feel about that?

a. Tell me how you feel about using the VR?

b. How would you describe your experiences using the VR?

Closing: Thank you again for participating in this research.

Appendix B: Focus Group Protocol

1- Basic introduction: Facilitator and participants. Thank you for coming to our focus group today to participate in this study.

2- Purpose: The goal of today's focus group is to hear your opinion about the SVVR and mobile application. I will be asking specific questions to guide our conversation. Also, the main goal for me to be here is to hear about your perspectives, experiences, and understanding regarding the feasibility of SVVR.

3- Informed Consent: I am passing out what is called informed consent. Signing this means that you are giving me permission to use what you say in this focus group for this research. Please read it over and sign if you agree to participate in this research study. If you have any questions, please let us know.

4- Before we start, I would like to remind you that this session will be video recorded. The recording will allow us to have the full picture about the ideas that everyone will share. It is good to mention that only the members of this project will have access to this data and will not share any of your personal information to the public.

5- I'm going to begin by demonstration of the use of the SVVR and then we will pass around some of the gear that we will be using. Then we will discuss your reactions to it.

Focus group questions:

Questions after the demonstration of the SVVR and mobile application:

1- What is your opinion about the SVVR and the 360 environments?

2- Does the SVVR look easy to use? Why/Why not?

a. Do you think the words on the screen are easy to read and understandable? Why/why not?

3- Do you think the SVVR is easy to learn? Why/Why not?

4- Do you think what is being taught (the curriculum) of the SVVR is clear? Why/Why not?

5- Do you think the SVVR is visually appealing? Why/Why not?

6- Do you think the images of the tasks are clear? In what ways? If not, in what ways?

7- What do you think about the feedback provided when the user chooses an incorrect option? Is it adequate? Why/Why not? What would you change?

8- Do you think the SVVR will make it easy to navigate the bus tasks? Please explain.

9- Do you think the 360 environments will motivate young adults with ASD to learn adaptive skills? Why/Why not?

10- Do you think the use of virtual reality technology will help to promote social and life skills for young adults with ASD? Why/Why not? Can you give examples of skills that might be taught through the SVVR?

To answer the first research question:

11- From your perspective, what are the obstacles that prevent you from using VR technology devices and their applications? Why do you think they are existed?

To answer the second research question:

12- How do you usually overcome obstacles if existed?

13- What do you think should be done to help increasing the SVVR mobile application adoption among other parents of ASD individuals?

General questions:

14- What else do you have to share about your perceptions of the SVVR and mobile application?

Closing: Thank you again for participating in this research and sharing your experiences and perspectives with us.

Appendix C: Consent Form

Title: Parents Perceptions of the Adoption of Immersive Virtual Reality for Individuals with Autism Spectrum Disorder

Researcher:	*Faculty Supervisor*	*Compliance Contact Person:*
Fahad Abdeen, Graduate Student	Dennis Beck, Associate Professor	Ro Windwalker, CIP
University of Arkansas	University of Arkansas	University of Arkansas
College of Education	College of Education	Office of Research Compliance
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813-278-0966	479-575-3846	479-575-2208

Purpose: The purpose of this qualitative study is to explore the factors that may influence parents of individuals with ASD who are currently enrolled in the EMPOWER program at the University of Arkansas regarding the adoption of the virtual reality technology. The intervention of 3D immersive virtual environment with a head-mounted display (HMD), as it is the current focus display technology, improved the development of social interactions of individuals with ASD. Therefore, the purpose of the study is to explore the factors that may influence parents of individuals with ASD when they are experiencing the Virtual Reality (VR) and mobile application regarding (1) challenges, (2) how to overcome these challenges, and (3) the user experience.

***Description/Role*:** Your role as a participant in this research study will involve two interviews. The individual interview will last approximately one hour. You will be asked general questions about you and your individual with autism. In the focus group interview, you will be asked to try-out the VR and share your experience with the group. The focus group will last approximately 90 minutes. A demonstration will be provided by the researcher.

***Risk and Benefits*:** There are no anticipated risks or discomfort by participating in this study. There will be no direct benefits to you by participating in this research study. However, your participation might help the researcher to build a better understanding of learning through simulation.

Participant's Expected Commitment: The total time expected to complete the individual interview is 60 minutes. The total time expected to complete the focus group discussion will be 90 minutes. Both individual interview and focus group will be video recorded with your permission.

Voluntary Participation*:* Your participation in this research is completely voluntary. This means, you are giving your consent to voluntarily participate and be part of individual interview and a focus group session and may withdraw at any time.

Confidentiality: All information collected from this research will remain confidential to the extent allowed by applicable State and university Law. No identifying information, such as name, job title, or work location, will appear throughout the study. Also, each participant will be assigned a code to serve as a pseudonym to protect their identity.

Right to Withdraw: You have the right to refuse to participate in the research and to withdraw from this study at any time and for any reason. Your decision to withdraw or refuse will bring no negative consequences.

Informed Consent: I, _____, have read the description, including the

(Please print)

purpose of the study, the procedures to be used, the potential risks, the confidentiality, as well as the option to withdraw from the study at any time. The researchers have answered all of my questions regarding this research, and I understand what is involved. My signature below indicates that I agree to participate in this study.

_____ _____

Signature **Date**

Appendix D: IRB Approval

UNIVERSITY OF ARKANSAS

To:	Fahad Abdeen
From:	Douglas James Adams, Chair IRB Committee
Date:	08/05/2019
Action:	**Expedited Approval**
Action Date:	08/05/2019
Protocol #:	1906199880
Study Title:	Parents of individuals with autism Perceptions of the Adoption of Immersive Virtual Reality.
Expiration Date:	07/18/2020
Last Approval Date:	

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution's IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

Protocols are approved for a maximum period of one year. You may not continue any research activity beyond the expiration date without Committee approval. Please submit continuation requests early enough to allow sufficient time for review. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study closure.

Adverse Events: Any serious or unexpected adverse event must be reported to the IRB Committee within 48 hours. All other adverse events should be reported within 10 working days.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, study personnel, or number of participants, please submit an amendment to the IRB. All changes must be approved by the IRB Committee before they can be initiated.

You must maintain a research file for at least 3 years after completion of the study. This file should include all correspondence with the IRB Committee, original signed consent forms, and study data.

cc: Dennis E Beck, Investigator