The Use of Virtual Worlds to Facilitate Social Interaction of Children on the Autism Spectrum

by

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Statement of Originality

I, MU, Wen Wen, hereby declare that I am the sole author of the thesis and the material presented in this thesis is my original work except those indicated in the acknowledgment. I further declare that I have followed the University's policies and regulations on Academic Honesty, Copyright and Plagiarism in writing the thesis and no material in this thesis has been submitted for a degree in this or other universities.

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Abstract

There is a growing consensus among researchers that virtual worlds are promising tool to support the socializing and learning of children with autism spectrum disorder. However, there are still many unanswered questions concerning the education application of virtual worlds. This study contributes to this area of research by exploring how educators can capitalize on a shared interest in virtual worlds to facilitate social interaction for children on the autism spectrum both in the school setting and in the format of small group environment, and by deploying the theory of Affinity Space in a blended environment with human and technology support to guide this learning process.

The virtual world chosen in this study was Minecraft – a popular virtual world game among school-aged children. Two sub-studies were conducted to address the research questions using a pragmatist stance and a mixed research methods approach. Sub-study 1 involved two special schools in Hong Kong using the qualitative inquiry. Observation and interviews were used in this study to understand the education application and impact of Minecraft in the classroom and extra-curricular activities. Sub-study 2 implemented a behavioral intervention program where a group of four children on the autism spectrum were taught specific social interaction skills over five months in a Minecraft interest group. Single-subject-multiple-probe design was used to evaluate the learning effects.

The results of these two sub-studies demonstrated that a virtual world such as Minecraft could be integrated into different learning contexts to provide a friendly and supportive multiuser learning environment for social development of children on the autism spectrum. The outcomes included successful individual behavior changes, a high rate of social engagement, and positive impact on sophisticated social interaction skills. The findings here suggested that during the learning process, guidance from educators is crucial. Moreover,

using evidence-based behavioral strategies and a structured group training format can also maximize the socializing outcome.

Researchers and educators should embrace the children's unique interest in virtual worlds to motivate learning and social interaction. They should be aware of the potential benefits of combining a well-designed virtual world with elaborated learning design. They should also continue to explore the many different ways new technologies can be used to facilitate the social development of children on the autism spectrum.

Keywords: Autism Spectrum Disorder, Social Interaction, Virtual World, Minecraft, Affinity Space

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List of Abbreviations

ASD	Autism Spectrum Disorder
ABA	Applied Behavioral Analysis
BST	Behavioral Skills Training
PND	Percentage of Non-overlapping Data
SRS	Social Responsiveness Scale
IOA	Interobserver Agreement

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Chapter 1 Introduction

1.1 Preparation and Professional Development for the Research

My research journey with Minecraft began in 2014 when I attended a conference in Macau - "Holistic Care for Students with Special Education Needs". I was excited to learn about the potential of teaching social interaction skills to children with special needs using a virtual environment -TeachLivE - developed by the University of Central Florida in the United States. After the conference, I kept on looking for a proper virtual world that could turn my research interest into reality. What I have found was that most of the virtual worlds used for research exist only in the university laboratory, and building one myself is obviously beyond my capability. Fortunately, a professional in the area of assistive technology introduced Minecraft to me. At the same time, I was deeply touched by the book A Boy Made of Blocks (Stuart, 2016) which is a fiction about a boy with autism spectrum disorder (ASD) who has an intense interest in Minecraft. He expressed his thoughts by building different structures in Minecraft and learn to understand the rules of real-life through the lens of virtual world. And then there was *Autcraft* - a Minecraft server designed for people with ASD, their parents, and helpers, and provided a safe and secure virtual environment for children with ASD to gain social experiences- which attracted my attention. After spending some time understanding this virtual world, I was confident that Minecraft was, indeed, an excellent technology platform to help children with ASD learn and socialize.

Before I enrolled in the Ph.D. program at The Education University of Hong Kong, my teaching and research experiences were mainly on social and motor skills intervention for children with ASD. Using technologies for education is an entirely new field for me. In the past four years, I

have had the privilege of working alongside a team that focuses on applying different technologies to help children with disabilities. We shared the same interest in using the Minecraft virtual world as a learning and social interaction platform for children with ASD both in Hong Kong and Mainland China.

Understanding the application of Minecraft to support the learning and social development of students with ASD and mild intellectual disability in special schools was the first stage of the study. Rather than just an observer, I have participated and assisted in organizing many Minecraft workshops. There were lots of opportunities to observe and communicate with teachers and students with ASD before the formal interviews were conducted. At the same time, I have also accumulated enough experiences to organize Minecraft-based activities by myself and entered the second stage of the study - teaching social interaction skills for children with ASD in a Minecraft interest group in which I was both the program designer and facilitator. To fulfill the requirement of the researcher role, I have also completed six courses of Applied Behavior Analysis (ABA) and participated as an intern in a school with a large number of students with special education needs. What I have learned from ABA have helped me tremendously in designing the Minecraft social skills training activities.

1.2 Definition of Key Terms

Autism Spectrum Disorder (ASD), is conventionally defined as a human neurocognitive developmental disability. Deficits in social interaction/communication skills and restricted/repetitive behavior and interests are the defining characteristics and gold standards for diagnosing ASD (DSM-5 of American Psychiatric Association, 2013). In addition to these core symptoms, autism can have other associated developmental disabilities. About a third has

intellectual disability, some will have attention-deficit/hyperactivity disorder (Leitner, 2014), and some will display emotional/behavioral problems and exhibit atypical sensory-movement development (Donnellan, Hill, & Leary, 2010). Although people with ASD share a similar pattern of social difficulties, these difficulties appear in highly diverse ways.

Social Interaction is a process by which we act and interact with each other. In this study, increased positive social interaction is measured by a) the performance of basic conversation skills such as ask and response to questions, ask and offer helps; b) the performance of advanced social skills such as cooperation, negotiation, and observable learning; c) the level of social engagement (appropriate behavior in social contexts) (MacCormack, 2016); and d) the development of social relationships.

Virtual World is a computer-generated environment that simulates the physical world or any imaginary scenarios (Bartle, 2003; Cobb, 2007). All virtual worlds have the following characteristics. First, many users can participate in the world at the same time, and hence the term "multi-user". Second, the users use a virtual identity (or an avatar) to represent themselves in the world and interact with each other (Moore, Cheng, McGrath & Powell, 2005). Third, all interactions happen in real-time. Fourth, most virtual worlds have a set of "house rules" that the users must follow, and many would allow their users to develop and submit customized content (or UGC – user generated contents). Fifth, the world is persistent; it can continue to exist and evolve whether or not any users are actively interacting with it. Finally, participants of these virtual worlds would also form social groups like teams, clubs, and communities in the physical world, extending their interaction with each other from online to offline.

Minecraft is a popular virtual world that this study has chosen as the research platform. It is a three-dimensional Lego-like virtual environment in which the users can build and interact with each other (Bos, Wilder, Cook, & O'Donnell, 2014, p. 56). In this environment, the player can use many different types of blocks to build different constructs, either alone or with other players. The environment has a day-night cycle, different geographies, and weather elements. Environments in Minecraft are commonly known as "worlds," and there are hundreds of thousands of players-constructed worlds that are running on servers around the world. Minecraft supports two gaming modes – Creative and Survival. Creative mode allows the players to freely build and explore, while survival mode requires the players to fight for survival (Brand, & Kinash, 2013). Regardless of which gaming mode a player has chosen, he can freely decide how much he wants to interact with the other players and be socially engaged (Ringland, Wolf, Dombrowski & Hayes, 2015). Minecraft, being a "sandbox" or "open world" type of game, gives the players considerable freedom to roam, make changes to the world, and pursuit nonlinear goals or tasks. Because of this freedom, a wide possibility of player behavior can be observed in the Minecraft world (Canossa, 2012).

Affinity Space is defined as a place where people get together because of their shared interests and goals, and activities that grow out of those interests (Gee, 2005; Gee & Hayes, 2009; Gee, 2013; 2017). And the space could be virtual or physical or a hybrid of both (Gee, 2004). The Affinity Space Theory was first proposed in the study of virtual world games (Gee, 2008), and it focuses on informal learning and social interactions inside and outside the virtual world.

1.3 Research Background

Ever since Kanner defined the term "early infantile autism" (Kanner, 1943), social interaction and communication impairments together with restricted and repetitive behavior and interest have been considered as the core autism features. Autism exists in a spectrum of heterogeneous disorders. (Nelson & Luciana, 2008), and signals an atypical neurocognitive developmental pathway that could last for a lifetime (Jones, Gliga, Bedford, Charman, & Johnson, 2014). Individuals with ASD often have difficulties interacting with other people and adapting their interests and activities to meet everyday challenges (Lyall, Croen, Daniels, Fallin, Ladd-Acosta et al., 2017). These impairments could negatively affect their acceptance by others, academic performance, and emotional health (Reichow &Volkmar, 2010). Educators and practitioner working with children with ASD must, therefore, identify and address the individuals' social development needs in the light of their specific cognitive profile (Lanou, Hough & Powell, 2012).

The rapid increase in the number of children diagnosed with ASD has aroused the concern of researchers and given rise to many different theories and intervention approaches. Current studies have shifted away from a traditional medical model to focus more on the sociological and cultural aspects of autism. The autism rights movement believes that people on the autism spectrum are just a different type of human being and nothing needs to be fixed (Virnes, Kärnä & Vellonen, 2015).

Therapeutic interventions and environmental modifications have been used to support children with ASD, but they are not the only options. Many researchers and professionals have begun adopting a strength-based approach (Voutilainen, Vellonen, & Kärnä, 2011; Gunn & Delafield-Butt, 2016; Steiner & Gengoux, 2018). Even though the restricted interests of children with ASD have always been considered as a deficit and avoided in earlier intervention approaches (Lewis &

Bodfish, 1998), intense interests and strengths could be closely tied together (O'Neil, 2008). And when the children are interested, they are engaged; and when they are engaged, learning happens (Mitra, 2010). Incorporating the children's interests could lead to successful education programs and facilitate the acquisition of other essential social skills (Campbell & Tincani, 2011; Dunst, Trivette, & Hamby, 2012; Jordan & Caldwell-Harris, 2012).

The above transition necessitates the implementation of new pedagogical models where technology could play a pivotal key (Passerino & Santarosa, 2007). "Technology makes things easier" for the ordinary people, but "technology makes things possible" for people with disabilities (Radabaugh, 1988; cited in Oberle et al., 1993). Information and communication technologies can create new instruction models or strategies, and they can assist daily activities or help mediate and support social interaction (Aresti-Bartolome, & Garcia-Zapirain, 2014). The appropriate use of technology may even elicit a hidden talent or special interest that some individuals with ASD may have. In order to reap the benefits of technology, researchers, educators and technology specialists must work together closely, leveraging on each other's strengths.

Playing video games and using digital devices are the most favorite activities for children on the autism spectrum (Eversole, Collins, Karmarkar, Colton, et al., 2016). The time boys on the autism spectrum spent playing video games is almost twice as long as their peers who are typically developed (Mazurek & Engelhardt, 2013). The stereotype at that people generally perceive computer games as being a waste of time, and that games are violent, anti-social, and isolate young people from society (FoxNews, 2008). But Norton-Meier (2005) stated that "video game has the potential to push an individual to learn and think cognitively, socially, and morally." There is mounting evidence that many students, including those with special education

needs, found the simulation techniques used in computer games highly motivating, can help increase their social engagement and allow active learning to take place (Habgood, Ainsworth, & Benford, 2005; Mohammadi, & Fallah, 2007; Ke, 2008; Rezaiyan, Ke and Abras's, 2013). So rather than just looking at the negative aspects of video game playing, educators should find time to truly understand how video games can help support teaching and make learning more fun and effective.

The growth of the internet and advances in communication technologies have made it possible to create massive virtual worlds that link hundreds of thousands of players together in the cyberspace (Schroeder, 2002). These virtual worlds offer access to a large network of people who share some common interests and are particularly attractive to individuals with ASD who often found their real-world environment overly stimulating. For these socially challenged people, virtual worlds provide many opportunities for them to develop their cognitive and social skills.

Virtual worlds are not without their shortcomings. There are valid concerns about cyberbullying, and studies have shown that individuals on the autism spectrum could be more vulnerable to online aggression and cyberbullying (Kowalski & Fedina, 2011). Given that the social difficulties encountered by these people in the virtual world are similar to the difficulties they encountered in the real world, a virtual world could provide excellent opportunities for these people to learn the appropriate behavior and generalize the learning to the real world (Marsh, 2010). The affinity space theory proposed by Gee (2004) also focused on the social interaction around the virtual world based on common interest.

Researchers have attempted to develop and use different virtual worlds to enhance the social interaction skills of children with ASD. They hope that the skills learned can be generalized and translated into real-life benefits. However, only around 5% of the digital resources intended for

people with ASD have any scientific proof of their effectiveness (Mazurek, Engelhardt &Clark, 2015). Some virtual worlds designed for educational use or intervention purposes have been criticized of being not fun. The gaming companies have much bigger budgets and move at a much faster pace than research labs typically do, making it extremely difficult for the latter to compete for the children's attention. However, the potential benefits of using an existing or ready-made virtual world as a research platform should not be underestimated. Minecraft, a Lego-like virtual world, offers a fun and engaging world where players can build any sorts of artifacts and interact with each other as much or as little as they want. When Minecraft was first released in 2009, it was not intended to be used in an educational context. But over time, because of its unique features, Minecraft has emerged as a powerful tool for teaching and learning. The game is very popular among young children and is especially attractive to children on the autism spectrum. (Kulman, 2015). However, only a handful of studies have explored the learning and social benefits that Minecraft can bring to children with special education needs (Cullen, Klein & Crockett, 2015; Ringland, Wolf, Dombrowski, & Hayes, 2015; Ringland, Wolf, Boyd, Baldwin, & Hayes, 2016; Ringland, Wolf, Faucett, Dombrowski, & Hayes, 2016; MacCormack, 2016; Ringland, Boyd, Faucett, Cullen, & Hayes, 2017; Stone, Mills & Saggers, 2018). The possibilities of using Minecraft as an education tool remain largely unexplored and are definitely worth further examination.

1.4 Research Questions and Aims

Interventions most commonly used for children with ASD who are facing social difficulties are deficit-based. Interest-based interventions, on the other hand, have seldom been used. While individuals with ASD have a natural affinity for technology, few researchers have looked at how

this “intense interest” in technology can be used to make social skills learning more effective. Virtual world is one such technology that individuals with ASD found immensely appealing. The few studies that look at virtual world-based social learning have looked at virtual world in isolation. The interplay between the virtual world and the physical environment has been largely ignored. As a result, there is limited data to show the benefits of mixing virtual and physical world-based learning. This study seeks to explore how a popular virtual world – Minecraft - can be used for social interaction skills learning purposes and investigate its impact on children on the autism spectrum by addressing the following questions:

1. How virtual world can be used for children on the autism spectrum in learning social interaction skills?
2. What are the impacts of using virtual world on the social interaction of children on the autism spectrum?

This thesis had conducted two studies to address the above two research questions. Sub-study 1 explores how Minecraft can be used in a school setting and discusses the application of Minecraft from an educator’s perspective. Sub-study 2 explores how Minecraft can be used in a small group setting, while evaluates the effect of a Minecraft interest group that incorporates behavioral social skills training strategy for children with ASD ages 7–9.

Sub-study 1: The application of Minecraft for children on the autism spectrum in a school setting

Research objectives:

1) To investigate the utilization of Minecraft in classroom and extracurricular activities for students with ASD in special schools in Hong Kong.

2) To explore the social benefits of using Minecraft for teaching students with ASD.

3) To identify the challenges and concerns in using Minecraft at special school.

Sub-study 2: Teaching social interaction skills to children with ASD in a Minecraft interest group

Research objectives:

1) To examine the effect of incorporating the interest of Minecraft into a behavioral social interaction skills training package on social skills performance of children with ASD in a group setting.
2) To measure the social engagement and relationship development of children with ASD both in physical Minecraft group activity and in Minecraft virtual space playing.

1.5 Significance of the Study

Over the past two decades, we see a dramatic increase in the number of individuals who have been diagnosed with autism spectrum disorder. The current statistic is that approximately 1 in 59 children is identified as having ASD (American Psychological Association [APA], 2013). Though the number does vary based on assessment methods and cultural differences across countries, it was estimated that about 1 percent of the world population has ASD (Baio, Wiggins, Christensen, Maenner, Daniels, Warren, & Dowling, 2018). Given that a lack of social skills is a core characteristic of children with ASD, social skills learning should be given a high priority in the education of these children. Many traditional intervention approaches for training social communication skills have uncertain outcomes. And several procedures utilized during intervention have little empirical support (Leaf, Townley-Cochran & Taubman, 2015). The search for the most effective or evidence-based intervention for social skills is still going on earnestly in the research community.

In this research, the author highlights the importance of recognizing and incorporating the interests and strengths in virtual world Minecraft of children with ASD to achieve success, rather than

merely addressing their areas of difficulty. In fact, seldom do professionals, teachers, and even parents look at what unique strengths these people may possess. The "savant skills" in autism are often overlooked (Howlin, Magiati, & Charman, 2009). Previous research is often taken from a deficit perspective, designing and implementing interventions to fix weaknesses in social competence (Diener, Wright, Dunn, Wright, Anderson & Smith, 2015). However, it can be equally important to incorporate the interests of these people to give them enough motivation to perform the social skills learned.

The social model encourages us to look at the social difficulties of individuals with ASD differently. Their skills and abilities may have a higher chance of being appreciated if the environment we provide to them is supportive and accommodating enough. A virtual world like Minecraft has many of the characteristics above. Not only does this platform offer many useful features that can be used for social skills training, this is also something that children with ASD love to do and are good at (Caron, Mottron, Rainville, & Chouinard, 2004; Passmore, & Holder, 2014; Pettit, 2017). This research advances the theory of affinity space by applying it to social interaction skills learning for children on the autism spectrum as well as by creating affinity spaces in traditional school settings for educational use. The affinity space theory was used mainly in literacy and information learning (Lammers, Curwood, & Magnifico, 2012), but recent research studies have also shown that there are positive socialization benefits both inside and outside a virtual world (Engelbrecht & Schiele, 2013). To further develop this theory and make it more sustainable, future research must be complemented with effort and perspective from social sciences.

Even though affinity space theory claims that the space can be both virtual and physical, most studies focus exclusively on online virtual interaction, and even fewer involve children with ASD (Newbutt, Sung, Kuo, Leahy, Lin, & Tong, 2016). This study fills in the gaps by focusing on the

blended space made up of both online and offline activities and applying this theory to individuals with ASD. This research also gives practical advice on how to nurture an affinity space that combines both physical and virtual environments.

This research explores the potential applications and benefits of using virtual world to facilitate the learning and social interaction of children with ASD. The findings of this study can provide more empirical evidence and add to the knowledge in this field which is still very limited (Schmidt, 2014). In sharing these applications, the researcher does not intend to propose a standard procedure that is to be followed exactly as described. Rather, the researcher wants to propose a framework built on affinity space theory and provide guidance to educators on how to take advantage of the students' "intense interest" in technology to facilitate social growth.

1.6 Layout and Arrangement of the Thesis

The thesis is made up of six chapters as outlined below.

Chapter 1 provides the background of the thesis; poses the research problems and research questions, explains the purpose of studying these issues, and describes the contribution to the field of knowledge. The researcher's own motivation to do this study is explained at the beginning of the chapter.

Chapter 2 considers the relevant literature and consists of 3 sections. The first section introduces the social challenges, interests, and strengths of people with ASD and the intervention strategies. The second section introduces the concept of virtual world, the affinity space theory, the virtual world chosen as the research platform – Minecraft, and Minecraft's application in education. The third section illustrates the conceptual framework of this research. This chapter reviews the work

of scholars and practitioners, provides a critical exploration of the research results with a focus on autism and virtual worlds, and finally identifies the research gap that exists.

Chapter 3 describes the research methodology chosen in this thesis. It discusses the researcher's stance to research and the reasons for adopting a mixed research methods approach. The chapter provides a detailed description of the rationale for selecting the case study elements and outlines the data collection and analysis procedures. The limitations of the research method and the ethical considerations are then addressed.

Chapter 4 is the sub-study 1 in this thesis. This chapter examines the current practice and formal studies of the educational use of Minecraft and puts forward some suggestions for best practices. It investigates how a virtual world platform like Minecraft can be used as an educational tool for children with ASD in a school setting. This sub-study reveals how educators use a virtual world in their classroom and in organizing after-school activities. It outlines the benefits and challenges of implementing virtual world-based learning from an educator's perspective.

Chapter 5 is the sub-study 2 in this thesis. A social skills training program was designed with a virtual world context and incorporated best practices in behavioral training. Four children with ASD, age 7–9, played Minecraft together for 16 two-hours long sessions. During structured play time, the participants were divided into small groups to complete team tasks and receive support on modeling, rehearsal, and feedback. This study examines the effects of a behavioral skills training package on the social interaction of children with ASD who have a shared interest in Minecraft.

The Figure 1 shows the relationship between Chapter 4 and Chapter 5. The two sub-studies are closely related and, together, they will provide answers to the research questions posed by this thesis. Findings from both sub-studies will be interpreted based on the affinity space theory which

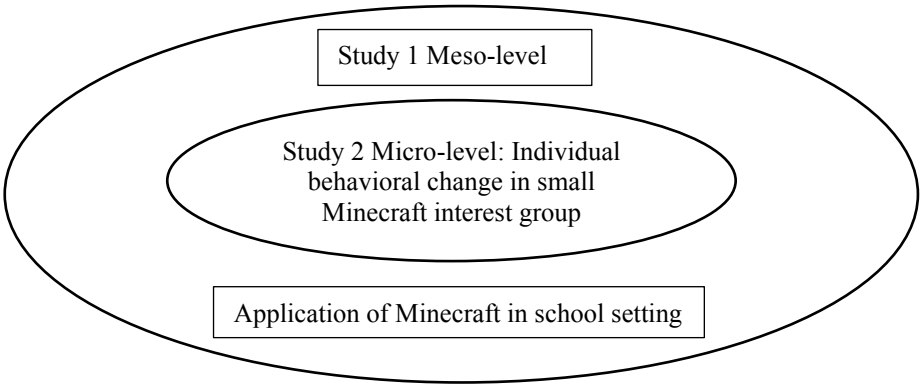


Figure 1: The relationship between the two sub-studies

proposes that social interaction happens both inside and outside the virtual world, and that affinity spaces can be both virtual and physical as long as people come together because of their shared interest. Sub-study 1 has a meso perspective. It depicts how Minecraft is used in a school setting (classroom and afterschool activities) for children with ASD, and how playing in the virtual world affects their communication skills and relationship in real life. Sub-study 2 has a micro perspective and focus on the individual subject. It examines how virtual world-based learning can happen in a small group with the use of a behavior training package. It then reports on the changes observed on the individual's social skill performance, level of engagement and relationship building.

Chapter 6 brings everything together and draws conclusions on the two research questions. The implications, as well as future directions in regard to the use of technology to educate children with ASD, are discussed. This chapter also examines the limitations of the study and clarify some of the issues encountered during the research study.

Chapter 2 Literature Review

Part One

"Autism, they stand among us, but not of us" (Barnbaum, 2008)

2.1 Autism as a Neuro-difference

While many in the scientific community would characterize autism as an illness, there is a growing number of researchers who see autism as a cultural difference and not a disorder that needs to be cured (O'Neil, 2008). These researchers see this difference as a representation of human diversity. Likewise, the autism rights movement continues to challenge the medical view of causation and cure. They believe that autism is a result of variations in gene sequence which is biological in nature. The autistic brain functions differently from a "normal" brain and is not something that can or should be corrected. (Crespi, 2016).

While the cause of autism is not yet fully understood, individuals on the autism spectrum have a huge potential for development and can benefit tremendously from adequate support and intervention which are based on a firm knowledge of the nature of autism and a deep understanding and appreciation of existing evidence-based approaches and strategies. (Masi, DeMayo, Glozier, & Guastella, 2017). Because of the wide variations of behavioral patterns of people with autism, the support given to them must be tailored to the individual's needs and strengths.

2.1.1 Understanding the Social Challenges of Individuals on the Autism Spectrum

The Manifestations of Social Difficulties and their Impacts on Individuals with Autism

Many individuals with autism find social interactions to be over-stimulating and asking them to involve in typical community life can be a real challenge. In most cases, people with autism do

not lack social interactions completely. Instead, it is the reciprocity of social interaction that is limited (Mintz, Gyori, & Aagaard, 2012). The exact behavioral manifestation may vary from one individual to another, according to the individual's age, intelligence, the severity of autism, personality, contexts, and so forth. Some common social deficits include lack of eye contact and facial expressions, poor joint attention, reduced emotion sharing, inability to initiate social interaction, and developing a friendship (DSM-5, 2013). Their tendency to resist change (Kanner, 1943) also prevented them from adjusting their behavior to the ever-changing contexts. Compared to their typically developed counterparts, students with ASD often kept a greater physical distance from their peers, focused more on off-task activities (Goldstein, Lackey & Schneider, 2014), and engaged in fewer and shorter durations reciprocal interactions with peers and teachers (Boutot, & Bryant, 2005; Owen-Deschryver , Carr, Cale, & Blakeley-Smith, 2008). High functioning autism is the fastest growing segment among children with ASD (Ke & Im, 2013). Even though "Asperger's Disorder" and other subgroups have been replaced by the more general "Autism Spectrum Disorder" in the new DSM-5, children with high-functioning autism have cognitive and linguistic abilities that are within the age-appropriate non-impaired range (American Psychiatric Association, 2013). Despite this, they can also exhibit social difficulties as mentioned above. Even though they may have an interest in socializing and making friends and have enough intellectual capacity to understand their surroundings, most often do not have the skills to overcome their social limitations.

These social deficiencies make it difficult for individuals with ASD to participate in normal social life. Their sometimes-awkward behavior can lead to social exclusion and marginalization. These children are more often exposed to bullying and teasing by their peers (Mintz, Gyori, & Aagaard, 2012). These incidents could negatively affect the emotion of these children, leading

further to anxiety and a sense of isolation; and eventually impacting their chance of academic success high quality of life (Koegel, Kim, Koegel & Schwartzman, 2013).

The Assumptions/ Theories of Social Difficulties for Individual with Autism

Many hypotheses and theories have tried to explain the social impairments experienced by people with autism. Psychological theories are trying to search for underlying neurobiological reasons. The views are constantly changing, and each explanation has its limitations. After all these years of searching and exploring, a prevailing unifying theory is still lacking.

Kanner originally proposed in 1943 that the primary impairment of children with autism was affective disturbance. Early psychological theories looked at autism from a perceptual and sensory processing angle (Hermelin & O'Connor, 1970). The arrival of the Theory of Mind (Baron-Cohen Leslie, & Frithet, 1985) has changed the focus once again. It has since been widely used to explain social skill deficits as well as inappropriate social responses. Theory of mind suggests that the impairments are in two major areas: “reading other people’s minds” and “empathizing with other people” (Baron-Cohen O'Riordan, Stone, Jones, & Plaisted, 1999). The theory was empirically tested and found to be consistent with theories that were neuroscientific in nature. The ‘mirror neuron theory’ proposes that the misfiring of neurons causes a lack of empathetic emotional response. The ‘Amygdala theory’ of autism suggests that social deficits are mediated by an inadequately activated amygdala (Barnbaum, 2008), and the weaker amygdala activation makes decoding mental state and emotional information difficult (Ezalla, & Esperduti, 2013). While Theory of Mind is widely used in explaining the social deficits in ASD, not all individuals with ASD fall into this category (Tager-Flusberg, 2007; Kimhi, 2014).

Contrary to theories that are deficit-oriented, the ‘Intensive World Theory’ proposes that the

amygdala of the “autistic” brain may be overly active and causes the environmental stimulus to become excessively intense (Markram, 2007). Under this theory, the exaggerated environmental stimulations result in social withdrawal and avoidance. The ‘Intensive World Theory’, though based on neurobiological findings, also elaborates on the impact of the environment. A highly predictable and calm environment is needed to protect a child with ASD from the sudden surprises (Emarkram& Emarkram, 2010). Social interactions can be made even more difficult by sensory overload and other context-related challenges. Therefore, flexibility in the environment and the forms of interaction are much needed to accommodate individuals with ASD.

Even though each theory offers its explanation of the social impairments experienced by people with ASD, the value of the theory also comes from its power to predict and guide treatment strategies.

Intervention and Support for Individuals with Autism

Therapeutic intervention and environmental support can both reduce the social difficulties of people with ASD, and the number of studies in this area has increased dramatically in the past decade (Reichow. & Volkmar, 2010). These researches differ from each other from their intervention approach, the definition of the social interaction skills, duration, and intensity of the intervention and the degree of adherence to a manual or curriculum (McMahon, Lerner & Britton, 2013). While clinical psychologists mainly conducted these studies, and often in a clinical setting, it is mainly the educators who are providing the training in schools for these children with ASD.

Many evidence-based practices for developing the social skills of children with ASD have been identified, such as prompting, reinforcement, discrete trial teaching, social skills group, peer

tutoring, visual cueing, teaching interaction procedure, Social Stories, Mind Reading, Floor Time, Pivotal Response Training, etc. (The National Autism Centre, USA, 2015). These practices can be used jointly or on their own to address a single skill or a general goal of a student with ASD. They are the building blocks of comprehensive treatment models designed to achieve multiple and more complex outcomes such as communication and social competence (Wong, Odom, Hume, Cox, Fettig, Kucharczyk, & Schultz, 2015). Some well-known examples of comprehensive treatment models are Treatment and Education of Autistic and Communication Handicapped Children (TEACCH) (Panerai, Ferrante, & Zingale, 2002); Relationship Development Intervention (RDI) (Gutstein, Burgess, & Montfort, 2007); Social Communication, Emotional Regulation, Transactional Supports (SCERTS) (Prizant & u.a, 2006) and several variations based on Applied Behavior Analysis (ABA).

2.1.2 The Interests of Individuals on the Autism Spectrum

Restricted, circumscribed, and perseverative interests refer to activities that a person pursue with high intensity and extreme focus. Although this characteristic is commonly found in many individuals with ASD, the nature of these interests, how they come about and change over time, or how they can be used to improve treatment effectiveness have yet to be extensively studied. In 1944, Hans Asperger provided the first precise description of ‘circumscribed interests’ and saw that as a fascinating characteristic of people with autism, and appreciated their strengths in original thoughts (Asperger, 1944/1991, p. 37). Baron-Cohen (2000) pointed out that people with ASD have a preference for working with objects rather than people and have a fascination with patterns and symbols. He also argued that autism’s systematizing skills could be advantageous in a highly structured and rule-based context (Baron-Cohen, 2006). Their intense focus on narrow

areas of interest can make them self-taught experts in those areas (O'Neil, 2008; Mottron, 2011), even though they may have difficulty grasping the more general knowledge. Caldwell-Harris and Jordan (2014) argued that special interests were not primarily repetitive behaviors, that people's cognitive strengths and personal styles prompted the development of special interests in particular domains. People with autism may have "high yet imbalanced intelligence" (Crespi, 2016). Autism's association with specific strengths have also been supported in many scientific works of literature. These strengths include increased sensory and visual-spatial abilities, increased focus, more deliberative decision-making, professional interests in engineering and physical sciences (Crespi, 2016). These findings raise the question of whether autism is a disability, or should we spend more time understanding how these interests/strengths can be made useful (O'Neil, 2008).

Current researches argued that restricted interests could become intrusively absorbing, consuming too much of the child's attention, and interfering with potential social interactions (Klin, Saulnier, Sparrow, Cicchetti, Volkmar & Lord, 2007; Spiker, Lin, Van Dyke, & Wood, 2012). As a result, program and intervention designers tended to avoid the topic of intense interest when treating people with ASD (e.g., Lovaas, 1987). However, in a survey done by Koenig and Williams (2017), people with ASD saw their intense interests as a means to mitigate anxiety and preferred to engage in vocational pursuits that were related to these interests. The research argued that strength-based preferred interests were positive, beneficial, and should be encouraged (Koenig & Williams, 2017).

Emerging evidences were showing that the intense interests of individuals with ASD where actually their unique strengths that could be leveraged to motivate them to learn other skills (Boyd, Conroy, Mancil, Nakao, & Alter, 2007; Spencer, Simpson, Day, & Buster, 2008;

Barakova et al., 2014). Further researches in this area could likely contribute to our understanding of autism and improve intervention effectiveness (Klin et al. 2007; Turner-Brown, Lam, Holtzclaw, Dichter & Bodfish, 2011).

2.1.3 Use of Intense Interests in Social Interaction Intervention

When training children with ASD, intense interests are most often used as a reward for completing a less desirable activity. Researches have shown that when adopting a token-based intervention, token presented with intense interests were more effective (Boyd et al., 2007) than tokens without the intense interests (Carnett, Raulston, Lang, Tostanoski, Lee & Sigafoos., 2014). Although this strategy can be an effective component of a behavior management program, children may get aggressive when they cannot tolerate reduced access.

Koegel, Dyer, and Bell (1987) found that engaging in preferred activities could reduce social avoidance behavior in children with ASD (Koegel, Dyer & Bell, 1987). Evidence has also shown that interests-based activities could be so powerful that they could induce changes even in the absence of an intervention program. Boyd et al. (2007) compared the effects of circumscribed interests to less preferred tangible stimuli and found that the former could result in longer social interaction duration and shorter social bids latency. Another study exploring whether incorporating the preferred interests of seven participants with ASD would improve their social interaction found that their engagement level and social initiation frequency have increased (Koegel et al., 2013). These studies suggested that, when their preferred interests are considered, children with ASD could improve their social behaviors even with minimal direct intervention efforts.

Research on using the child's intense interests in social interaction skill intervention is relatively

new compared to other methods of intervention that focus on reducing deficiencies rather than building on strengths. One such research found that "learning social interaction skills while doing an activity was considered easier or more enjoyable because it could help maintain focus or provide something to talk about" (Bottema-Beutel, Mullins, Harvey, Gustafson & Carter 2015, p. 7). Nuernberger, Ringdahl, Vargo, Crumpecker and Gunnarsson (2013) taught reciprocal conversation skills using topics that were of interest to the individual participants with excellent results. A few social skills intervention programs also claimed to focus on developing the child's strengths and interests. Gagnon (2001) developed the *Power Card* strategy, using the restricted interests of children with ASD to motivate and facilitate their learning in academic and social areas. The teaching staff involved in the study found the strategy to be effective in increasing the student's direction following ability and enhancing their social interaction skills. They also found the strategy reasonably easy to implement (Campbell & Tincani, 2011). *LEGO therapy* attempts to bring about behavioral changes by building on children's natural interest in play, targeting skills such as verbal and non-verbal communication, turn-taking and collaboration (Lindsay, Hounsell & Cassianithe, 2017). The *Superhero* social skill curriculum incorporated the children's self-interests in its training programs (Radley et. al 2014b). Research has shown that programs that incorporate the children's interests are more effective in helping them develop social skills than those that do not (Dunst, Trivette, & Masiello, 2012). It is probably because including the restricted interest in activity can increase their willingness to participate, and the more engaged they are, the more natural learning will take place.

2.1.4 Social Interaction Intervention with an Affinity to Technology

Individuals with ASD have shown an affinity to computers and other digital devices (Ploog,

Scharf, Nelson, & Brooks, 2013). The field of special education technology attempts to use different technical means to compensate for disability and can cover a wide range of individual needs. Here are some examples of how technology can be used to enhance the development of social interaction skills. These technologies can range from day-to-day tools such as digital pictures, videos and mobile apps to the more sophisticated tools such as computer-assisted instruction, video games, virtual reality and social robots (Reichow & Volkmar, 2010; Southall & Campbell, 2015; Virnes, Kärnä & Vellonen, 2015).

Technology can be used to address difficulties related to social interaction by targeting discrete kind of communication skill such as verbal speech (Paul, 2008; Ascari, Pereira, & Silva, 2018). Over the years, different kinds of autism-specific training systems have been developed. TeachTown (2006) was designed to improve social understanding, self-help skills, and the use of receptive language (Whalen, Liden, Ingersoll, Dallaire, & Liden, 2006). SymTrend (2006) was developed to provide guidelines to cope with the identified behavioral problems after the children's behaviors have been observed and analyzed (Picard, 2009). Digital online tools such as email, discussion forums, and social networking sites are strongly preferred by people with high functioning autism (Benford & Standen, 2011). These tools all provide some form of low and focused stimuli. Their use does not involve any non-verbal cues, sharing of emotion or ambient stimuli that people with autism tend to have difficulty with. These digital channels offer social support and create alternative means for making a social connection and forming communities of interest (Cafiero, 2012). Robots have been used to teach basic social interaction skills and have been used as objects for joint attention training (Goldsmith & LeBlanc, 2004). Computer games, as well as other activities on the computer or mobile devices, have been widely used as rewards or behavioral reinforcer for students with ASD (Southall, 2013).

Using technology as an intervention strategy also has its risks and limitations. There is a widespread concern that addiction to computer-based activities may deepen social isolation. People with autism, due to their limited social knowledge, are more prone to be cheated or bullied online. And some researchers have argued that while individuals with autism are more comfortable with computer-mediated interactions, it is still difficult for them to maintain long term online relationships. So when selecting what software to use in an intervention program, practitioners should consider the preferences and abilities of the individuals carefully, and how much the software can be customized to meet these highly individualized needs (Ramdoss, Machalicek, Rispol, Mulloy, Lang, & O'reilly, 2012). A piece of technology, no matter how sophisticated, is not a "miracle cure". Over-confidence in assistive technology would inevitably lead to frustration and disappointment (Gyori, Stefanik, & Kanizsai-nagy 2015). Last but not least, practitioners need also consider the cost of implementing these technologies. While some are quite affordable, more sophisticated technologies such as virtual reality and social robots are still out of reach of most common households (Goldsmith & LeBlanc, 2004).

Many studies have demonstrated the positive impact of using technology with children with autism. That the use of computers can enhance motivation and reduced inappropriate behavior (Goldsmith & LeBlanc, 2004). Most of these studies, however, lack rigorous comparison or scientific proof of how much technology-based approaches are better than the traditional non-tech or low-tech approaches (Goldsmith & LeBlanc, 2004; Ploog et al., 2013; Southall, 2013). More research and comparison need to be done before a definitive answer can be given.

Part Two

"Virtual worlds are places where the imaginary meets the real."

2.2 The Potential of Virtual world for Supporting Individuals with ASD

2.2.1 Overview of Virtual World

Virtual worlds have a long and rich history. They were initially known as Multi-User Dungeons (or MUD) (1978). After attracting an enormous number of players, this genre of the game became known as Massive-Multiplayer Online (or MMO) Games. The Universities mainly maintained the first generation of virtual worlds until the emergence of the World Wide Web where a massive number of people started coming online. Virtual world games like Ultima Online was first conceived in 1997 to be a rich and deep virtual world with an emphasis on community building, player-driven action, and the ability to accommodate different playing styles. Meridian 59 gave the players a greater sense of being by using 3-dimensional graphics. Virtual worlds are not just computer games though they may begin as such. People can certainly play games in the virtual worlds, but these games are mainly created for accumulating points to advance to the next level. Virtual worlds as social spaces have no such focus (Schroeder, 2008; Girvan, 2018). Virtual worlds are not just simulations though they may simulate the physical world to create a sense of immersion. Virtual worlds are not just a communication channel though all virtual worlds have tools that allow the players to communicate with each other easily. Ultimately, "*they are just a set of locations-places, people go to places, do things there, and then they go back to real life*." (Bartle, 2003).

Virtual worlds and virtual reality are two different concepts. Virtual reality is made up of a set of technologies and with "a computer-generated display that allows or compels the user to have a

sense of being present in an environment other than the one they are actually in, and to interact with that environment" (Schroeder 1996). Virtual worlds are persistent virtual environments in which people can interact with each other as if they are together in the physical world. A virtual environment can be single-user or multi-user (Neale, Cobb, Kerr, & Leonard, 2002), and it can be textual or graphical.

Virtual worlds have many potential uses beyond mere entertainment. They are often used for human behavior research. For instance, social scientists have studied avatars and their social life since virtual worlds allow life-like social interaction to take place (Chesney, Chuah, Hui, Hoffmann, & Larner, 2014). Psychologists have found two aspects of virtual worlds particularly interesting: identity construction (Parmentier, & Rolland, 2009) and addiction (Sepehr, & Head 2013). The optimistic researchers concluded that the experiences in virtual worlds could drastically advance personal growth and self-awareness (Jakobsson, 2006). Educators took an interest in virtual worlds and have used them to teach second language (Panichi, 2015), simple programming (Rico, Martínez-Muñoz, Alaman, Camacho, & Pulido, 2011) and team-building skills (Qiu, Tay, & Wu, 2009).

2.2.2 Social Interaction in the Virtual World

Virtual worlds provided rich environments in which people can interact with each other and develop relationships. It came as no surprise that the most researched aspects of virtual worlds are social interaction and relationship development. (Cole & Griffiths, 2007; Donkin & Holloway, 2017). Virtual worlds provided abundant immersive social contexts that embody different types of social activities, can users can learn social interaction skills through problem-solving with a team (Gallup, Little, Serianni, & Kocaoz, 2017). Studies have demonstrated that

meeting new people and making friends is what motivated the majority of people to participate in virtual worlds (Welles, Rousse, Merrill, & Contractor, 2014). Munn (2012) argued that virtual worlds provided a form of online interaction that is distinct other alternatives such as chat rooms, email and instant messaging. It is more like the physical world where shared activity is core to developing and sustaining friendships (Munn, 2012). On the other hand, some studies have found that the extent of social activities in virtual worlds might have been over-estimated, and virtual interactions do not usually provide the kind of deep emotional support that people expected (Steinkuehler & Williams, 2006). Schroeder (2002) proposed that the study of virtual worlds should be integrated with the study of the other communication media, and how they fit into our daily life.

How one's virtual and real life affects each other is also an important issue. As people became more and more involved in the virtual worlds, it is starting to have an impact on their lives in the real world. Putnam (1997) predicted that "*we will be faced with a group of socially withdrawn teenagers who are 'addicted' to living in their virtual worlds"* (p. 211). Valentine and Holloway (2002) stated that *"the virtual" is going to pollute the real."* On the other hand, Granic, Lobel, and Engels (2014) argued that participating in virtual worlds may foster psychosocial benefits in the real world. That social skills learned in the virtual worlds could generalize to real-life social relationships. Donkin and Holloway (2016) explored the use of virtual worlds for 5 to 12 years old children. He found that these children were able to collaborate and cooperate with others and were able to develop and maintain a friendship in the virtual world. As such, these virtual spaces have the potential to enhance children's social skill development as well as improve their emotional wellbeing.

A few studies have explored the different patterns of interaction happening in virtual and real

worlds. Boellstorff (2008) asserted that there are clear ontological differences between online and offline activities. People may react differently to virtual versus real human beings (Ebombari, Marianne, Ecañadas, & Ebachmann, 2015). Hammick and Lee (2014) concluded that shy people felt less of communication apprehension on the virtual world *Second Life* than face to face communication. Face to face communication, on the other hand, was more effective in influencing others' behavior. However, the "virtual" and the "real" may overlap (Jordan, 2009). Bartle (2003) considered that the virtual is governed by the real, and that virtual society can be regarded as a subclass of the real society. Jakobson (2006) stated that virtual worlds are swarmed with real people interacting with each other and arousing true emotions, so there are no fixed boundaries between the two worlds. Yee's (2006) study supported that social norms in the real world also govern social interactions that take place in the virtual worlds. Welles et al. (2014) revealed that friendship developed in the virtual worlds bear many resemblances to friendship developed in the real world. Young people tend to interact with the same group of people, both online and offline, resulting in much overlap between the two worlds (Welles et al., 2014).

2.2.3 Facilitate Social Interaction of Individuals with Autism through Virtual World

This research will not consider the single-user virtual environment or other computer-based social training programs which have merely adopted virtual reality technologies. A new breed of collaborative virtual environments is emerging and is mostly used for training purposes. If these collaborative virtual environments could only be accessed by one user and a coach or instructor, and have no interaction between the users, they will also be excluded in this review. Also, virtual worlds are persistent, and the users will continue to build, interact, and develop content. Collaborative virtual environments, on the other hand, do not (Newbutt, 2013). Researches

regarding the massively multiplayer online roleplay games (MMORPG) for autism are included, as they are a subset of virtual worlds (Schroeder, 2008).

Virtual worlds not only share the advantages of many other computer-based learning tools, but they also have some special characteristics that make them an ideal social learning tool for children with ASD (Strickland, 1998; Passey, 2014, p.111). These characteristics include a) Virtual worlds create a safe and less stressful environment where people can freely interact; b) Since this is computer-generated world, the users can choose to go through the same scenarios or perform the same tasks over and over again; c) The designer of the virtual worlds can choose to simplify complicated social context or behaviors into smaller chunks that fit the individual needs; d) Interactions in the virtual worlds can be manipulated and made more predictable than interactions in the real world; e) Many virtual worlds offer visually stimulating graphics that play well with the visual perception strengths of individuals with ASD (Grandin, 2006); f) Autistic children are often intrinsically motivated by computer-based or rich multimedia formats (Baron-Cohen, Golan & Ashwin, 2009); g) Interpersonal communication and development of social relationship are key aspects of all virtual worlds. They provide many opportunities for the participants to interact with each other (Georgescu, Ekuzmanovic, Eroth, Ebente & Evogeley, 2014); h) Virtual worlds allow individuals with ASD to gain experiences of real-life scenarios that are very hard to talk about without actually going through.

Social Interaction around Virtual World for Individuals on the Autism Spectrum

Children with ASD tend to spend more time in front of computer screens and have higher cases of addictive video game use (Mazurek, Shattuck, Wagner & Cooper, 2012). Moreover, studies have found that addictive video game use is associated with oppositional behaviors such as

arguing, aggression, and refusing to follow directions (Mazurek & Wenstrup, 2013). There is an additional concern that people with autism will come to rely on a computer as their only source of social interaction (Parsons et al., 2000). Early studies have found that people with ASD have difficulty understanding social conventions in a virtual world, the same kind of difficulty they experience in the real world, (Parsons, Mitchell, & Leonard, 2004), and spent very little time interacting with each other in these worlds (Parsons & Cobb, 2011).

On the positive side, Cobb et al. (2002) observed that participants with ASD found virtual worlds to be interesting and fun. Virtual world has the potential to become a platform for people with ASD to meet their peers on equal footings; help them overcome social anxiety by relying less on social cues such as eye contact and gestures; and provide a safe environment to practise social skills (Fusar-Poli, Cortesi, Borgwardt, & Politi, 2008; Stendal, & Balandin, 2015). Fusar-Poli et al. (2008) also suggested that for learning to take place, a safe space is needed in which mistakes can be tolerated. For example, one of the virtual communities within Second Life is Brigadoon. It is a restricted area where only selected high-functioning autistic individuals, and their supporters can access (Lester, 2005). Members of Brigadoon create avatars, called 'Dooners', and interact with each other without fear of ramifications. This provides an excellent opportunity for them to practice social interaction skills in a risk-free environment that can be hard to find in the real world. Stendal & Balandin (2015) also found that virtual worlds offered some unique opportunities for people with autism to become a part of a community where they can develop and maintain friendships.

Virtual World Use in Social Interaction Intervention for Individuals on the Autism Spectrum

Virtual world is a promising direct intervention strategy that can be used with individuals with

ASD (Wainer & Ingersoll, 2011). Some studies have adopted specially developed virtual worlds for social skills training. Parsons et al. (2000) created the Asperger's Syndrome interactive project which modified a Virtual Café within a Virtual City (Brown, Neale, Cobb, & Reynolds, 1999) for developing social awareness amongst adults with ASD. The result showed that, after practicing in this virtual café, the subjects have shown improvement in their social reasoning skills and became more aware of common social conventions (Parsons & Cobb, 2011). Based on cognitive behavioral therapy, the COSPATIAL project (2009-2012) used virtual world games to train communication and collaboration skills for children with ASD in school (Parsons, Millen, Garib-Penna, & Cobb, 2011). Researchers at the University of Missouri have developed iSocial to deliver social competence curriculum to students with ASD and have shown positive results (Stichter, Laffey, Galyen, & Herzog, 2013). In Brainville - a virtual town created by researchers at the University of Texas – people with ASD can practice their social skills in a safe and controlled environment with the presence of coaches (Words & Koller, 2015).

Instead of developing a brand-new virtual world from the ground up, some researchers have opted to use existing virtual worlds such as Second Life and Minecraft. Newbutt, in his doctoral research (2013), examined how students with ASD can benefit from learning in a virtual world. Second Life was used as the research platform and contents were created to fit each student's capability and needs. The research demonstrated that these students with ASD had shown reduced stereotypic behaviors; more engagement in positive behaviors: mirroring of real-world behaviors and increased communication with peers, when compared to classroom observations (Newbutt, 2013). Didehbani, Allen, Kandalaft, Krawczyk, and Chapman, (2016) also used Second Life to build different social scenarios to investigate the impact of Virtual Reality Social Cognition Training on children with ASD, and the outcomes were quite positive.

Virtual worlds have been used to help people with ASD develop empathy, emotion recognition, social competence, spontaneous greetings, and social conflict resolutions. They have also been used by researchers to understand better how human process social information (Ramdoss, Lang, Mulloy, Franco, O'Reilly, Didden, & Lancioni, 2011). Given that this is a relatively new research area, the most published literature is descriptive with limited empirical support. (Wainer & Ingersoll, 2011). They are summarized and analysed along the following dimensions.

Effect: The impact of the virtual world-based intervention varied across studies. While social skills related outcomes were consistently positive, effects could range from small to large (Ramdoss et al., 2011). The studies have also suggested that, in terms of social skills training, face-to-face instruction is no more effective than computer-based instruction.

Strategy: A small number of programs reviewed have combined virtual world-based intervention with real-world physical activities. Most, however, have used virtual world as the only means to train the target skills. Some studies have combined computer-based instruction with teacher-led sessions (Wainer & Ingersoll, 2011). Virtual worlds could, indeed, incorporate certain elements of social interaction by allowing parents or caregivers to play alongside the person with autism, or teachers playing the role of virtual coaches (Parsons & Mitchell, 2002). It is essential to point out that the intervention or teaching strategies used were just as important as the technology itself if not more.

Generalization: In many ways, life in the virtual world is similar to life in the real (Parsons et al., 2000). Virtual worlds, with their vibrant graphics, animations and endless diversity of computer-generated scenarios also help facilitate generalization of the skills learned to the real world (Herreraa, Jordanb & Vera, 2006; Southall, 2013). However, as Mazurek (2013) suggested, more research is needed to determine to what extent does generalization take place. It is also worth

noting that most studies are focusing on simple social skills that are rule-based or procedural while the social skills demanded by the real world are much more complicated (Mazurek, 2013). There was also variability in responding, suggesting that programs need to be carefully targeted according to the individual abilities of children (Parsons &Cobb, 2011). In addition, while screen-based technologies can provide exciting functions for the teaching of social skills, their long-term effectiveness is still questionable. The long-term goal is still to get people with ASD to interact well with real people - parents, siblings, classmates or colleagues at work.

Participants: Parsons, Leonard, and Mitchell (2006) cautioned that virtual world, just like any other tool, is not a "cure all" and may not be suitable for all people with ASD. Researchers have acknowledged that the relatively small group sizes in the studies, though children, teens, and young adults have all been involved.

This review strongly suggested that using virtual worlds to improve the social interaction skills of individuals with ASD is a promising strategy (Ramdoss et al., 2011). Virtual worlds are flexible enough to accommodate multi-modal communication, diversity of scenarios, and incorporating personal preference, which are all touchstones of a successful social skills training program. With all the benefits offered by virtual worlds, the amount of empirical data supporting their effect is still relatively limited. This is what motivated the research, as will be discussed in the next section.

2.3 Affinity Space Theory and Its Application

Gee (2004) defined the notion of Affinity Space which is "a place or set of places where people from a variety of backgrounds affiliate with each other based primarily on shared activities, interests" (Gee, 2004, p. 77). Affinity Space Theory was first proposed in the studies of virtual

world games. ‘The Game beyond the game,’ the Game with a capital G refers to the social interaction that goes on in the context surrounding the game (Gee, 2008). This theory advances the theory of “communities of practice” or “communities of interest” which claims that people are typically bound together by shared activities around specific interests (Obst, Zinkiewicz, & Smith., 2002). Communities of practice is not a new phenomenon. People learn by interacting and sharing experiences with each other, especially in the acquisition of tacit knowledge (Agrifoglio, 2015). When a group of people collaborates online, they also form a "virtual community of practice" (Dubé, Bourhis & Jacob 2005). However, Gee (2004, 2005, 2013) argued that the concept of community of practice is hard to understand; that more and more virtual social spaces do not imply group membership or a instills a sense of belonging, and the concept fails to capture cases where the individuals are separated from each other geographically and participation is unstable. Duncan and Hayes (2012) further emphasized the importance of affordances and constraints offered by the environment to an affinity space when participation is much more fluid.

Affinity spaces can have many manifestations – they can be pure virtual spaces, pure physical spaces, or a hybrid of both virtual and physical spaces. There are also many unique types of affinity spaces, and participation in these spaces can vary a lot. Some people may come only once, while others may visit frequently. A nurturing affinity space allows the participants to interact closely with each other, which is good for learning and socialization. Though in practice, many affinity spaces have failed to reach this ideal state. We need to study the relationship between affinity spaces and social interaction within the virtual worlds and how the two can work together to enhance learning and lead people to types of knowledge that are not games-specific (Gee, 2011).

Even though the affinity space theory claims that the space can be both virtual and physical, current studies focus mostly on virtual affinity spaces. In addition, they are mostly concerned with how these spaces can be applied in information learning, language, and writing. Bebbington and Vellino (2015) conducted a case study to understand how players learn specific information literacy skills in Minecraft affinity space. Wu (2016) used a Minecraft affinity space to understand how young people can be transformed from consumers to producers of digital contents. Currently, researchers are seeking to expand the affinity space theory to other areas and drill deeper on what the affinity space concept has told us about learning and interactions in the virtual world. (Lammers, Curwood, & Magnifico, 2012; Pellicone & Ahn, 2015; Jackson, 2016; Wu, 2016; Murphey, Fukada, & Falout, 2016).

2.4 Minecraft and its Application for Social Development of Individuals on the Autism spectrum

2.4.1 Minecraft and its Application in Education

Minecraft is chosen as the research platform for several reasons. Firstly, its massive user base. More than 17. 5 million copies of the game have been sold worldwide since it was released in 2011 (Overby & Jones, 2015). Over 100 million users from more than 66 countries have logged more than 1 billion hours of playing time (Ellison & Evans, 2016). Secondly, the appeal of the game to children. Minecraft uses pixelated and blocky graphics which children, especially those with ASD, found very appealing (Kulman, 2015). Thirdly, accessibility. Minecraft is relatively inexpensive and is available in many different platforms – PC/Mac, mobile, gaming console. Last but not least, variability. The structure of Minecraft provides multiple entry points to reflect on and hence, has attracted much attention from educators and researchers (Wu, 2016).

Minecraft is commercial software and was not originally designed for educational use. However, because of the many unique possibilities in using Minecraft for teaching and learning, Minecraft has been heavily discussed in education-related research (Olivia, 2012). Minecraft has been used to teach a great variety of subjects including computer coding, mathematics, engineering, history, language, arts (Overby & Jones, 2015). Minecraft Edu is a platform that grows out of a need to use Minecraft in the classroom. It was developed by Teacher Gaming in 2011 and provided additional tools to help teachers adapt Minecraft to their own curriculum needs (Perez, 2016). By September 2012, an estimated 250,000 students have played Minecraft through Minecraft Edu. The possible applications of Minecraft do not just end with curriculum use. It could help spark children's creativity and develop important executive function-related skills such as flexible thinking, planning, and organization (Kulman, 2015). It could also help young people express their feelings, control their emotions, and better engage in teamwork (Ellison & Evans, 2016). Researchers and teachers have started to consider the potential of using Minecraft for social skills training. Frank, Pappas and Tarshis (2013) have conducted group therapy to teach social skills to students with ADHD. Satisfaction level from the participants was high, and previous concerns regarding technology barriers did not happen (Frank et al., 2013). Minecraft could also facilitate the learning of interpersonal skills. When playing in survival mode, players often need to rely on each other's help in order to keep alive.

When appropriately used, Minecraft could help build a positive classroom climate whereby teamwork could develop organically as students work together in the virtual world (Risberg, 2015).

2.4.2 A Minecraft Affinity Space for Individuals on the Autism Spectrum

Minecraft is an excellent research platform for affinity spaces because the game encourages dynamic interaction among the players, and there is no lack of activities for them to perform (Pellicone & Ahn, 2015). The help-seeking, knowledge sharing, self-expression and mutual support aspects of the game all work together to create an environment conducive to social learning.

Autcraft is the first Minecraft server created specifically for children with ASD and their families. As Autcraft is built on a common interest – Minecraft (Zolyomi & Schmalz, 2017), it can be considered as a Minecraft affinity space. The success of Autcraft is an excellent example of Minecraft's attractiveness to children with ASD and its potential impact on their real life. Autcraft was created by Stuart Duncan who, not only has autism himself, but also a child with autism. He created Autcraft so that children with ASD could have a safe and secure environment to play the Minecraft virtual world game. Autcraft is a white-listed server. Only children and adults with ASD and their families and friends who have been given prior permission could access and play. In this world, grieving and bullying are not allowed. Duncan (2011) has chosen to use Minecraft because of its many age-appropriate activities. According to Duncan (2011), "Minecraft strips away the pressures and distractions of the real world. You can really just be yourself". But Autcraft is more than just another online community; it is also a tool that helps autistic children practice social interaction skills and build a friendship. Ringland (2014, 2015, 2016) conducted a series of studies on Minecraft and stated that for the autistic population, the social support and friendship experienced in an online virtual world is an excellent first step towards enhanced social interaction and relationship in the real world. There is a concern that these online relationships may constrain the development of offline relationship. However, this

has been proved otherwise, emerging evidence has indicated that these online activities can indeed facilitate offline relationships (Ringland et al., 2014, 2015, 2016).

2.4.3 Using Minecraft as a Social Communication Tool

Minecraft can be seen as a type of Computer-Mediated Communication. In a computer-mediated communication environment, users often communicate with each other using text, graphical icons, sound, or other means (Banakou, Chorianopoulos & Anagnostou, 2009). A virtual world will not only provide direct communication channels but will often provide other "side channels" to further support socialization (Ringland et al., 2016). For example, within Minecraft, users can communicate with each other by sending text messages through a chat window or install third-party modifications to talk via voice. Minecraft is also tightly connected to other social networking sites such as Facebook and YouTube (Pellicone & Ahn, 2015). These social channels allow individuals to connect without the need of nonverbal social cues such as eye contact, facial expression and gestures (Mazurek et al., 2015), things that individuals with ASD found extremely challenging. When the children are not playing Minecraft, they may be sharing their experiences on YouTube, helping each other out in discussion forums, or creating new blog posts. In other words, they are still engaging in Minecraft related activities.

Minecraft vs. LEGO. Zolyomi and Schmalz (2017) conducted a survey on Minecraft playing for children with ASD and ADHD. The parents and professionals commented that playing LEGO could be a positive creative outlet for their children, but LEGO was less social than Minecraft (Zolymomi & Schmalz, 2017). Minecraft offers new communication modalities make joining a social group possible for individuals who may found joining a physical social group intimidating. Cullen, Klein, and Crockett (2015) observed 3 boys playing LEGO together and on Minecraft.

The data suggested, while playing Minecraft, the communication among the children are of higher quality, and that they were willing to focus more on their tasks (Cullen, Klein, & Crockett, 2015). MacCormack (2016) compared Minecraft play-based social competence intervention with Lego social skill program for children with ASD. The results showed that children have a higher level of initiation and engagement while playing Minecraft (MacCormack, 2016).

Minecraft is both an educational tool and a learning platform. It has the power to engage children's interest and could change the way students learn. Changes are already happening in the classrooms of many countries. It is essential for teachers to understand what Minecraft has to offer and try to over the barriers of bringing this game to the classroom. For individuals with special educational needs, including those with ASD, Minecraft opens a whole new world. Minecraft will enrich the technical repertoire of researchers and continue to inspire new research that uses the game as the experimental research platform.

Part Three

2.5 Conceptual Framework

Figure 2 shows the conceptual framework of this study. Affinity Space Theory is the main theory used as a backbone of this research. The Theory looks at the social interaction around the virtual world based on common interest, and social interaction that occurs simultaneously in both virtual and physical spaces (Gee, J. 2004, 2011). By applying this theory to children on the autism spectrum, it is expected that the children's intense interest in Minecraft could motivate them to participate as an active learner in the social development process.

Shared interest is the core concept of the Affinity Space Theory. Most studies conducted on Gee's affinity space theory have focused on the motivations to learn (Durga, 2012), the active process of learning (Davies, 2006), and the social interaction happening within the affinity spaces (DeVane, 2012). Our lives are made up of both private social experiences as in private social gathering and public social experiences as in large community events. Affinity spaces or virtual world-based activities could be designed to simulate both types of social interactions. This study achieved the research goal by first describing social interaction skills learning in a school setting (sub-study 1) and then focusing on individual performance in a small group setting (sub-study 2) for children with ASD.

The framework is meant to guide educators to support the student's social and behavioral growth by focusing on their specific interests and strengths. From a neurodiversity point of view, we should recognize and value the way autistic people socialize and their strengths and interests (Ke & Moon, 2018). For children with ASD, an immersive virtual scenario can be an attractive learning environment because there is less physical inflection in the virtual world and releases

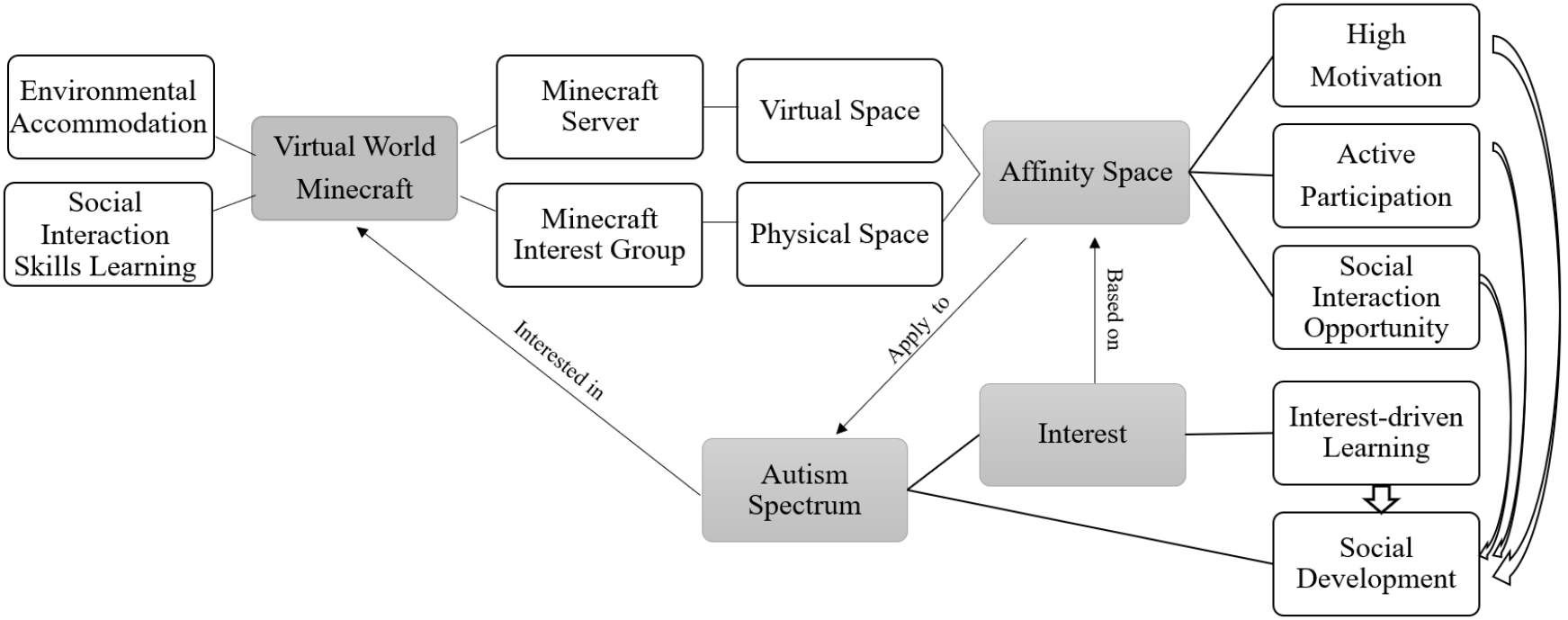


Figure 2: Conceptual framework of the present research

their pressure (Guazzaroni & Pillai, 2019). The interest-based approach and versatile technology solutions engaged children with ASD as active participants in the development of skills (Kärnä & Virnes, 2015).

Virtual world offers a context for social interaction and the opportunity for the players to interact socially both inside and outside the world. In online virtual worlds where multiple users are participating at the same time, communication happens in real-time. Solitary activity is instantly transformed into a social activity. And how people interact with each other in computer-generated virtual worlds has a positive impact on the players' offline life. (Schroeder, 2002).

The opportunity to interact with each other is an important motive for participating in a virtual world. These virtual worlds become playgrounds for shared activities and offer an alternative means for relationship building. Research has shown that virtual worlds offered a wide range of opportunities for children to play and that online and offline play are very closely related (Burke & Marsh, 2013).

The social model looks at disability as not purely a consequence of an individual's functional limitations but also dependent on the extent to which the social environment can support the impaired individuals to participate in everyday activities (George, Cockton & Greenough, 2010). The environmental accommodations include the physical surrounding, people, and learning programs. If social interaction is only defined by face-to-face communication with a physical presence, then undoubtedly, most individuals with ASD may have a deficit. However, such a definition will no longer be valid when online communication becomes more and more common, and presence can be both physical and virtual. Virtual worlds, for instance, can create a strong sense of presence through interactions that take place virtually (Blascovich, Loomis, Beall, Swinth,

Hoyt, & Bailenson, 2002). Minecraft, in this research, is playing the role of that virtual world, giving the players a sense of presence and the context for interaction learning (Fanella, 2012).

In this research, the Minecraft affinity space is made up of two components. Firstly, the Minecraft virtual world which includes the game itself, the servers, and the websites that relate to the game. Secondly, the Minecraft interest group, including both classroom and after-school activities, where children will play the game in the same physical space. Social interaction occurs simultaneously both online and offline, during virtual world gameplay and social group activities. This virtual world-based activity offers a motivating environment that triggers increased social interaction and facilitates social communication; it also creates teachable moments and opportunities for skills training (Burke, 2013).

2.6 Summary

Children with ASD have a particular affinity to Minecraft, and the amount of research on the educational use of Minecraft has been growing. However, the potential of using Minecraft to support the learning and social interaction of children with ASD is still a relatively new area that needs to be further explored.

Current studies are mostly either on virtual world itself or social skills training. Seldom are the two combined to see how a virtual world can be used to support the social skills training for individuals with ASD. Many studies were descriptive and only focused on single-user experiences. Some only describe the experimental design but do not report on behavioral outcomes or learning gains. This research is trying to bridge different areas by incorporating the virtual world tool into traditional school education and social interaction skills instruction to optimize the learning outcomes.

Chapter 3 Research Methodology

This chapter discusses the philosophy underlying the research approach chosen by the researcher. It then discusses the researcher's pragmatic stance to research, which leads to the choice of a mixed research method approach. The chapter then explains the adoption of case study as a research strategy and provides an overview of the data collection and analysis methods. The research limitations and ethical issues are discussed towards the end.

3.1 Research Philosophy

Underpinning the methodology is a philosophical stance related to the purpose of research. In this case, the researcher has adopted a pragmatist position. She is more concerned with finding a solution to a problem (Rossman & Wilson, 1985; Patton, 1990), and is not committed to any one system of philosophy or reality (Creswell, 2014, P. 11).

Pragmatists emphasize that effectiveness is the criterion for judging the value of the research (Mertens, 2015, P. 37). And that researchers are not just distanced observers, they are free to "study what interests you and is of value to you, study it in the different ways that you deem appropriate and utilize the results in ways that can bring about positive consequences within your value system" (Tashakkori & Teddlie, 1998, P. 30).

This study is an applied research. The researcher wants to have a deep understanding of a new phenomenon regarding the use of virtual world in social development intervention for children with ASD. The researcher's major concerns are whether virtual world actually "works" for children with ASD; how to apply it in different settings; and if the present theory of virtual world could be interpreted and tested for this population.

3.2 Mixed Method Research Approach

The pragmatic paradigm provides the underlying philosophical framework for mixed methods research (Morgan, 2007; Tashakkori & Teddlie, 2010). Pragmatism grants the researchers "permission" to adopt and combine different research methods to best fit their research questions. Despite the differences between a qualitative approach which analyzes textual responses (Miles & Huberman,1994) and a quantitative approach which collects and analyzes numbered data (Haq, 2015), both of them are compatible with the pragmatic paradigm.

Over the last decade, the mixed method approach has gradually established itself as the standard research approach in education sciences and applied research projects. The main reason why researchers have chosen to use mixed method was that they were looking at the research problems from different perspectives (Creswell, 2014, P.4), and different methods were needed to interpret the discrepancies and improve the credibility of the data.

The convergent parallel mixed research method was used in the full investigation of the research results. In this method, qualitative and quantitative research are conducted separately and carried equal priority (Creswell, Plano, Clark, Gutmann, & Hanson, 2003; Creswell, 2014). The results of the two individual data collections were discussed in the findings section of this thesis.

In sub-study 1, the researcher was interested in understanding the experiences and perceptions of the educators towards the application of virtual world game for children with ASD. Therefore, a qualitative approach to the philosophy of social interpretivism was adopted. In sub-study 2, the researcher would like to evaluate the impact of a behavioral skill training program when combined with a shared interest in a virtual world game on social interaction skills learning for children with ASD in a group setting. To ascertain the effectiveness of the intervention program, the researcher has adopted a post-positivist philosophy and a quantitative approach in which

details about effectiveness were measured objectively. An embedded mixed research method was also used in sub-study 2. Under this method, the researcher has chosen a dominant strategy - single case experimental design - and nested the results of the field notes, photos and videos in the interpretation phase of the study. The data collected are interpreted together to evaluate the effectiveness of the intervention program.

3.3 Research Strategy and Design

3.3.1 Rationales for Methodology Choice

Research in special education requires a deep understanding of the research subject. Individuals with disabilities can differ widely in their abilities and generating conclusions across people, time and contexts are difficult, if not impossible. Because of this, researchers in the area of special education will usually adopt a case study, action research or single-subject research approach (Clark, Dyson & Millward, 1998; Farrell, 2012). In addition, it is challenging to get the required number of participants to do a gold standard randomized controlled trial.

The nature of the research questions primarily guided the selection of case study as a research strategy. Swanborn (2010) claimed that "if we want more information about what groups of people perceive and decide, in relation to their interaction during a certain period, a case study seems to be the optimal strategy (Swanborn, 2010, p27)". That is especially true for broad descriptive questions about a social process that we have little knowledge of, and when the researcher was interested in interpreting the behavior of different stakeholders and how they cope with problems (Swanborn, 2010, p41). In this research, using a virtual world game in a school setting for children with autism was a relatively new phenomenon in Hong Kong and Mainland China. Little research, if any, has been done on this topic, and so a case study approach would be

deemed appropriate.

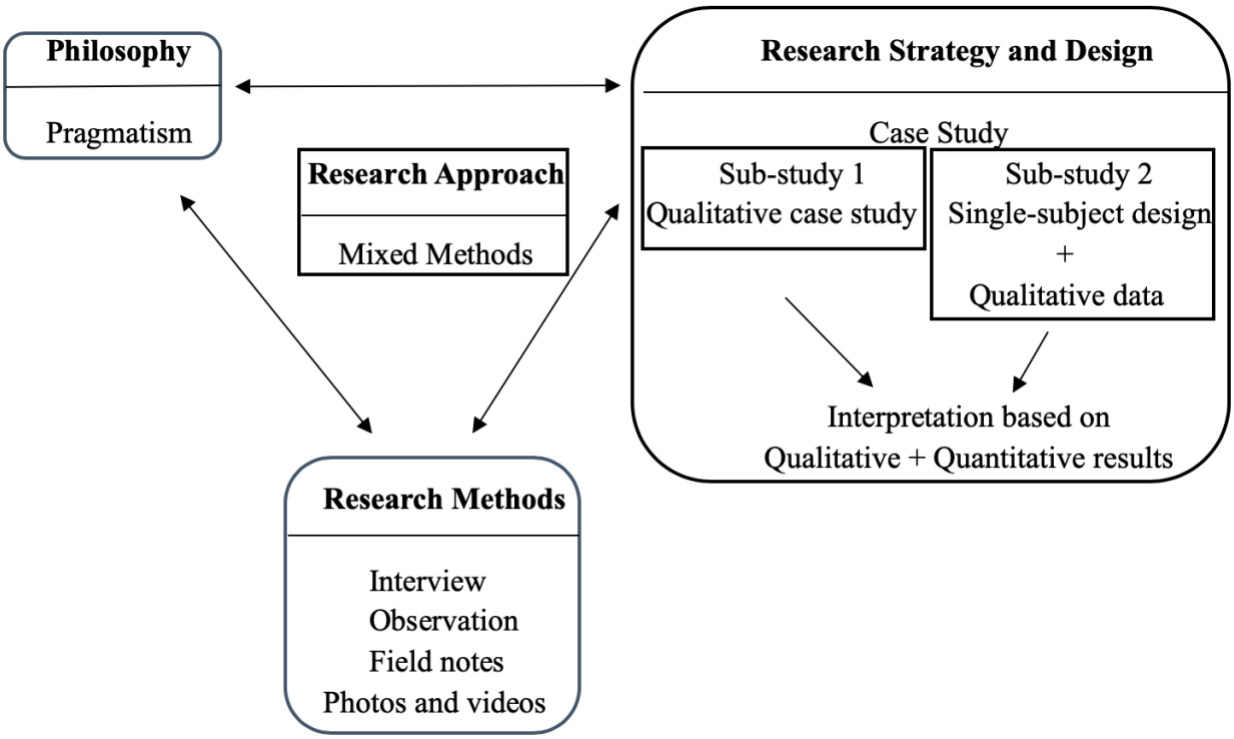


Figure. 3: A framework of methodology adopted from Creswell (2014)

Figure 3 showed a framework of methodology adopted in this study. A mixed method design is useful when combining the strengths of quantitative and qualitative approaches can provide the best understanding of a research problem (McKim, 2017). The researcher wanted to both have an overview of virtual world application in a school setting and develop a detail perspective of how virtual world is impacting the individuals, as a result using a qualitative approach in sub-study 1 and a quantitative experimental design in sub-study 2. When conducting sub-study 1, the researcher has only interviewed a small number of participants to understand the application of Minecraft in a special school for children with ASD. Alternatively, the researcher could have surveyed a bigger group of people and then followed up with a few participants to get their specific views. This strategy of survey combined with individual interviews would be the preferred choice. Unfortunately, this was not possible because only two special schools have

used Minecraft in their classroom and afterschool activities. A single-case design was chosen for sub-study 2 to focus on the individual performance on behavioral changes as students with disabilities often perform poorly with standardized measures. Even if the participants have demonstrated improvements in a specific skill area during training and generalization, sometimes a standardized assessment tool would not have shown any statistically significant improvement (Loftin, 2003; Ardoin, Roof, Klubnick, & Carfolite, 2008).

3.3.2 Case Study

In this research, case study was used as the general methodological framework and was generally known as the intensive approach. Yin (1984) defined a case study research method as an empirical inquiry in which a contemporary phenomenon was studied using multiple sources (Yin, 1989, p23; Swanborn, 2010, p13). The use of case study has become an increasing respected research strategy, especially in educational sciences (p. 4). Case study is often used to understand the complexity of a given issue thoroughly. The researcher is genuinely motivated to understand the "how" and the "why." Case study is the appropriate method to use when the analysis is dealing with contemporary events and the subject is being considered in a new light. Case study also encourages a research scope that is deep rather than broad and emphasizes the analysis of some events and their relationship (Soy, 1997).

Embedded case study is different from holistic case study. Embedded case study examines some aspects of cases and sometimes involves more than one unit, or object. Furthermore, it often requires an interdisciplinary approach because research problems do not usually end at disciplinary borders. They cannot be treated simply by one of the known analytic methods, such as experiment, proof, or survey (Scholz, 2002, p. 5). A multiplicity of evidence or dependent

variables are required to understand the problem and its solution. This study contained qualitative as well as quantitative elements. A qualitative approach incorporating multiple methodological techniques was chosen, such as semi-structured interviews, observations and field notes. Single-subject research design and quantitative methods will be combined to collect data on behavioral changes.

The research strategies and design utilized in this study were outlined in Table 1 below.

Table 1: Research design

	Aim	Sample /Participants*	Research Design	Research Methods	Data Collection	Data Analysis
Study 1	The application of Minecraft for students with autism in a special school	Three educators and fifteen students with autism from two special school for students with mild intellectual disabilities in Hong Kong	Qualitative case study	Semi-structured interview Field notes Participant observation	Voice recording Written notes Photographs	Thematic analysis
Study 2	Teaching social interaction skills to children with autism in a Minecraft interest group	Four children with autism, 7-9 years old, average IQ or above, attending mainstream school, who loved playing Minecraft	Single-subject- A multiple probes across behaviors with concurrent replication across participants design	Experiment Social validity questionnaire Participant observation Field notes	Behavior observation sheet Videotape and photographs, screen capture and screenshot Dairy	Visual analysis of graphed data Effect size Descriptive Analysis

*The recruitment criteria of the participants were discussed in Chapter 4 and Chapter 5. The detail of the measurements used in sub-study 2 was discussed in Chapter 5.

Participants are considered as “social actors” in the case study and may be placed on the micro (persons and interpersonal relations), meso (organization, institution), or macro-level (large

communities, nation-states) depending on their interests (Swanborn, 2010). In this study, a combination of micro- and meso-level actors were involved. In sub-study 1, a meso-level of two special schools were involved, and in sub-study 2, a micro-level of 4 children with ASD participating in a group was involved. According to Cook (1979), it is compatible with quasi-experimental designs

In terms of the in-depth examination of an individual, case study and single-subject designs are quite similar. However, one should note that case study lacks the control element, while the single-subject approach encompasses experimental control. The essence of single-subject design is using repeated measurements to understand the progress of an individual which can be used to determine the effects of treatment and make the necessary adjustments. Using single-subject design avoids the problem of not having enough subjects in a particular area of study. Case study is highly flexible because a researcher can implement both qualitative and quantitative data to provide a thorough explanation of a phenomenon. Furthermore, the use of qualitative data when examining a subject allows a researcher to incorporate multiple strategies in the same study. This includes the use of observation, analysis of one's history, and reconstruction among others. The case study approach is not limited to statistical analysis and inferences, whereas the single-subject design relies heavily on quantitative data (Zainal, 2007).

3.3.3 Single-Subject Design

Sub-study 2 uses a single-subject design to measure behavioral change. The study compares intervention effects on a group of single subjects rather than across groups of subjects. Group designs and single-subject designs share similar attitudes and components, but the components are used differently. In single-subject design, as in all experimental research, variables are

manipulated and then you measure the effect of the Independent Variable (IV, the interventions or treatments used to encourage or maintain change in behavior) on the Dependent Variable (DV, the target behavior that is measured to determine the effects of the independent variable). Single-subject design differs from group design in how it demonstrates experimental control. In single-subject design, the significance is demonstrated in two ways – a) through the replication of the effectiveness of treatment across the baseline and the subsequent intervention sessions within a subject, or b) replication of the effectiveness of treatment across subjects (Cooper, Heron, & Heward, 2007).

Single-subject design in sub-study 2 has also incorporated elements of qualitative and quantitative procedures. As in much quantitative research, there was a focus on the changes in target behaviors which can be objectively verified for each individual. Meanwhile, as in much qualitative research, the research emphasized the changes happening within the individuals and how their significant others perceived those changes. Therefore, interviews and observations with family members, teachers and the participants themselves were used. Data gathered from these multiple sources were used to verify the changes happening.

Multiple-Probe Design

Multiple-probe design is a common variation of multiple baselines where continuous baseline assessment is replaced by intermittent probes to document performance in each condition. Probes reduce the burden of data collection because they remove the need for continuous data collection (Byiers, Reichle & Symonsa, 2012). And when taking continuous measurement is either too costly or impractical, probe provides an alternative means of establishing the baseline (Horner & Baer, 1978). There are many benefits of using a multiple baseline design, particularly when (a)

withdrawal or reversal designs may not be feasible due to ethical concerns about withdrawing treatment that is working or the achieved target behavior cannot be reversed; (b) there are more than one target behavior, setting, or individuals needing interventions; (c) generalization of behavior change is monitored through the design. Multiple baseline design is versatile and relatively easy to understand.

3.3.4 Research Methods

Qualitative Semi-Structured Interviews

A semi-structured interview is a qualitative interview that is defined by a pre-set question guide. It aims to provide in-depth findings through informal discussions with the participants (Jamshed, 2014). This interview method was chosen over unstructured or structured interviews such that the researcher will ask specific questions but not so much (unstructured) that it generates useless data, and not so less (structured) so as not to miss out on any unanticipated information. The semi-structured approach also allows the researcher to probe the participants' answers. Answer probing was particularly useful in responses where more explanation was needed to understand the answer fully. The themes in this study were derived mainly from the literature review and were used in developing the research questions. In sub-study 1, the semi-structured interviews were targeted at teachers of the two special schools who have used Minecraft in their classroom or afterschool activities, that way, the respondents would be better able to answer the questions related to the research topic. In sub-study 2, the interviews of parents were used to collect information about the social skill deficits of the participants.

Participant Observation

Observation focuses primarily on human behavior. But observation of physical artifacts, material resources and people's surroundings may also help develop useful insights on the processes at hand. Participant observation was used in which the researcher played a functional role in the social system under study during a certain period. For instance, the researcher was a teaching assistant in some parts of the afterschool Minecraft activities in sub-study 1 and was a group facilitator in sub-study 2. In both cases, the researcher observed how children with ASD interacted with each other while playing Minecraft. A wide variety of data was collected during participant observation. It includes, among other things, written notes, pictures, and video recordings. In sub-study 1, the observation was carried out during the special school field visits and during the research phase of interviewing. In sub-study 2, the researcher developed an observation sheet and coded the offline social interactions among the children. At the same time, the whole interaction process in Minecraft was recorded using a screen recording software. The data was recorded in real-time and the researcher noted down each user's acts and behaviors regarding the number and type of social encounters with the other avatars (or participants) in the virtual world.

3.4 Case Selection and Data Collection

3.4.1 Sampling Method

Saunders, Lewis, and Thornhill (2007) asserted that most case study strategies would adopt a non-probability sample. A non-probability sample is one in which one does not know how likely a particular sample will be selected from the total samples (Oppenheim, 1992). In sub-study 1, it would be ideal if the researcher could conduct as many interviews with as many staff members in

as many schools as possible. However, under this research context, there was only a limited number of special schools in Hong Kong that have used Minecraft in their classroom. The number of teachers and students with ASD that could be selected to take part in the study is too small to be considered a probability sample. And even in those special schools that have used Minecraft, only a handful of teachers have used the tool. Therefore, the researcher has selected to use a non-probability sample and focused more on the teachers and students who have experience with Minecraft in teaching/learning. In sub-study 2, due to the time constraints and resource limitations, only four participants who fulfilled the selection criterions were enrolled in the Minecraft interest group.

3.4.2 Primary Data Collection

Easterby-Smith, Golden-Biddle and Locke (2008) claim that two types of data can be collected – primary and secondary. When a researcher collects his own data (primary), he would have more control over the structure of the data and have more confidence that the data collected could be used to answer the research questions. The researcher, therefore, has chosen to collect primary data from the participants' setting (special school and Minecraft interest group) using interviews, direct observations, questionnaires, photos, and videos.

A digital recorder was used to record the semi-structured interviews, and the conversations were transcribed verbatim. This way, the researcher was able to discern and document words and emotions which would not be available if other forms of interviews were used. The researcher has collected data on a behavioral checklist, visited a research site and observed the behavior of individuals. Screen recording software and video camera were used to record the online and offline social interaction of the participants which will then be coded on an observation sheet.

Videotapes of the individuals are very useful in helping define the target behavior and scoring the dependent variable without intruding too much on the experiment environment. While it is true that the presence of cameras and recorders can also influence the individual, the use of videotaping and audiotaping could help avoid reactivity (which refers to the individual being observed altering his or her behavior as a response to being observed) in some degree (Haynes,.& Horn, 1982; Penner, Orom, Albrecht, Franks, Foster, & Ruckdeschel, 2007).

3.5 Analysis of Research Findings

3.5.1 The Application of Theory

In applied case study research, the use of existing theory is strongly advocated, however, it is not the researcher's explicit intention to develop or to test theory (Swamnorn, 2010, p77). The focus of case study is to develop an encompassing and empathic case understanding and to search for general theories that might be applied to explain things (Baxter, & Jack, 2008). Cases may be used instrumentally to illustrate different aspects or notions of a theory or concept (Rule, John, 2015; Ridder, 2017). And case study could be used to generate or explain a hypothesis about the causal mechanisms (Mueller, 2014). An extant theory of *Affinity space* was used in this research. This theory was used to describe and explain the phenomenon of utilizing virtual world game to educate students with ASD. The researcher also tested the theory by thoroughly checking whether a certain theory could be used to develop interest-based interventions for social skill learning for children with ASD. The result of using a testing approach was that a hypothesis, formulated in measurable form at the start, was confirmed, refuted, or remains undecided (Swanborn, 2010, p76). However, since no single theory or model is encompassing enough to explain complex real-world problems holistically, other alternative theories such as interest-

based intervention and ABA would be included in the study.

3.5.2 Qualitative and Quantitative Data Analysis

Both qualitative and quantitative data could be included in embedded case design (Scholz, 2002, p. 266), and the researcher used all reasonably applicable methods to report and analyse the results. The types of data analysed were numeric, text, image and voice recording and video of conversations and activities with the participants.

Interviews, notes and observations were compiled and analysed qualitatively in sub-study 1. The significance of behavior change was examined quantitatively and qualitatively in sub-study 2. The overall goal of the research was to demonstrate that an experimental criterion has been met (i.e., the independent and dependent variables are functionally related), and a therapeutic/educational criterion has also been met (i.e., the change achieved is of significance) (Alberto & Troutman, 1999). Techniques of ABA were used to gather and analyse the data. In sub-study 2, the result data was graphed and analysed visually rather than statistically to draw conclusions about the significance of the treatment approach. These data were used to measure the social behavior change of the participants. Using single-subject design and qualitative analysis together allowed the researcher to analyse aspects of behavior changes that were not always captured in numerical variables, and to better illustrate the relationship between the dependent and independent variables.

3.6 Ethics and Limitations

Approval has been obtained from the Human Research Ethics Committee of the Education University of Hong Kong. The research was conducted according to the ethical guidelines which

included the method used to recruit and contact the participants; honouring the participants' rights to decline to join or withdraw from the research; ensuring confidentiality of research data; distributing the sample of bilingual consent form and information sheet to the potential participants and scripting of the interview and other measure instruments.

When conducting research for children with ASD, pragmatists emphasized ethics of care for the youngest members of society (Hall, 2013). Vigorous ethical principles were adopted and multiple recourses were used to gain understanding from different perspectives (Morgan, 2007). The researcher would ensure that the participants' identities were not disclosed nor any data leaked that would adversely impact the children. Written informed consents from school, participants and those responsible for their well-being were obtained before the interview and intervention program. The participants were allowed to review the transcript of their interview, and none of them was amended. The issue of confidentiality was also taken care of. Participants in the research were informed that the information provided was to be securely stored and would not be accessible to persons other than the researcher for five years. At the end of those five years, all paper records and digital data related to the participants will be destroyed.

Parents always worried about the potential risks of video game playing, such as game addiction and online safety. To minimize those risks, the research has adopted specific tactics including behavioral management and online safety instruction. For instance, we made an agreement at the beginning of the activities on the length of play time and rules that every participant must follow. The observation in the virtual world created another ethical issue as the avatars was a virtual representation of the participant. Respecting the privacy rights of the avatars during the observation period has also been considered.

There were also ethical issues regarding the research methods. As single-subject design could

incorporate powerful methods for influencing the behavior of individuals, the ethical concerns have been thoroughly addressed. In single-subject research, it was essential that the interventions resulted in outcomes that were meaningful to the lives of the participants. The research has been conducted humanely, and the results generated were of educational significance.

Educational/social significance refered to the concern that being just statistically significant was not enough. The results merited conclusions that the interventions used were translated into real-world benefits. In single-subject research, educational/social significance refered to the social validity of the study which was closely related to the ethical treatment of human subjects.

Long baseline without any intervention or the use of reversal design just to prove the intervention effect was also deemed unethical. To avoid this problem, the researcher adopted the multiple-probe design in which withdrawing or reversing the intervention was not necessary. Using the probe procedure for the targeted behaviors was more suitable and efficient than the traditional baseline data approach.

Because of the small number of cases, the issue of generalization was often raised when discussing the advantages and disadvantages of using the case study approach. The term analytical or theoretical or logical generalization was established in Yin's (1984) argument. It was assumed that in case study research, we are less concern with a sample-to-population logic but more with generalizing the case results to a theory or model. In addition, when the case study was performed in a natural setting, the result should be more generalizable than when the study was performed in a controlled or experimental setting. Though in general, generalizing results from studied cases to other more general cases remains a difficult task. The validity of the conclusions with respect to non-researched cases was a matter of more or less plausible argument (Swanborn, 2010, p70).

Single-subject research design has certain characteristics that may weaken its internal and external validity. One such characteristic is maturation, whereby changes may occur when the participants grow older. In such circumstances, it is hard to determine whether the intervention is responsible for the observed change. Another is that single-subject design focuses on an individual as opposed to a group, and this raises the concern as to whether it is possible to generalize the results. Besides, things such as intervention conditions, baseline length, changing variables and conditions, etc may all affect the validity of results. Richards, Taylor, and Ramasamy (1997) stressed that visual analysis commonly used in single-subject design has its limitations because of the subjectivity that may be involved. The common agreement among researchers is that the characteristics of the graphed data can at least partially offset the subjectivity in this method of analysis (Alberto & Troutman, 2013). Richards (1999) concluded that visual analysis should not be the only method used to evaluate the results. The researcher is advised to compare the statistical results to those yielded through visual analysis. Such a combination would allow for an objective confirmation or refutation of a significant behavior change through statistical procedures, while still provide the flexibility to examine changes in level and trend that may help explain more subtle aspects of the study (Richards, 1999, p277). There were also limitations and disadvantages of using a mixed method research design. Collecting data through interviews and participant observation was time-consuming, and the complexity of the research data makes interpreting and analysing very difficult. The whole data collection and analysis phase took almost a year and a half to complete.

3.7 Summary

The researcher's pragmatic stance resulted in the adoption of the mixed methods approach used

in this study. This pragmatic stance and the mixed methods framework subsequently shaped the research strategy and design. The relatively new application of virtual world in educating children with ASD justifies the use of a case study approach. Primary sources, such as interviews, observation, extensive field visits, and notes, along with video and photos were used to provide the data for the thesis. The data were analysed under the format of theory. Analysis of the behavioral change was carried out using visual analysis which provided a more vivid picture of each participant's performance. The limitations of the study and the ethical issues were considered. The first limitation mentioned related to the problem of generalizing with a small number of cases. The other limitation noted concerned the single case design and visual analysis. Several ethical considerations were also discussed in this chapter. The details of the research method would be provided in sub-study 1 and sub-study 2 respectively.

Chapter 4 The Application of Minecraft for Students on the Autism Spectrum in Special School

(Mu, W. W. & Sin, K. F. (2018). The application of Minecraft in education for children with Autism in special schools. Published in S. C. Kong & et. al. (Eds.). (2018). *Proceedings of the International Conference on Computational Thinking Education 2018*. Hong Kong)

4.1 Introduction

A Massachusetts Institute of Technology's white paper suggested that schools have a "critical role" in helping learners make the most of technology-based experiences (Klopfer 2009). It is essential for administrators and teachers in the school to prepare, understand, educate, and stimulate today's students who are living in an ever-changing and increasingly digital world. According to Gee (2003), the gap between how adults thought young people should use technology and how these young people use technology is widening at an accelerating pace. Gee then proposed the affinity space theory and illustrated its features as the opposite of the traditional school system. He argued that school educators must learn to curate the affinity spaces and ensure that all children have the opportunities to explore their own interests and develop the sorts of passions that fuel deep learning (Gee, 2011). Bommarito (2014) expanded the model of affinity space to take into account existing school conditions. He suggested that classroom teaching could incorporate affinity spaces, and students could even design their own affinity spaces with help from the teachers (Bommarito, 2014).

Minecraft is a commercial virtual world game that is exceptionally suitable for integrating into the school curriculum. As more and more potential educational uses of Minecraft are being uncovered, and the interest of Minecraft among school-aged students (mainly primary and lower high school) continues to grow, maybe it is time for the educators to become more aware of this tool. It is vital for teachers to understand what Minecraft has to offer and overcome the barriers to introducing this game to their classroom. In western countries, Minecraft is already very well

known in the education community. A growing number of teachers see Minecraft as a valuable tool that can help engage their students in more active learning.

Even though people like Gershenfeld (2014) have argued that games can have the most profound impact on learning when they become an essential part of the school experience, it is still difficult to convince traditional schools to believe in the educational value of computer games (Smeaton, 2017). A lot of experienced teachers still have a very negative attitude towards video games playing and consider them as classroom distractions that are to be avoided (Baek, 2008). Since most teachers are not aware of the pedagogical possibilities of digital games (Futurelab, 2005), it is understandable that they felt unsure how games could be used in their classroom (Wu, 2015). That being said, this negative attitude towards digital games has been slowing changing, and game-based learning has become more widely accepted and used by teachers worldwide. For instance, Sandford, Ulicsak, Facer, and Rudd's (2006) indicated that teachers in the UK have a positive attitude towards using digital games in their classroom. Wu (2015) investigated 116 teachers in the United States; the majority of them have shown a positive attitude towards using games for instruction.

As Minecraft grows in popularity, and more teachers started to incorporate the game into their classroom practice, researchers begin to collect evidence on how Minecraft can impact students' learning. Saez-Lopez, Miller, Vazquez-Cano, and Dominguez-Garrido (2015) concluded that there was an increase in creativity when Minecraft was used in history and architecture classes for the 6~8 graders. Smeaton (2017) took an anthropological view of Minecraft as a teaching tool. The study looked at how teachers employ Minecraft in their classroom using a comprehensive survey and in-depth case studies. By presenting the routines of a typical 'Minecraft Teacher' the paper showed how teachers could incorporate Minecraft into their

existing units of work and the positive impacts that Minecraft could bring to learning and student motivation. The Minecraft Teachers, as described in the study, first started as a Google group in 2011 by Joel Levin (2012). The group brings together enthusiastic Minecraft teachers from all over the world. They actively share their knowledge and best practices and help each other introduce Minecraft to their classroom. The Minecraft Teachers group is an excellent example of how teachers are also forming learning communities about virtual world in the virtual world.

4.1.1 Context of the Study

In Hong Kong, many efforts have been made to promote the use of Minecraft in schools. Hong Kong Cyberport, Microsoft and The Education City have all organized talks and contests using Minecraft as a tool to encourage students to learn how to code and to be creative. Even though more than 500 schools have participated in those competitions, only very few of them are actually using Minecraft in their day-to-day teaching. A few international schools have organized extracurricular activities that use Minecraft to teach coding. Wang and Towey (2013) noted the Hong Kong International School has used Minecraft in their science classes and saw learning improvements and some enhanced "soft" outcomes. Zhu (2017) conducted a case study with three teachers and 50 students in Hong Kong secondary schools, exploring how Minecraft can be used for teaching Chinese history. The results indicated that students' motivation had increased significantly. Currently, minimal research can be found on how Minecraft can be used for students in special schools.

There are 61 special schools in Hong Kong with a total enrolment of about 8000 students. Of the 61 special schools, 41 are for students with intellectual disabilities which can be classified into mild grade, moderate grade, mild to moderate grade and severe grade (HK Education Bureau,

2017). Among the 12 schools for students with mild intellectual disabilities, the two schools that have been chosen to participate in this study had been pioneering the use of Minecraft to enhance the learning of their students, more than half of whom were diagnosed with ASD.

4.1.2 Research Questions

Minecraft has garnered much attention among educators and academics. However, there is minimal research on how Minecraft can be used for students with special needs in a school setting. Using a tool like Minecraft for learning is clearly unconventional teaching. In order to accommodate the many different learning styles and to maximize the potential impact of using this tool, we anticipated that teachers would need to adjust their teaching styles and ways of content delivery to better suit the individual preferences of their students.

Under the notion of affinity space, the focus of this study is to answer the question "What would happen if we integrate Minecraft into teaching students with ASD in special school in Hong Kong?" This core question can further be broken down into a series of sub-questions "How did the educators find out about Minecraft?" "What did the educators do with Minecraft?" "What are the benefits of using Minecraft for teaching and learning?" and "What are the challenges of integrating Minecraft into the special school classroom?" Based on the research findings, this study will attempt to provide some practical guidance to educators who are interested in incorporating Minecraft into their teaching practice for students with ASD in special schools.

4.2 Method

To investigate how Minecraft is being used for students with ASD in special schools, a few qualitative research methods have been adopted - observation, tracking of students' "digital

footprints" (for instance, structures created in Minecraft), and interviewing three educators who have already been using Minecraft in their classrooms. Qualitative data can help explain complicated questions and issues (Woods, 2011). More than just providing a list of ideas, the researcher attempts to provide a rich description and evaluation of how these educators practice active learning and what matters most to them when designing their lesson plans with the use of Minecraft.

4.2.1 Participants

Two teachers, one principal and 15 students with ASD coming from two local special schools in Hong Kong for students with mild intellectual disabilities were involved in this study. All the students were boys and ranged from grade three to seven.

Table 2: Educators' background information in sub-study 1

	Education Background	**Subjects Taught**	**Teaching Experience**	**Personal Interest in video Games**	**Length of Time Using Minecraft in Teaching**
Teacher Participant A	Arts and computer science	Visual Arts, Computer, Social studies	15 years	Yes	3.5 years
Teacher Participant B	Chinese literature	Chinese literature	More than 10 years	No	10 months
Principal Participant	Economics	Computer, Math, Liberal studies	13 years teaching; 9 years as school principal	Yes	10 months

4.2.2 Research Procedure and Data Collection

Semi-structured interviews were conducted only with teachers who have been using Minecraft in their schools. The interview guidelines were designed based on previous researches on the

educational use of Minecraft (Smeaton, 2012). The interview is made up of 4 background information questions, ten open-ended questions, and a few follow-up questions. The main goal of the interview was to uncover the benefits and the challenges of using Minecraft as an educational tool and to discover any other themes that may be of interest as the interview progresses. The questions were aimed at developing a detailed understanding of how educators are using the game and the results. The interviewees were encouraged to talk about their feelings towards Minecraft and the successes and challenges that they have encountered.

The interviews were conducted in the classroom or meeting room during school time, and each interview has taken about 30 minutes to complete. For one of the teachers that we have met and had informal interviews many times before, the interviews were conducted both in person and via Skype. The entire interview was recorded using the Voice Memo application on an iPhone and on a digital voice recorder and then transcribed manually. All the participants had agreed to have their interviews recorded and understood that all interview data would be erased when the research paper was finished. All the participants have a chance to read the ethics package and were given a chance to ask questions or withdraw their participation in the project. The transcript of the interview was sent back to each participant for review.

The researcher also did classroom observation and took detail notes during several Minecraft workshops and interest club sessions. Artifacts created by the students were recorded by taking computer screenshots and recording on video.

4.2.3 Data Analysis

The data was processed using thematic analysis to get to the main themes related to the research questions. The themes were formed as the interviews progressed and were finalized in the data

analysis phase. This process of generating codes and categorizing them into established and important themes were accomplished through several cycles of analysis. Written notes and voice recordings were taken during each of the interviews. The researchers later transcribed the voice recordings in a verbatim format. The transcribed text then became the data to be analyzed. The interviews were conducted and transcribed by two researchers, and the data were analyzed independently for different research purposes. Following each interview, the researcher would analyze the response and look for noteworthy patterns or themes. A set of initial codes was generated and compared to the previous research literature, and codes from the different interviews would be cross-referenced in search of common themes. The established themes were reviewed, refined and named with regard to the research question and then organized into findings. The conclusions were drawn mainly based on the interview data, and also on the combination of observation notes, student-generated Minecraft artifacts, and the literature review.

4.3 Findings

4.3.1 Different Stories of '*How do you start?*'

Teacher Participant A has been exploring the educational use of Minecraft since 2014 and has integrated Minecraft into her classroom for more than three years. She has used Minecraft to teach visual art, computer, and other subjects. This teacher has a computer science bachelor's degree as well as a major in art from a 2-year certificate course. Even though this teacher has a personal interest in video games, she is only a casual gamer. Minecraft was introduced to her by her student, and her interest in Minecraft stemmed from it being not just a game but also a powerful creation tool. Some of her students have expressed keen interest in using Minecraft to

create 3-dimensional products in her digital art class.

Teacher Participant B and Principal Participant were from the same school, and they have been using Minecraft for ten months since it was first introduced during a Minecraft workshop organized by a specialist team in Hong Kong. Teacher Participant B majors in Chinese literature and language, and she has taught in the school for more than ten years. Other than some very common mobile applications, this teacher has little personal interest in new technologies, especially games. However, after seeing how Minecraft and other educational apps can increase the engagement of students and reduce the workload of teachers, she began to try using Minecraft more heavily in her Chinese language class. The Principal Participant has implemented a wide variety of e-learning strategies in his school and has encouraged his teachers to try using different educational apps for teaching. He has a keen interest in e-learning practices and a firm belief that technology could really help students with special needs. He saw Minecraft as a promising learning tool, especially for students with high functioning autism.

4.3.2 Various Uses of Minecraft for Students on the Autism Spectrum at Special Schools

Using Minecraft in the classroom

Minecraft was used as a tool for learning visual arts, computer programming, language, and social study. Figure 4 showed the use of Minecraft in teaching different subjects. Both teacher participants emphasized that Minecraft was particularly suitable for learning topics that involve construction and storytelling. Topics that involve animal, space, and history have also been mentioned.

As an example, Teacher Participant B asked the students to create a story in Minecraft based on a story in a Chinese textbook. The tenant of the story was "Everyone has strengths and we should

Figure 4: Teaching different subjects by using Minecraft

not laugh at others' shortcomings". The students were able to create a story to demonstrate their understanding of the story using different characters in Minecraft. The teacher further commented that, in the future, Minecraft could even become an assessment tool. Assessing what the students understand is always a difficult task in special schools, especially when the students do not have language skills to express themselves in words.

Setting-up School-based Minecraft Server

Educators are always looking for safe and protected environments that can offer their students great learning experiences. Minecraft, a multiplayer virtual world, has all the potentials to become such an environment. People can play with their friends by joining servers that either they set up themselves or hosted by other people. Teacher Participant A has set up a private Minecraft server in her school with access restricted only to her students. Since access is strictly

controlled, the students have a very safe environment to socialize and work with each other. This teacher has built two servers – one for those who are new to Minecraft and one for the more experienced players. Dozens of students use the server for beginners to play Minecraft and socialize with their classmates. The advanced level server is open to about 20 or so students who have been playing Minecraft for some time. This server is used for more "serious" work such as preparing for the public Minecraft competitions and showcasing student works to the public.

Learning Together in Minecraft Interest Club/Workshop

In addition to using Minecraft in the classroom, another common approach for educators who want to try out Minecraft is to organize after-school interest club and workshops. This way, new ideas can be tested incrementally before they are formally integrated into the classrooms. In the summer of 2016, Teacher Participant A organized a Minecraft workshop in collaboration with Assistive Learning and Technology Association, an NGO in Hong Kong focusing on assistive technology. The theme chosen was “smart home”. A group of 6 students with ASD gathered together to design and build a smart home for the elderly inside Minecraft. This theme was chosen to introduce the STEM (science, technology, engineering, and mathematics) concepts to the students.

The Principal Participant is eager to explore if Minecraft is a useful tool to enhance teaching and learning. Not only did he encourage his teachers to use the tool in the classroom, he also started an after-school interest group that meets on Friday each week. A teacher always guides the interest group, and the students will get together to learn Chinese, mathematics, and social subjects with Minecraft.

Using Minecraft to tell Stories

When Minecraft is complemented with other technologies, the students can become storytellers. When the students are creating in Minecraft, they are actually acting out a story in their own mind. And one way they can tell that story is to create a storybook that is made up of images from the Minecraft world.

Figure 5: E-books of Minecraft story

"I always encourage my students to showcase their work to the whole class. For example, by telling stories using Minecraft and Book Creator (Book Creator is an app on the iPad / iPhone that allows users to create their own e-books)."

Children with ASD often have difficulty expressing their thoughts in words. Telling stories using Minecraft is one way of expressing their thoughts and feelings, giving these children an alternative means to communicate with others.

Using Minecraft as a Reinforcer

Teacher Participant B used Minecraft as an encouragement to motivate the students to improve their attitude and become more engaged in school.

"*Some students often do not submit homework, or even if submitted, the quality is very poor. So, I*

used Minecraft as a reward, and I told the students that if they could practice reading, proactively ask questions and can write without any typo, then they could play Minecraft. If there is no improvement or any lapse in performance, then they will not be allowed to play."

Since the students love playing Minecraft so much, the game can be used as an effective motivator to effect behavioral changes.

4.3.3 Benefits of Minecraft-based Learning

Enhancing Collaboration and Teamwork

Working with their classmates is probably one of the most challenging aspects of school life for students with ASD. Effective teamwork requires the students to exercise social skills such as negotiating, active listening, following directions, and accepting criticism. Playing in Minecraft offers many opportunities for students to develop such skills. A single student can seldom do large scale creation in Minecraft. It requires a team of at least 4-6 students working seamlessly together to complete.

"Students choose their role based on their expertise and interest. For example, some students are good at building railways, some are good at building Redstone devices, and some are good at crafting building. They pick what they want to do and work together to create something amazing".

When working or playing together in Minecraft, the students have many opportunities to communicate with each other, either with members of their team or members of the other teams. Constructing is a truly collaborative effort. Teacher Participant B gave a passage from the textbook about the building of "Changjiang bridge" to two groups of students to read and asked them to recreate the bridge in Minecraft. The teacher reasoned that if the students can recreate

the bridge in Minecraft, that means they understand the meaning of the passage.

Figure 6: Students built the “Changjiang bridge” inside Minecraft

To the teacher’s surprise, not only did the students build the bridge based on the passage given to them, they have gone to the Internet to search out more detail information about the bridge so they can represent it more faithfully in Minecraft. This is self-driven learning at its best.

Improving social Interaction and Developing Relationships

Students with ASD have many difficulties developing and maintaining a friendship with their classmates. Working together on a Minecraft project gives them many opportunities to express their needs, make suggestions, ask for help, and make friends with each other. And after building up enough positive experiences, hopefully, they will be able to transfer these skills to the real world.

“A parent shared with me that his child used to never call his classmates at home. However, once he faced a problem in completing a task in Minecraft, he would take the initiative to call his classmates for help."

Students are a lot more willing to talk about their interests with classmates and teachers. Shared

interests such as the love for Minecraft can help build friendship and deepen the relationship between teachers and students

"When I ask students how to accomplish certain tasks in Minecraft, they start talking endlessly. Never saw them like this before."

"When they saw their classmates building something interesting, they would take the initiative to ask them how they did it. There is strong motivation to interact with each other."

"In normal handcraft / digital art classes, students usually only focus on their work and rarely will they pay attention to what others are doing. However, in the Minecraft world, it is very common to see students moving around to showcase their work to each other. And this shared learning experience is very different from being just a spectator."

"There are WhatsApp groups between students and me, as well as among students themselves. And they regularly exchange information about Minecraft. Many of them took the initiative to talk to me, report on their tasks and share their works in Minecraft. I am getting closer to my students."

Playing Minecraft is social. The desire of sharing their work in Minecraft with others encourages students with ASD to practice communication and social interaction skills that they usually would shy away from in daily life. They started showing more positive attitudes and developing better relationships with their classmates.

Becoming Active Learners

Minecraft almost forces the students to take charge of their learning and become active learners. Because they all want to become an expert of the game and show off their skills to their classmates.

"They will go online (for example, YouTube) to find solutions. Even if the video is not in Chinese, they will find a way to understand the materials. They are learning how to learn independently which is a critical 21st-century skill."

"E-learning is not just a one-way instruction from the teacher. Instead, students find the answers to their questions by interacting with others and develop the spirit of inquiry along the way."

When using Minecraft to tell stories, students must create their contents. For example, if the student has chosen to use a horse as the main character, he/she needs to find out many things about the horse rather than just using his/her imagination. The creation process enhances the students' listening, speaking, writing and logical thinking skills, and significantly broaden their knowledge.

Reducing Behavioral Problems

Students in special schools have significant individual differences. Some students with ASD have better cognitive abilities, while others have less. Traditional one-way question and answer type of teaching method has a lot of "wait time." As a result, students with ASD will get impatient quickly and can lead to many behavioral problems in the classroom.

"Learning in Minecraft engages the students deeply. They will not feel bored and start disrupting the class. They feel challenged and are happy to immerse themselves in the Minecraft world to explore, to learn and to play."

"They used to run around when classes were off. And now students are racing to resume their creative work in Minecraft."

"One student was drowsy every lesson (even falling asleep in the first lesson in the morning). After I began using Minecraft in class, he became much more focused and engaged."

Video games playing has often been associated with opposition behaviors such as arguing and not following instructions. In reality, the types of games that children choose to play have a direct impact on their behavior. Educators should take advantage of the affinity for games like Minecraft among those with autism and find ways to use the game for educational purposes.

4.3.4 Challenges and Concerns

Need Elaborate Instruction Design

Integrating Minecraft into the classroom is not a simple and straight forward process. Teachers need to spend much time on instruction design and materials preparation. This is especially true when the teachers do not have much experience in using Minecraft to start with. Although nowadays, the students are more comfortable learning by themselves, there are key teaching moments when the teacher need to step in and take the lead. In projects that require cooperation among the students, the teacher must help with the discussion process. Some teachers also use thinking tools such as *Mind map* to help students discuss the project approach and how to divide up the work. Also, the teacher must have excellent time management skills, and keep reminding the students of the time allotment.

"I once conducted a project for building a 'smart school' in Minecraft. Firstly, I need to guide the students to discuss what should be built and where, what information they need to find out before they can actually build them."

"*They need to think about who the actors are, what time the story happens, etc. I need to give them enough instructions or they will get stuck in some parts of the story and lose sight of the whole picture."* When recreating a story in Minecraft based on the story "pig nose elephant", the students need to fully understand the story and answer a few important questions before they can

start building.

In Minecraft class, the students are not set free to create without any rules. They must learn under the guidance of teachers. Teachers must manage class time effectively and control any excessive behavior from the students. These are all very challenging tasks that require a lot of experience and wisdom from the teachers.

"When a chicken suddenly appeared in the Minecraft virtual world, the students all got excited and joked about burning the chicken. I immediately explained why we should not do that."

Sometimes the students' reaction can be fierce and brutal. Educators must seize the teaching opportunity to tell the students how they should react and behave.

Online Addiction and Safety

Teachers should restrict the play time of Minecraft to prevent addiction. Teacher Participant A sets the school Minecraft servers to be available from 7 am to 11 pm, and the survival mode (needs to play against zombies and creepers) can only be used at home. Teacher Participant B and Principal Participant only allow their students to use Minecraft in school under the supervision of a teacher.

Teachers need to prevent cyberbullying before it happens. Teacher Participant A decided to set up their private server to protect the students from potential harassment by strangers. Furthermore, teachers and students will set playing rules together, such as forbidding the use of dynamite (or "TNT"), killing animals, bullying each other, and so forth.

School-Home Cooperation

Parents are key stakeholders in the whole learning process. Many parents worry about their

children getting addicted to Minecraft. On the other hand, there are also parents who are willing to explore how they can play Minecraft with their children. To make learning effective, it is imperative to get the understanding and support from parents.

"Whether you let them play or not, they will play. You don't know what they're doing if you don't get actively involved. Parents will see that the child is not just playing a game, he/she is doing the homework assigned by the teachers. Very often, we will also show the products made by the students to their parents."

As teachers come to understand the benefits of Minecraft for learning, they need to also share this information with parents, using it as an opportunity to increase communication and partnership between home and school. Teachers and parents can work together to set up the playing rules. And once parents began to understand that virtual world-based learning is all about, they can really help their children learn.

Technical Expertise

There are many different versions of Minecraft and different versions may have slightly different functions and features. It is not easy for teachers who are not that familiar with Minecraft to decide which version to use for their students. There is also an education version of Minecraft that gives more control to the teachers. No matter which version to use, the teachers would need a certain level of technical expertise to set things up.

4.4 Discussion

4.4.1 Social Benefits of Using Minecraft for Students on the Autism Spectrum

There is little evidence to support the commonly held belief that digital games lead to anti-social

behavior (Durkin & Barber, 2002). More researches claim that the game can facilitate social play and positive online norms of behavior. Smeaton (2017) noticed that students were more inclined to play games that allowed them to play together or offered opportunities for social interaction. Kulman (2014) stated that games offer children with ASD many opportunities to improve social interaction skills, develop friendships, and practice a variety of crucial executive functioning skills. Minecraft offers a unique multi-player online game where the players can set up their servers to play with their friends. (Dikkers, 2015). In 2013, Stuart, a father with an autistic son, created a Minecraft server that is dedicated for use by people with ASD - Autcraft. Autcraft provides a safe, fun, and friendly environment for children on the autism spectrum. It offers the order and control that they crave in real life and thus assists the players in becoming at ease with each other (Stuart, 2013).

Interacting with other people is something that students with Autism find difficult. In this research, the Principal Participant mentioned that helping his students develop social interaction skills was one of his primary focus, and Minecraft helped him achieve this goal. Teacher Participant A uses Minecraft as a teaching tool, and his students use the school server to play and socialize with each other even after school hours. When students started to make new friends in the virtual world, unavoidably they must negotiate with each other and set up playing rules so that they can all play happily together.

It is the educator's job to offer great social learning experiences within a safe environment for the students. Minecraft offers the social element of a Massive Multiplayer Online game but without the potential danger of playing with strangers. The teacher can set up a private server and say with complete confidence that the space is safe for school use (Dikkers, 2015). The educators in this study mentioned that using the multiplayer server allowed them to address various online

safety concerns and teach students how to behave appropriately and resolve conflicts. The school-based multiplayer Minecraft server allows the students to explore, make mistakes, and learn from each other under the guidance of a teacher. Teacher Participant A specifically talked about an incident where a potential online abuse was turned into a teaching moment. She is using virtual world interaction to teach real-world skills.

4.4.2 Interaction among Students, Educators and Technology

Students play a central role in any educational innovation. Even though the two schools started their Minecraft journey very differently, they all come back to the students. Minecraft was introduced to Teacher Participant A by her students. The other school came to know about Minecraft through an expert in the field. The two schools actively sought out feedback from the students and based their decisions on how well the students react to the new tool. Students with ASD have specific learning advantages and disadvantages; the educators in the two special schools respect the students' learning styles. It became apparent during the interview process that the participants were most interested in how their students reacted to the use of Minecraft and the impact that Minecraft had on behavior, motivation, and learning. They both use Minecraft purely for the benefit of the students.

Youngsters of the new generation tend to be more familiar with new technologies than adults are. When using Minecraft, the students were often the experts that teachers could learn from. Learning with and from students is a form of learning everywhere. Previous research and experience using game-based learning in various fields have shown how useful a game-based learning approach can be in creating student-centered learning environment (Motschnig-Pitrik & Holzinger, 2002). Teachers interested in implementing Minecraft in their schools have to have a

student-centered mentality to receive the full benefits (Petrov, 2014). In this research, all educators are not as familiar with Minecraft as their students do. Teachers are willing to give students autonomy in managing the school Minecraft server and structuring their learning experience. It is possible that learners can develop self-directed learning skills, take more responsibility for their learning, choosing which paths they want to take.

While students are capable of learning on their own, teachers must be there to provide guidance. Games like Minecraft are just a platform or motivational tool which creates learning opportunities. The use of technology must be integrated with the teachers' learning design to be effective. Educational tools and course design are equally important. Smeaton (2014) argued that instruction experience is an important factor because experienced teachers could deliver knowledge more effectively and can guarantee learning benefits for students.

4.4.3 Limitations

The study mostly looked at data related to teaching practices and details of how Minecraft is applied for students with ASD in a special school. Due to the qualitative nature of the study, most of the findings are also open to interpretation and are, to some extent, a subjective view of what the researcher considered them to be.

This research was based on the views of an enthusiastic group of educators who have found success through implementing Minecraft in their schools. All the participants were highly biased toward Minecraft as they were already using it in their school, their responses were, in a sense, a reinforcement of the beliefs that the research already had. The element lacking in the study was an analysis of the problems that may exist when using Minecraft in special schools. The case studies are unable to draw conclusions about the shortcomings of incorporating computer games

into special schools. Using a less biased sample of schools that hesitate to use Minecraft, or just starting to use Minecraft, or have used Minecraft unsuccessfully, could provide a much richer data set.

The number of respondents was too small to show any significant patterns or trends. While the data is very positive, it is difficult to generalize to a bigger population. There are also studies that question the effectiveness of using technology in the classroom (Richtel, 2012). The reasons can be complicated, and this research has only looked at Minecraft. More researches need to be done to examine whether and how technologies can enhance the teaching and learning for students with special needs.

4.4.4 Outcome and Ways Forward

The primary outcomes that could be drawn from this study were that educators in special schools who have used Minecraft for students with ASD have been able to gain significant benefits. The students involved have improved their communication and collaboration skills, developed a deeper relationship with their peers, and demonstrated a high level of engagement in active learning. The cases in this study offer the exemplars to inspire more researches on the educational use of Minecraft in special schools for students with ASD.

Chapter 5 Teaching Social Interaction Skills to Children on the Autism Spectrum in Minecraft Interest Group

5.1 Introduction

In sub-study 2, a Minecraft interest group was created to train social interaction skills with behavioral intervention strategies. The chapter first started with a discussion of social intervention skills teaching in a group format, and then reviewed the implications of implementing Behavioral Skills Training (BST) procedure - a teaching procedure based on the principles of Applied Behavior Analysis (ABA). The recruitment of the four participants, the structure of the Minecraft interest group, the experimental design and procedure, and the data collection and analysis would be explained in detail in the Method section. The results were made up of the participants' target behaviors performance, social engagement in the group activity, and the description of social interaction and relationship development within and outside the virtual world. Implications for practice and future research and research limitation would be included in the Discussion section.

5.1.1 Social Interaction Skills Interventions in Group Teaching Format

Group-based social interaction skills interventions are widely used to address social impairment and foster social skills in individuals with ASD, especially for school-age children, adolescents, and young adult. However, according to several systematic reviews conducted in recent years, the results such group interventions were largely inconclusive (McMahon, Lerner & Britton, 2013; Spain & Blainey, 2015; Gates, Kang & Lerner, 2017). There was an exception in a systematic review conducted by Miller, Vernon, Wu, and Russoet (2014) which included various

study designs (randomized controlled trial, pre-pro, single-subject, qualitative, repeated measures, case study). They concluded that there was significant evidence for the effectiveness of social interaction skills groups as an intervention strategy for individuals with ASD.

White, Koenig, and Scahill (2010) stated that the use of group-based social interaction skills training was questionable given the lack of consistent, meaningful change on quantitative measures of social functioning. Many studies only reported survey data (self-report, parent- and observer-report and teacher-report) as a measure of effectiveness and did not evaluate any behavioral performance for any of the children with ASD. These studies often lack adequate data to demonstrate the effectiveness of training within the group (Gates, Kang & Lerner, 2017). Furthermore, the effects were small for parent-report and insignificant for teacher-report, the large positive effects were mainly based on self-reports that they have learned social knowledge but not that they have enacted social behavior performance (Gates, Kang & Lerner, 2017).

McMahon, Vismara and Solomon (2013) suggested that future research should recognize the limitations of current measurement approaches and adopt more precise, sensitive, and comprehensive measurement methods. Many group-comparison studies have methodological limitations. Firstly, sample sizes were usually very small with heterogeneity within the sample (Golder, Loke & Bland, 2011). It was crucial not to take for granted that the two experimental groups were equivalent, and intervention has resulted in different changes (Gates, Kang & Lerner, 2017). Secondly, standardized treatment is inflexible. The intervention is not individualized and the adjusted to best meet the individual's needs (Leaf, Leaf, Milne, Taubman, Torres & Townley-Cochran, 2016). Thirdly, almost without exception, social interaction skills group interventions were based on behavioral and cognitive-behavioral principles (Miller et al., 2014). Very few studies have incorporated new technologies such as virtual environment to teach

social interaction skills in a structured group manner. Kandalaft, Didehbani, Krawczyk et al. (2013) used virtual social cognition training for young adults with high-functioning autism; Mitchell, Parsons and Leonard (2007) used virtual environments for teaching social understanding to adolescents with ASD.

Meanwhile, even though plenty of individualized, behavioral approaches targeting specific social behaviors implemented in a one-to-one setting has shown positive results (White, Koenig & Scahill, 2010), only a handful of social interaction skills groups guided by ABA principles have used single-subject design in a group teaching format (e.g., Kamps, Leonard, Vernon, Dugan, Delquadri, Gershon, Wade & Folk, 1992; Mitchell, Regehr, Reaume & Feldman, 2010; Palmen & Didden, 2012; Plavnick, Sam, Hume & Odom, 2013; Radley et al., 2014a, 2014b; Dotson Leaf, Sheldon & Sherman, 2010; Leaf et al., 2010; Radley et al., 2014a; 2014b; Kassardjian et al., 2014; Plavnick & Duenas, 2018). One possible reason was that ABA focuses on identifying problems with an individual's behaviors and then directly addresses the issues detected. Intervention strategies based on ABA commonly have complicated procedures that require intensive effort and time. However, the results of most of these studies were positive, which may be due to individualized assessment and intervention, continuous measurement of behavioral performance, and smaller groups which allow more opportunities for practice and feedback on the use of targeted skills (Miller et al., 2014).

Group-based social interaction skills intervention for individuals with ASD is appealing for practitioners. There are several benefits of implementing the intervention in a group format, especially when teaching social interaction skills. Firstly, group instructions provide opportunities for children to learn by seeing their peers performing the desired behaviors. Secondly, group instruction places children with autism close to other children, thus increasing

the opportunity for interaction. Finally, a group format often requires the learner to interact with others and may promote generalization of skills learned (Dotson, et al. 2010). Group instruction means instructions can be delivered to multiple students at the same time which is more efficient than individual instruction and is more practical to implement in the environments where services are typically provided (i.e., public schools) (Plavnick et al., 2013).

In order to take full advantage of group-based social interaction skills intervention, a good understanding of this teaching format is needed (Leaf et al., 2016). Many promising strategies and best practices have been identified, such as making group rules explicit, reinforcing children's response attempts (White, Koenig & Scahill, 2007)

5.1.2 Behavioral Skills Training in Social interaction skills Intervention

There is a growing number of empirical investigations examining different intervention strategies or tactics incorporating behavioral components to improve social behavior for individuals with ASD. The result of the previous review has shown that methods and techniques of ABA are among the most effective social interaction skills intervention strategies for children with ASD (Camargo, Rispoli, Ganz, Hong, Davis & Mason, 2014; Ng et al., 2016). Moreover, the search for techniques that can produce an effective change has led to the combination of different components under the term Behavioral Skills Training (BST) (Buck, 2014).

BST is a multi-component teaching procedure under the ABA framework and is used for teaching new skills. It is a combination of four components: 1) Instructions – there are written or verbal instructions describing the relevant components of appropriate behavior or skill set(s) to be learned. 2) Modeling - the correct behavior is demonstrated to the learner who will then try to imitate the model. Video modeling or live demonstration can be used. 3) Role-playing/rehearsal

in natural context (in-situ training) - it provides an opportunity for the learner to practice the behavior after receiving instructions and observing the demonstration from the model. In-situ training usually followed each successful role-play. Research has shown that in-situ training might increase the treatment effect of BST by having a positive impact on maintenance and creating success in the natural environment (Nuernberger et al., 2013). 4) Feedback - immediately after the learner has performed the behavior. It involves correction of errors, further instruction on how to improve performance, and praise or other reinforcers for correct performance (Shayne, Rachel, Miltenberger, Raymond, 2013). The components of BST have been used independently or combined since 1970s. The term BST was first described empirically in 1984 (Breidenbach, 1984). Meanwhile, some researchers have highlighted one or two components of this package in their studies. Nuernberger et al. (2013) described it as a role-play training package, and others have emphasized the modeling and practice parts. Some researches tried to delineate its active components. Kornacki, Ringdahl, Sjostrom and Nuernberger (2013) conducted a component analysis of BST package to provide evidence regarding the contribution made by the various components of the treatment package. The study used each component of BST procedure to teach conversation skills for young adults with ASD. The result showed that not a specific component is responsible for the acquisition of social interaction skills and using specific components by themselves appeared to be less efficient than implementing the entire package (Kornacki et al., 2013).

BST has been used in various skills training program, such as child safety, staff, and parent training (Pan-Skadden, Wider & Sparling, 2009; Buck, 2014). Many types of research have examined this procedure for training novice professionals as well as parents who have provided intervention for individuals with ASD (Sarokoff & Sturmey, 2004; Miller, 2009; Dogan, King,

Fischetti, Lake, Mathews & Warzak, 2017). Even though Taras, Matson and Leary (1988) have implemented all the behavioral parts of this package for social interpersonal skills training for two children with ASD, the application of it in direct intervention for individuals with ASD have not been extensively discussed until the last few years. Leaf et al. (2015) described BST as one of the procedures implemented clinically with numerous individuals with ASD. Though limited, a growing body of studies has used this package to teach individuals with ASD specific skills (Ng et al., 2016). A brief review of the empirical support for using BST in social interaction skills intervention for individuals with ASD can be found below.

Table 3 shows the result of a review of eight studies that have used BST in social interaction skills training for individuals with ASD.

This review only included researches that have utilized single-subject research design and excluded studies with a group-comparations study. Multiple baseline design across participants and behavior were commonly adopted in the studies. Trail-based probes were the primary measure used to evaluate behavior change. There was a total of 32 participants with ranged from preschool age to adolescents or adults with ASD. Most of the studies have incorporated other strategies in addition to BST. Radley et al. (2014a) incorporated BST with social script and self-monitoring. Additional reinforcement was also used in a couple of other studies (Nuernberger et al., 2013; Kornacki et al., 2013). Hood, Luczynski and Mittieer (2017) used BST with noncontingent reinforcement, differential reinforcement, and textual prompt based on individual assessment.

In those studies, a wide variety of skills were taught to the participants. Nuernberger et al. (2013) evaluated the number of steps performed correctly according to a task analysis while engaging in conversation with a peer, including vocal and non-vocal conversation skills. Ryan, Brady,

Table 3: Review of using behavioral skills training in social skills training for individuals with ASD

Author and year	No. and Age range of participants with ASD	Instruction format	Dependent variable	Research design	Training	Duration	Setting	Generalization	Reported result
Taras et al., 1988	2 (9-10)	1 to 1	Perseveration, appropriate affect, appropriate content of speech, appropriate sitting, eye contact.	Multiple baseline design within subjects and across behaviors	Behavioral skills training			None	Somewhat effective
Palmen and Didden, 2012	6 (15-30)	Group format with two-person each time	Off-task behavior Questions for help	Multiple baselines across participants	Behavioral skills training and self-management strategies	1h once a week over 4-6 weeks;6 weeks follow-up	Regular job-training setting	None	The decrease in 'off-task behavior; No significant change in asking for help
Kornacki et al., 2013	1 (21)	1 to 1	Engaging in conversation with a peer	Multiple baseline design across participants with an add-in component analysis	Behavioral skills training In-situ training Additional reinforcement	2-3 week	University-based rehabilitation facility	None	Effective
Nuernberger et al., 2013	3 (19-23)	1 to 1	Initiating and maintaining appropriate vocal and non-vocal conversations	Multiple baselines across participants	Behavioral skills training In-situ training Additional reinforcement	1~5 10 min sessions per day over 4 weeks, 6-8-weeks follow-up	Living unit and private observation room in a rehabilitation facility	None	Effective

Author and year	No. and Age range of participants with ASD	Instruction format	Dependent variable	Research design	Training	Duration	Setting	Gen	Reported result
Peters and Thompson, 2015	Experiment 1 4 (5-9) Experiment 2 6 (4-9) Experiment 3 4 from experiment 2 (5-9)	1 to 1	Ask a question; Change the topic when the listener was uninterested; Learn to shift to the other trained response	Multiple baseline design across participants	Behavioral skills training	Ten to fifteen 30 min sessions	Clinic for children with autism	None	Effective
Luczynski and Mitteer, 2017	3 (8-15)	1 to 1	Conversation skills and greeting skill	Multiple baselines across behaviors	Behavioral skills training Textual prompt Reinforcement	1-2 h a week across 5 months	University-based clinic	Pre and Post Novel adult and peer	Effective

Holloway and Lydon (2017) used BST to increase appropriate conversation interactions. Radley et al. (2014a) measured the frequency of social initiations and responses. Research by Peters and Thompson (2015) focused on the social response to the conversation partner's interest. Radley et al. (2014b) measured the percentage of steps that correctly demonstrated *participation*, *conversation*, *perspective taking*, and *problem-solving skills*.

There were different levels of generalization after the intervention, and some studies did not evaluate generalization at all. Research by Radley et al. (2014a) suggested that pull-out social interaction skills training with BST procedure may result in more generalizations to natural settings. Nuernberger et al. (2013) stated that BST was effective, and the effects were maintained during follow-up observations.

5.1.3 Purpose of the Study

The purpose of this study was to investigate whether after-school Minecraft interest group, when incorporated with ABA training component, was effective in increasing social engagement, improving the accuracy of using specific social interaction skills, and developing group membership of children with ASD. Sub-study 2 hypothesized that this program could result in positive behavior change for individuals with ASD.

This study attempted to extend precious literature by incorporating each social interaction skills training component (e.g., BST procedure, group teaching, special interest) as mentioned above into the intervention package for four participants ranged 7-9 years old who were diagnosed with ASD. Within this study, a multiple baseline design was used in a group teaching format using a virtual world game which can stimulate a high level of social interaction, such as collaboration and negotiation. Several assessments were performed to evaluate participants' social behavior

change and parents' social acceptability throughout the 16-session long social interaction skills group.

5.2 Method

5.2.1 Recruitment and Inclusion Criterion

Participants were recruited from the Parents of Children with Autism Association in Guangzhou, China. The researcher has organized a briefing session to introduce the program to the parents, and the recruitment information was posted in the parents' WeChat group by the association.

A 30 min screening interview and observation session were conducted to identify potential participants who could meet the following inclusion criterion –

(a) Have a previous formal and independent diagnosis of ASD by a paediatrician specializing in children with ASD;

(b) Exhibited social impairment as described on the Social Responsiveness Scale (SRS; Costantino & Gruber, 2005);

(c) Were within 7 to 12 years old;

(d) Have not attended similar social interaction skills intervention from school or other agencies;

(e) Have a full-scale IQ score of 80 or above;

(f) Displayed the ability to request and follow one-step direction vocally;

(g) Agreed to participate in one 120 min weekly session over four months; and

(h) Agreed to use the iPad version of Minecraft as a training media.

When the researcher was interviewing the parents, the research assistants would observe how well the child could handle the iPad and his/her proficiency in Minecraft. The child's interest in Minecraft was also measured by asking him/her questions like "do you enjoy playing

Minecraft?", "what do you like most about Minecraft?" and "how long have you played Minecraft?"

Before the child was accepted into the program, parents and guardians were given a detail explanation of the purpose and research procedures of the social interaction skills group. Eventually, four out of sixteen children who have gone through the interview were enrolled in this research. All the participants' guardians have given consent to their child's participation, following the guidelines from the institutional ethical review board.

5.2.2 Participants

Four children with ASD with the age ranging from 7 to 9 years old participated in the study. All the children were attending mainstream schools without receiving any additional special education services, and all of them have average or above average academic performance.

Table 4: Participants' profile in sub-study 2

Name	Age	Gender	Grade	Diagnosis	SRS-raw score	Minecraft experience
Ray	7	Male	First	ASD	88	Three to six months
Louise	7	Male	First	ASD	95	Three to six months
Bill	8	Male	Third	ASD	63	One and a half years
Lee	9	Male	Third	ASD	96	Two years

Ray was a seven-year-old boy who was diagnosed with ASD before he was two years old. He had received rehabilitation training in a remote province and later returned to Guangzhou when he was six years old. Ray was attending first grade in a mainstream primary school. He has a strong desire to communicate with others and could speak in full sentences. However, Ray could not pronounce clearly, so sometimes it was hard to understand what he was trying to express.

When he did not know how to respond, he would repeat other people's questions. Minecraft was the only game that he enjoyed playing.

Louie was a seven-year-old boy diagnosed with ASD. He was attending first grade in a mainstream primary school. Louie has received clinic-based services at his preschool age. He could speak in three to four-word sentences but has poor articulation and loose sentence structure. He would say, "do I like your painting?" to express "I like your painting." Sometimes, he would have difficulties controlling his emotion and following instructions. Minecraft was his most favourite game, and he would play it with his elder sister at home.

Bill was an eight-year-old boy attending third grade in a mainstream primary school. He was diagnosed with autism when he was three years old and was medically discontinued as typical autism at the age of five. However, his parents said that Bill still has significant social difficulties and did not have any friend, so further intervention was warranted. He spoke in full sentences and could follow multi-step instructions. He did not exhibit vocal stereotypy (repetitive no conversational vocalizations) but talked with a perseverative speech on restricted topics, and he has difficulty in shifting the conversation. Sometimes, he would use words inaccurately, such as using "pure" to describe "like real." He has been playing Minecraft for more than one year. His parents controlled strictly his daily playing time fearing that too much video game playing will hurt his eyesight.

Lee was a nine-year-old boy attending third grade in a mainstream primary school. He could follow the classroom routines and have the desire to communicate with people, but he did not know how to get along with others. He acted defensively, did not understand, and resist others' intimacy intention. He spoke with a flat tone and preferred to use written language. His mother was more tolerant of his games playing. He also has a strong interest in programming, video

games, and robots.

5.2.3 Structure of the Minecraft Interest Group

Social interaction skills were taught in a group instructional format to the four children. In addition to the four participants, Leo, a 16-year-old boy diagnosed with Asperger's syndrome who had extensive experience playing Minecraft, has volunteered to become a helper in this research study. During the session, everyone would sit around the table, two group members on the left and two on the right. The primary group facilitator (the researcher) would sit on one end of the table, two undergraduate-level research assistants would stand directly behind the participants and deliver social reinforcement for appropriate behaviors, such as sitting quietly, looking at the teacher, and following instructions. The research assistants would also help in setting up the equipment and observation recording. Parents would sit at the back of the room the whole time, observing their child's behavior, and learning the teaching methods of the facilitator.

5.2.4 Setting and Technology Support

The research was conducted in a university clinic in Guangzhou, China, and that clinic has been providing services for individuals with disabilities. Both the teaching session and the game-play session took place in the same room. All assessments and intervention sessions were conducted in Mandarin - the primary language for all the participants and the researcher. The lab room was about 6m by 4m big, with a smart TV in the front, and a rectangular conference table at the centre.

To make the environment more interesting, the researcher would decorate the place with many Minecraft-themed props such as toys and posters. There were about ten books and guides related

to Minecraft for pre-class reading and after-class borrowing. This small library of books also opportunities for interaction among the participants, the research assistants, and the researcher. This study has also used a few technology devices. The mobile tablets (iPads) were connected to a private multiplayer server via a Wi-Fi router. PowerPoint slides with curriculum materials/content were displayed on a laptop computer connected to either the smart TV or overhead projector. The iPad was connected to either the laptop or directly to the projector using the *Lightning Digital AV Adapter* so that everyone could see what is going on in the Minecraft world. The Lightning Digital AV Adapter supports mirroring of what is displayed on iPad screen to HDMI-equipped TV or projector or other compatible display. *Airplay* and the *Air Sever App* were used in the first couple of sessions to display the iPad screen on the projector. However, the researcher found that it took too much time to switch between different devices using Airplay, and the long wait time has affected the effectiveness of the intervention process. So that Airplay was dropped in favor of the Lightning adaptor. A video camera was used to record group sessions.

5.2.5 Selection of Target Social Interaction Skills

Indirect Assessment

Parent interview. The researcher spoke with the parents to get detail information on the social difficulties that their child was having. The researcher also highlighted some skills selected from social interaction skills programs (Koenig, 2012) and social validity studies on social interaction skills (Quinn, Sherman, Sheldon, Quinn & Harchik, 1992), and asked the parents for the expectation of their child performance in those areas.

Social Responsiveness Scale, (SRS; Constantino & Gruber, 2005). The SRS has been widely

adopted in autism research. It is a 15–20 minutes screening for individuals with ASD ranging in age from 4 to18, designed to measure the severity of social deficits associated with ASD. The SRS includes 65 items and can be completed by people who are familiar with the person being assessed. The subscales do not have sufficient items to determine the choice of instructional strategy (Constantino & Gruber, 2012), but the total raw scores are helpful to the researcher. The total score of SRS is a reliable assessment of social deficits related to ASD (Bruni, 2014). High scores are associated with more severe social impairments. The use of SRS has been identified as less capable of evaluating intervention effect (McMahon, Lerner, & Britton, 2013) and is usually used to develop a profile to verify enrollment eligibility (McMahon, Vismara, & Solomon, 2013).

SunYat-sen university (Guangzhou, China) obtained the authorization from Western Psychological Service in 2008, to perform a revision and reliability test of SRS for Chinese. The study showed that the Chinese version of SRS has good content validity and internal consistencies. Researchers found that the total raw score of 59.5 was the most accurate cutoff point as a diagnostic of social impairment for individuals with ASD living in major cities of China (Chen, 2009).

In this research, SRS was used to assess the social impairment for each participant based on their parent's report. It was also used, in conjunction with direct behavioral observations and other assessment results, to identify three to five target skills (priority rankings for high score items). These skills were then embedded into the social interaction skills training curriculum.

Direct Assessment

Direct observation through behavior probes (performance opportunities) based on the SRS

findings and parents' description was used before training commenced. The researcher programmed evocative situations during group gameplay time to observe the reported concerns from parents and the social interaction among the participants. Following the direct assessment, the researcher shared the observation results with the parents and confirmed the deficits that needed addressing.

Selection of Target Skills

The researcher selected social interaction skills based on direct observation, SRS findings, and interviews with parents. Thus, the researcher attempted to select skills that were deemed significant by those who were familiar with the participant. The target skills selected were also based on the homogeneity of the whole group.

The target social interaction skills, steps, and specific requirements selected for each participant were presented in Table 5. For example, both Lee and Bill were advanced Minecraft player; they were taught to "offer help" to Ray and Louise, who were less experienced with Minecraft. Ray and Louise have language delay, so asking them to "give compliment" only required them to say something general like "It is good!" or "It is cool!".

Each target skill was decomposed into 2-5 behavioral steps, and each step was objectively defined as represented in Table 6. The researcher did a task analysis that included vocal and non-vocal steps to initiate and maintain an appropriate interaction with peers by referencing sources that addressed common social interaction deficits exhibited by individuals with ASD in previous studies (Quinn et al., 1992) as well as the social interaction skills training curriculum (Taubman, Leaf, McEachin & Driscoll, 2011).

Table 5: Target social interaction skills for each participant

Ray	Louise	Bill	Lee
Answer question	Answer question	Make a statement/question related to the topic	
Make a statement/question related to the topic	Make a statement/question related to the topic	Wait patiently (natural pause) for the other person to respond	
Ask for help	Ask for help	Offer help	Offer help
		Negotiation	Negotiation
Presentation	presentation	Presentation	Presentation
Giving compliment	Giving compliment	Giving compliment	Giving compliment
Response to compliment	Response to compliment	Response to compliment	Response to compliment

In addition to the target social interaction skills selected for each participant, social engagement in group activity was also a target behavior for all the group participants. Social engagement during discussion time was defined as active listening, following instructions; responding to questions, asking questions, taking turns to speak, sharing of activities or materials with peers, and making positive comments on other people's works or behaviors (Koegel, Matos-Freden, Lang & Koegel, 2011). Social engagement during structured play time was defined as creating theme-related items with other team members in the same world or discuss with other team members during the construction process; asking questions or answer questions; initiating invitations or accepting other people's invitations; asking for help or providing help. Exceptions are breaking other people's buildings; blocking others from building things; frequently placing creatures (animals or villagers) in other group members' buildings or public areas; killing creatures other than monsters; building objects that are unrelated to the theme.

Table 6: Task analysis and definition of target social interaction skills

Evocative situations		Skills	Task analyzes and definition	
Discussion time	Discussing group rules, game playing theme, what has happened during gameplay and other topics	Turn-taking during conversation	Active listening	Looks directly at the face of the communication partner while listening
			Answering questions	Respond with content that relates to the question.
			Make a statement/question related to the topic	The first response to preidentified topics was designated as appropriate. All subsequent response emitted during a session should differ from previous statements or questions, or if pertaining to one of these topics were scored as perseverative speech. (Fisher, Rodrigucy, & Owen, 2013; Nuernberger et al., 2013; Luczynski & Mitteer, 2017)
			Wait patiently for the other person to respond	Waiting to speak until a natural pause occurs in the group member's response. This excluded verbal initiations in the form of positive feedback, for which the aim of the response was not to take over the speaker role. (Beaulieu et al., 2013; Luczynski & Mitteer, 2017)
Game playing time	Building something that the participant wants to but do not know how. Facing difficulties in the virtual world	Helping	Ask for help	Face towards the person or call his/her name
				Clearly explain the kind of help you need, such as "can you help me to…"
				Thank the person for help, or wait or ask other group members for help if the person you asked is busy
			Provide help	Give help when asked to, or politely say "I am busy with my own work. Would you mind waiting?"
				Say, "let me help you" when he noticed that group member needs help
				Respect the will of the person who is being helped

Game playing time	Working together under the same theme/task, facing some conflicts on materials, space, etc.	Basic negotiation	Orient towards group member and maintain a normal voice tone	
			Politely states what you want (Give a reason for the request)	
			If the request not accepted, asks for a solution	
			If you do not accept others' solutions, propose an alternative solution.	
			Thanks to the person who takes the compromise	
Presentation and compliments	Introducing their works built in the virtual world and appreciating the work of others	Presentation	Greet the audience and introduce yourself	
			Introduce the work you have produced in the virtual world (such as material, feature, and function).	
			Not playing when others are presenting	
			Complete the introduction within the specified time	
			Thank the audience for listening at the end of the presentation	
		Compliments	Giving compliments	Orient towards group member
				Respond with a generic compliment (e.g. "that's cool!") or could appreciate the work/behavior with specific words, no rude or offensive statements.
				Compliment first before making a suggestion
			Responding to compliments	Orient towards group member
				Saying "thank you." or "thanks."

5.2.6 Dependent Measures and Inter-observer Agreement

Probes were opportunities that arise when the researcher set up evocative situations to see if the participant would display the target social behavior. Evocative situations in group discussion and virtual world game playing include discussing the group rules, building together in the same server, arranging the participants to work on the same topic, and sometimes building together to accomplish the same goal. There were many opportunities to practice cooperation and negotiation skills. The researcher did not prime, prompt, or reinforce during baseline and follow-up probes. In-situ training probes were conducted after every BST training in the training room, and feedback and reinforcement were provided. The master criterion was set when a participant displayed a minimum of two consecutive probes of 100% for the target skill in role-play training/rehearsal sessions (Radley et al., 2014).

The dependent measures for turn-taking in conversation, asking for or offering help, and complimenting skills were the percentage of probes with a correct response. The number of correct responses for each skill was divided by the total number of response opportunities set up by the researcher and multiplied by100 to convert to a percentage for each target skill during each session (Plavnick et al., 2013; Hood, Luczynski & Mitteer, 2017). The percentage of steps correctly performed to measure the progress of presentation and negotiation skills that both are very complex skills to master. The researcher would record which steps the participant has performed accurately, inaccurately, or omitted and then reported these data as a percentage of proper steps, defined by the task analysis (Dotson et al., 2010; Nuernberger et al., 2013).

$$\text{Percentage of probes with correct response / Percentage of correct steps of skills} = \frac{\text{The number of correct responses / steps}}{\text{The total number of responses opportunities /steps}} \times 100\%$$

An adult initiated conversation skill probes in the group discussion session. Usually, there were about 3-5 opportunities for turn-taking conversation during one session, so one inappropriate response would decrease performance to 80%, 75% or 67% respectively; 2-3 opportunities from peers for helping and complimenting skills, so each incorrect response would decrease performance to 67% or 50% respectively.

Social Engagement. Level of engagement was measured using 1-minute interval momentary time sampling observation. The participant's engagement during a 1-minute interval was rated as engaged or disengaged based on whether he was socially engaged or not at the end of the interval. Social engagement was measured during discussion time and structured gameplay time separately. Some of the characteristics used to measure the level of engagement that was meaningful in the virtual environment were different from the characteristics of engagement in physical group activities (e.g., shared joint attention of avatars representing the participants within the game) (MacCormack, 2016).

Interobserver Agreement, (IOA) between the researcher's score and a video coder was evaluated during 25% of sessions across participants. The video coder independently recorded data and the intervention conditions (baseline, training, follow-up), which were shown in no fixed order. The video coder was an undergraduate student in special education trained by the researcher; training criterion was at least 80% agreement with the researcher on sample probes. An agreement was defined as both observers recording correct or incorrect response for each step of the task analysis. Percentage of agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. Acceptable IOA should equal or exceed 80% (Bailey & Burch, 2002). Mean percentage agreement ranged from 80% to 100% in this study for all ratings calculated. Mean percentage agreement was 100% for

presentation and compliment skills, 85% for negotiation skills, 84% for help skills, 80% for turn-taking in conversation skills. Mean percentage agreement was 100%, 83% and 87% for role-playing, in-situ training, and follow-up probes respectively. Mean percentage agreement was 81% for social engagement across participants.

5.2.7 Group Curriculum Adaptation and Individualized Teaching

This study did not follow a single or specific curriculum. Instead, the researcher individualized each session's curriculum based on multiple sources (Leaf et al. 2016), including (a) the student's individual social difficulties; (b) the group instructional goal; and (c) social deficits identified on various assessments, such as parental responses to SRS (Constantino & Gruber 2005), *Super Skills* social profile (Coucouvanis, 2005); and (4) parent concerns. The content of group lessons was driven by a combined list of high priority skills for each participant, and the list was used to develop the group curriculum (Minihan, Kinsella & Honan, 2011). The researcher also drew upon a few curriculum books (e.g., *Super Skills,* Coucouvanis, 2005; *"Crafting Connections",* Taubman et al. 2011; Painter, 2006), and, at times, the researcher created her curricular targets and materials based on what happened in the previous group session.

The research used both (a) individual intervention plans and (b) customized group instruction modules (White et al. (2010b), to implement the intervention package (BST procedure, social script, reinforcement procedure). The intervention package was individualized to meet the needs of each participant, such as social script prompt was only used for Louise and Ray, and variable-interval reinforcement only for Louise to maintain his social engagement in the group discussion. The researcher used a structured yet flexible approach in instruction and made assessments of what and how best to teach in real time. (Leaf et al. 2016). Besides the target skills for each

participant, several types of social interaction skills were taught to this group of children with a specific focus on conversation skills, cooperation skills, relationship development using both direct and incidental teaching methods. For example, Ray was taught to accept criticism one time when he destroyed another group member's building in the virtual world.

5.2.8 Experimental Design and Procedure

Multiple probes (Horner & Baer, 1978) across behaviors with concurrent replication across participants design was used to evaluate the effects of using the BST package to establish social interaction skills. This study consisted of three experimental phases: baseline, intervention, and follow-up. Phase changes between direct instruction of new target skills were made when all participants demonstrated mastery criterion for each of the targeted skills during training. The independent variable was sequentially administered to each target behavior of an individual participant. Based on the criteria for identifying causal, or functional, relations in single case research (Kratochwill, Hitchcock, Horner, Levin, Odom, Rindskopf & Shadish, 2013), a single participant represents a complete experiment with additional participants demonstrating replications of the initial experiment.

Figure 7 shows the research procedure of this study. During the intervention phase, the sessions were held weekly for 2 hours for 15 weeks. Follow-up sessions were held four weeks later after the training sessions have ended. The initial four sessions were for establishing baseline conditions, followed by eleven sessions of BST package intervention. It is important to set up rules for group instruction and during gameplay in the initial sessions before the actual training was conducted. In the last intervention session, a summary of the group activity, sharing of participants' works in the virtual world, and token exchanges represented the farewell of the

group meeting.

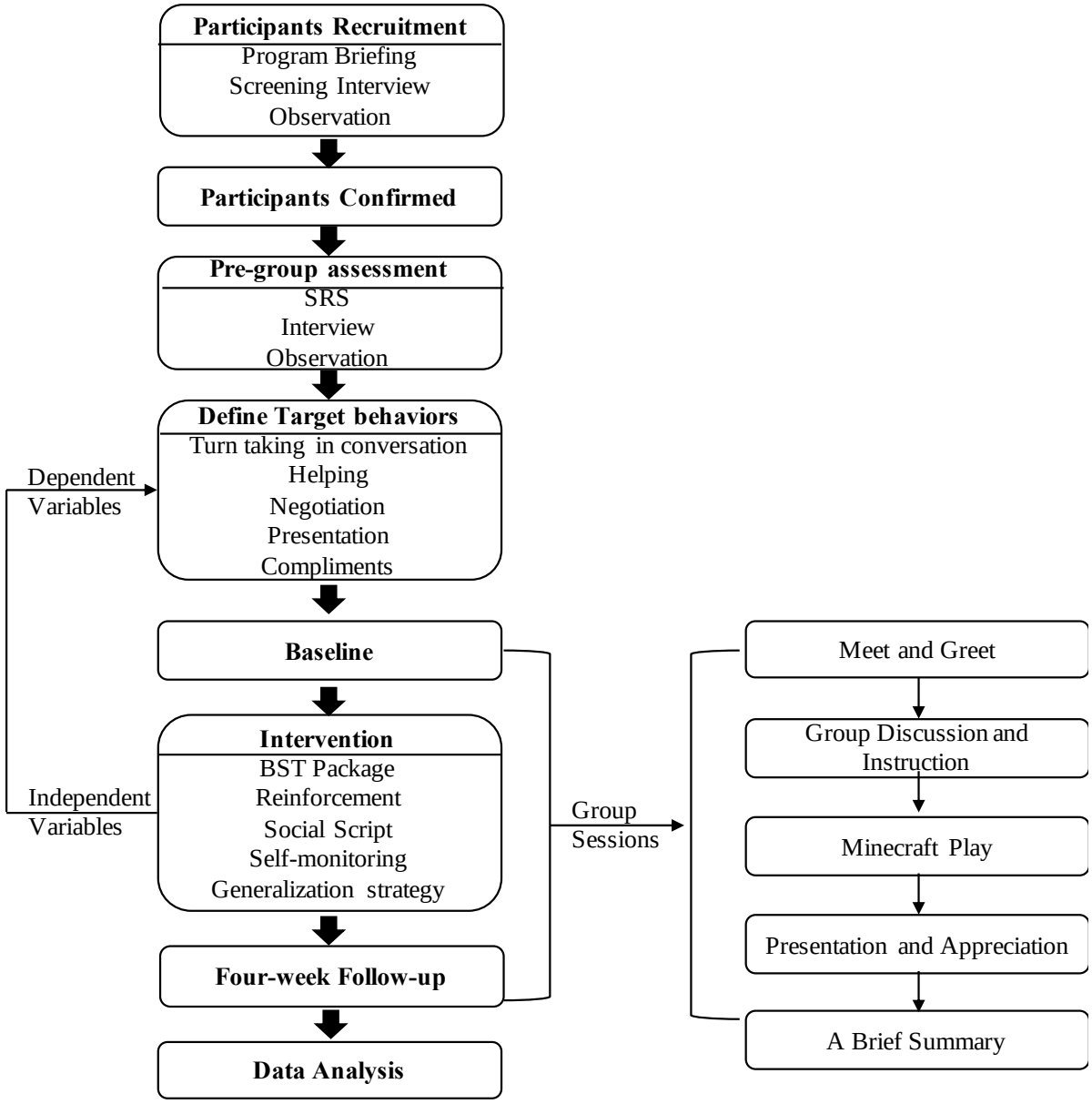


Figure 7: Research procedure for sub-study 2

Each session was made up of the following activities:

Meet and greet (10mins): Socializing and networking. Different activities such as self-introduction, remembering group members' name, noticing who is missing - were used to encourage paying attention to and having an interest in others.

Group discussion and instruction (30mins): Reviewing rules and structure, discussing the day's activities and target social interaction skills. BST and conversation skills in-situ training allowed for explicit instruction and practice of target responses.

Gameplay (40mins): The gameplay section is based on a "build" concept. The participants were asked to build a particular structure in Minecraft, and they would work in teams or individually (depending on the activity) to complete the task. All the participants would play in the same server and would need to work together both online and offline to complete the tasks assigned to them. There would be in-situ training (natural Minecraft playing time) for help, negotiation, and conversation skills.

Presentation and appreciation (30mins): Introducing your work and give positive feedback to the other team members. BST teaching and in-situ training for presentation and compliment skills allowed for explicit instruction and practice of target responses.

A brief summary (10mins)

Social Interaction Skills Teaching Sequence

Leaf, Dotson, Oppenheim, Sheldon and Sherman (2010) conducted independent sessions for each target skill, whereas Hood et al. (2017) embedded opportunities for the skills into a single conversation. The present study highlighted each target skill in separate sessions but incorporated all the skills in an integral group activity. The researcher staggered the three sets of skills so that only one skill was intervened at a time. According to the multiple baseline design across behaviors, targeted skills were introduced sequentially once evidence of achievement of the previous skill was exhibited (i.e., 100% on training probe trials over two consecutive sessions)

The initial set of skills was turn-taking in conversation. Offering help and basic negotiation were the following set of social interaction skills. These skills were essential for collaborating in actual game playing. The last two sets of social interaction skills were presentation and appreciation. Presenting, sharing, and appreciating each other's work was a core part of the group activity.

Pre-group Assessment

During the pre-group assessment, the researcher met with the participants' parents to understand the details of the child's social deficits and the parents' expectation. SRS and *Super skill* profile measures were administered.

Baseline

The present study included multiple baseline data collection to avoid the possibility of familiarity effect (i.e., an increase in social interaction as a result of familiarity). However, free play of the virtual world game without direction simply to establish baseline levels of social interaction was unethical. Therefore, although there was no skill teaching when taking the baseline measures, group activities and gameplay were structured and guided by the researcher. In the baseline session, the researcher would create opportunities for each participant to emit each of the identified target behaviors by engaging in antecedent behaviors that tend to evoke the target response. Activities organized by the group facilitator during the baseline session provide opportunities for the participants to engage in the targeted social behaviors.

During the first four group sessions, behavior probes were conducted without programmed consequences for correct or incorrect responses. This was to measure the current levels of target behaviors for each participant. To initiate a probe, the researcher provided the antecedent(s) to

see whether the participant did or did not perform the target response within 5s of the antecedent stimuli. If the participant performed a target response during baseline, he/she would receive a natural consequence - praise from the researcher. This sequence was repeated until all participants have a couple of opportunities to engage in all the targeted behaviors. The researcher was the social partner for "offering help" and "maintaining conversation/ turn talking" trials because these behaviors required a specific social antecedent, such as demonstrating the need for help or initiating a conversation. During baseline taking, the participants would not receive any instruction from the researcher.

The baseline sessions consisted of a general introduction of the participants, the group facilitators (the researcher and assistants), the group rules and the incentive system - token economy.

The group rules include a)) basic group behaviors, such as put down the iPad when playing time is over; 2) group rules that integrated into the individual target behavior, such as cooperate and help with each other to complete the task; 3) rules in the virtual world-Minecraft, such as respect each other's work, caution to use TNT (a building block that explodes shortly after being ignited). The group rules and token economy were explained during the last baseline group session.

There were three phase changes with concurrent baseline control in at least three points in time. After the initial baseline sessions, BST was initiated for the first skill set and probes for the remaining skill sets which were conducted every four sessions. In addition, at least two to three consecutive baseline probes were administered immediately before the application of BST to a specific skill.

Intervention

Behavioral Skills Training Package. After establishing the baseline, the researcher began teaching targeted social behavior to the group members using BST embedded in a 120-min Minecraft interest group meetup. Incorporating the participants' area of interest helped focus their attention, and recommendations from the facilitators were more likely to be remembered and used. The researcher first focused on teaching the participants basic rules for the social interaction skills group such as following directions, sitting still, and looking at others during social interactions. The researcher also incorporated the target social interaction skills into the group rules. For example, "Listen attentively, take turns to speak, encourage others!" The researcher then alternated between teaching the rules and providing opportunities for the participants to engage in targeted social behaviors. The initial social skill set was taught until the participants have demonstrated an increase in performance or have reached a stable state of 100% correct response during role-play condition. At that time, an additional set of skills would be introduced.

The researcher provided the participants with instructions, modeling, role-play and feedback during each teaching session. First, the evocative situation would be described together with the corresponding skill. For example, "If another group member asks you to help him build the Metro, but you are busy with your work, what are you going to say/do?" A written description of the task analysis was given to the participant and had him/her read it out. The description described how to perform the steps of the target skill correctly. Next, the facilitators would model the target skill with the correct behavior. Then the participants would practice the skills with another group member using role play. If the participants performed the target response, they would receive praise and token from the researcher. If the participants did not engage in the

correct behavior, they would be told by the researcher that it was a nice start, but that next time they needed to adjust certain aspects of their behavior to perform the social response correctly. Following an incorrect response and feedback, the researcher would instruct the participants to sit down and wait for their peers to finish. After that, another opportunity would be given to the members who previously displayed the incorrect response. The rehearsal would repeat until all the participants could complete 100% of the steps correctly during the role play, after which they would proceed to actual gameplay for in-situ training. No participant required more than three role plays to reach 100% accuracy before each in-situ training. Every in-situ training session was conducted following BST and the behaviors were assessed and demonstrated in a more natural setting. In this study, in-situ training was conducted during group discussion and game playing time after the BST time. Immediately following the rehearsal, including the role play and in-situ setting, the group facilitator would give the participants feedback regarding their performance. Feedback was given regarding the steps that were performed correctly and the steps that were not completed correctly. Corrective feedback for incorrect or no response would use a flexible prompt fading procedure.

Reinforcement. A token economy system combined with BST was used to teach the social interaction skills for the whole group. A token economy (Kazdin, 1982) was implemented throughout the intervention across all the participants. The participants received tickets with a *Creeper* image for attending and listening to the facilitators and other group members, asking and answering questions, acting in roleplays, and displaying their individual target social interaction skills during group sessions. Participants received tickets both during teaching and throughout the entire social interaction skills group. The tokens functioned as reinforcers because creeper was their most favorite figure in Minecraft, and the stickers could be exchanged for free

play time at the end of each social interaction skills group (only for Louise and Ray), and Minecraft Lego toys at the end of the whole group meeting sessions. During group instruction, it was hard to deliver immediate token, and sometimes immediate token delivery would impact the conversation fluency during the discussion session. So, tokens were usually delivered after the group discussion time, though vocal praise for each correct response could still be given. In role-play and in-suit training sessions, tokens were delivered immediately after every correct response.

In addition to the token economy, the researcher also implemented the variable-interval schedules of reinforcement (occur when a response was rewarded after an unpredictable amount of time has passed) to Louise. Variable-interval reinforcement was used to reinforce his on-seat, waiting, and listening behaviors during the group discussion time.

Social script (Louise and Ray). An add-on component of social script was given to Ray and Louise due to their errors in repeating the question or having no response in the initial training. A script prompt would be provided following incorrect responses and when there was no response in 3s. Social scripts were laminated pieces of paper (7 cm by 21 cm) with the right skill or scripts typed in 26 pt SimSun font in Chinese. An advantage of script prompts over vocal prompts was that the trainer could provide feedback without interrupting the flow of the conversation. All participants could read the script prompts before the session started. Continuous script prompt would be used first followed by delayed script prompt. To fade the script, the researcher would remove some words and leave blanks in the sentences. When the participant could perform the target skill at a satisfactory level, the researcher would remove the script prompts and only provide feedback for incorrect response and reinforcement for the correct response.

Self-monitoring card (Bill). After three sessions of direct instruction and role-play training for

turn-taking on conversation, Bill was provided a self-monitoring card for his target skill of making a statement on topic and no-interrupting during training. This was to facilitate generalization of newly acquired skills to the classroom (Koegel, Park & Koegel, 2013).

Generalization strategies. During the intervention, the researcher employed several generalization strategies as suggested by Osnes and Lieblein (2003): multiple exemplars - various scenarios were presented during training; common stimuli - the group setting offered an ongoing social environment and activities with peers; a few unfamiliar peers were present (as part of the group members) during some training sessions.

Four-week Follow-up

Maintenance and generalization of target skills in 4-week follow-up were also measured for behavioral change. Maintenance can be viewed as the length of time that elapsed between the termination of therapy and the continuance of the behavior. Generalization refers to the extent the behaviors learned in the clinical context occur at appropriate times, and to socially relevant persons in socially relevant settings. The processes will not occur by chance and therefore any sophisticated treatment program must directly address them (Wodarski, 1980).

Four weeks following the intervention, the researcher organized another group meeting. Two participants returned to the clinic building for the 4-week follow-up session. Follow-up probes were done as in baseline sessions. There was no feedback, no prompt, but new peers. There were ample opportunities to probe the maintenance of target skills in the training room. A couple of previously unknown peers was present and there were new facilitators to probe for generalization of the target of introducing oneself. In order to achieve maintenance in naturalistic situations, the researcher also removed the tokens to sustain the motivation to engage in social interaction skills

by natural consequences.

5.2.9 Parent and Sibling Involvement

Parents were welcome to sit at the back of the room to observe the intervention sessions. They were debriefed at the end of each session and could provide suggestions or get feedback about their child's performance through the WeChat social network. The researcher was also able to invite the participants' other family members to join the group activity (Louise' sister came to the group four times and played Minecraft with other group members together). There were three formal meetings with parents to discuss the results of the assessment, individual target skills, and the chosen intervention strategies.

5.2.10 Social Validity

Social validity is the attempt to determine the meaningfulness of the selected skills, teaching procedures, and degree of improvement (Hood et al., 2017). This research did social validity measurements for both parents and participants.

Parents of the participants were asked to give satisfaction ratings concerning the selection of target skills, intervention procedure, and their child's overall performance on an anonymous Likert scale adapted from Social Validity Scale (Leaf et al., 2010). The rating scale included questions specific to the current investigation. The score ranged between 1 and 5 representing the extent to which they " highly disagree," " disagree," "neutral," " agree, "or "highly agree," with questions related to the critical components of social validity (i.e., goals, process, outcomes) as identified by Wolf (1978). The parents were also asked if there were any additional social interaction skills, they thought their child would benefit from learning. The parents were highly

involved throughout the sessions. They were asked to give an opinion on the target skills chosen for their child and the explanation of the teaching strategies. They could sit at the back of the room during the group session so that they could observe their child's behavior. Before filling in the rating scale, the researcher would explain the evocative situations, target skills, task analysis of skill steps and intervention procedure to the parents so that they could attend specifically to these skills when filling in the questionnaire. The parents completed the questionnaire independently, but a research assistant was available to answer questions.

In the last group session, the researcher also asked the participants to rate their satisfaction level and provide the rationale. The researcher read out the questionnaire and took note of their answers. The participants were asked about how comfortable they were in engaging in Minecraft social interaction skills training group and whether they could benefit from learning these social interaction skills.

5.2.11 Data Collection and Analysis

This study collected different data by observing representations of action in and across multiple spaces. All the data of what happened on and off-screen were collected, from multiple perspectives, and at different time. Video recordings, interviews, field notes, photographs, and work samples were transcribed and combined into a rich, multimodal data set.

Video recording. Two stationary video cameras were used to take video recordings of all the sessions. In-game interactions in the virtual world were collected using the built-in screen recording tool of the iPad. Video recordings of in-person and in-game play were coded to determine the quality of social play - target skills displaying correctly and social interactions such as collaboration, relationship development within and outside the virtual world.

Observation Timer App. Levels of engagement were coded during the group activity scene using "*Insight*", a behavior observation recording timer with features such as customizable interval length and behavior labels. The researcher set the interval for 1-min, and the behavior label was either engaged or unengaged.

Dairy. Immediately following each group session, the researcher would jot down important notes and reflections which would be used as a foundation for the design of the next group activity and discussion content.

Visual analysis. Visual analysis of the graphical display of data is a core feature of studies using a single case experimental design (Lane & Gast, 2014). Data are graphed for each participant. Effects of the intervention package on correct performance of target social interaction skills were evaluated by visually analyzing the level, trend, and stability of data within and between conditions.

Effect size. The utilization of effect size metrics as adjunctive support to visual analysis. Non-overlap techniques are distribution-free, nonparametric strategies designed to synthesize graphical representations of data obtained during within-subject of single-subject experiment design (Lenz, 2013). They are seen as indicators of performance differences and have been included in recently proposed standards for evaluating single case experimental design (Horner Carr, Halle, McGee, Odom & Wolery, 2005; Parker, Vannest & Davis, 2011). Percentage of non-overlapping data (PND) was defined as the percent of intervention phase data points which exceed the single highest baseline phase data point in determining the effectiveness of the intervention. (Scruggs, Mastropieri & Casto, 1987). The calculation formula for PND is

$$\frac{\text{The number of intervention phase data points exceed the single highest baseline phase data point}}{\text{The total number of intervention data points}} \times 100\%$$

PND can be implemented with smaller data sets (i.e., n < 20) and has a consistent correlation with visual analysis judgments during meta-analysis (Lenz, 2013). It was calculated by hand with graphical representations of data in this study. Scruggs and Mastropieri (1998) suggested that effect sizes of .90 and greater are indicative of very effective treatments, those ranging from .70 to .89 represent moderate effectiveness, those between .50 to .69 are debatably effective, and scores less than .50 are regarded as not effective.

5.3 Results

5.3.1 Target Skills Performance

The primary dependent variable of the current study was the correct performance of target skills in a training setting. The target skills performance of Bill, Lee, Ray and Louise are depicted in Figures 8-11, respectively.

Bill

Figure 8 shows the target skills performance of Bill. Bill demonstrated the skill of turn-taking in conversation with means of 35.1%, 71.6%, and 71% of total opportunities during baseline, intervention, and follow up conditions. Bill exhibited low variable levels of on-topic talk without perseverative speech and waiting appropriately without interruption during the baseline group discussion sessions. Also, in the baseline session before the rules were introduced, Bill's level of interruption increased after he got more familiar with the other group members. During BST teaching, the researcher taught all four turn-taking conversation skills to Bill, and Bill managed to meet the mastery criterion for each skill during the role-play sessions. However, during in-suite training, Bill exhibited only a medium level of turn-taking conversation skills with self-monitoring card and when the token was delivered after the whole discussion session. Across 11

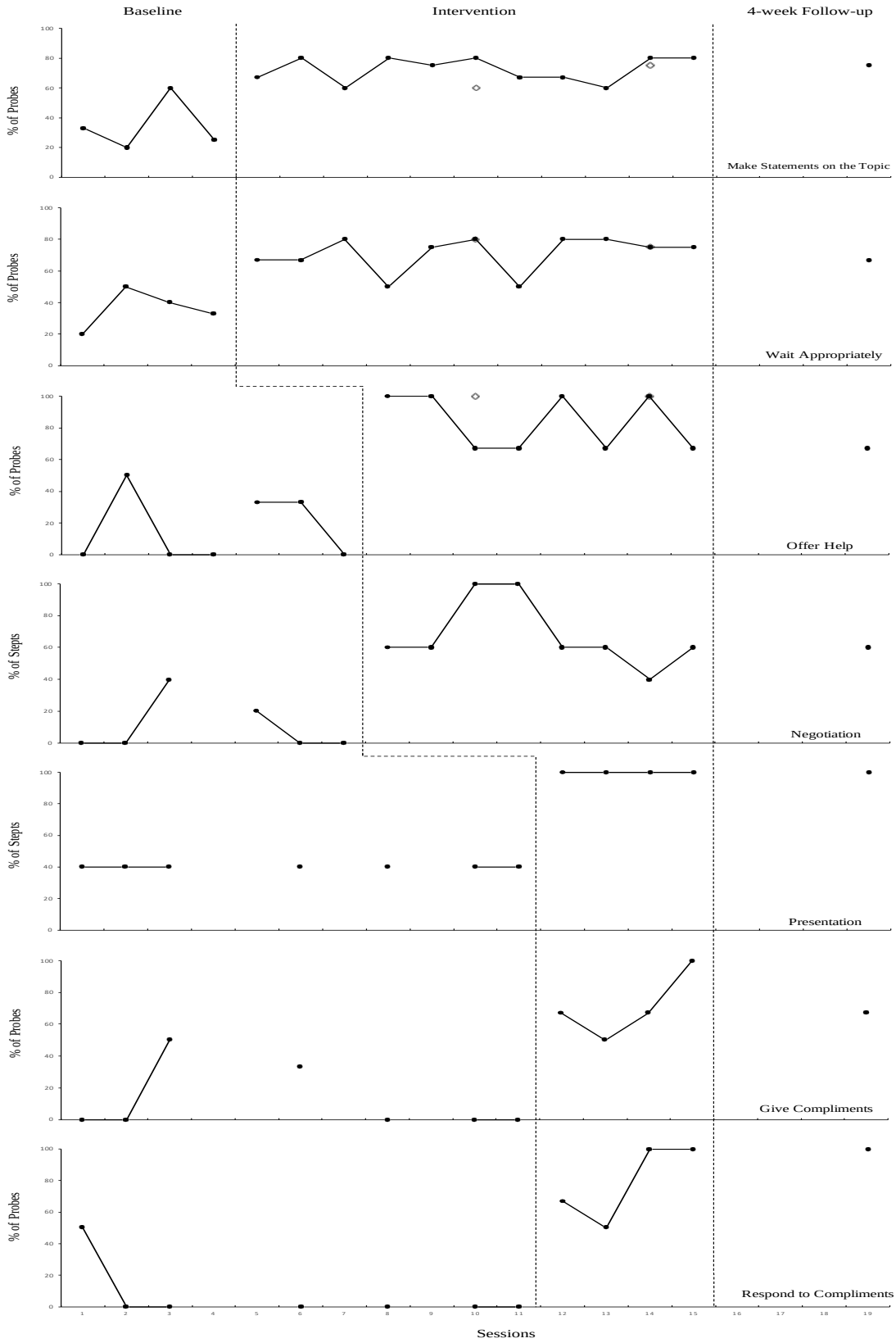


Figure 8: Percentage of opportunities/steps with correct performance for target skills across sessions for *Bill*

weeks, Bill continued to exhibit a medium level of performance of these two skills and has 1-3 incorrect responses during each in-situ training session. This represented a slight improvement over the low skill performance level during baseline.

Next, Bill demonstrated a clear change in helping skills with a mean percentage of 16.6%, 83.5%, and 67% of total opportunities during baseline, intervention, and follow up conditions; and mean percentage of 10%, 67.5%, and 100% of steps in negotiation skills during baseline, intervention, and follow up conditions. During baseline, low level of self-initiated help and negotiation behaviors were observed. Bill shouted every time when he was confronted with conflict during baseline. But Bill met the mastery criterion following one training session of help offering skills and two sessions of negotiation skills. During the in-suite training, the researcher provided feedback for each incorrect response and reinforcement for every correct response. Bill exhibited a high but variable level of performance of these two skills. Most of the time Bill would only collaborate with Lee. So usually there were few opportunities for negotiation, and negotiation was a complicated skill to demonstrate. Therefore, the researcher used the percentage of steps correctly performed to measure the progress of this skill. Moreover, Bill did quite good during generalization probe with a typically developed girl on offering help. This is proof of a functional relationship between the training and generalization of the BST procedures and reinforcement.

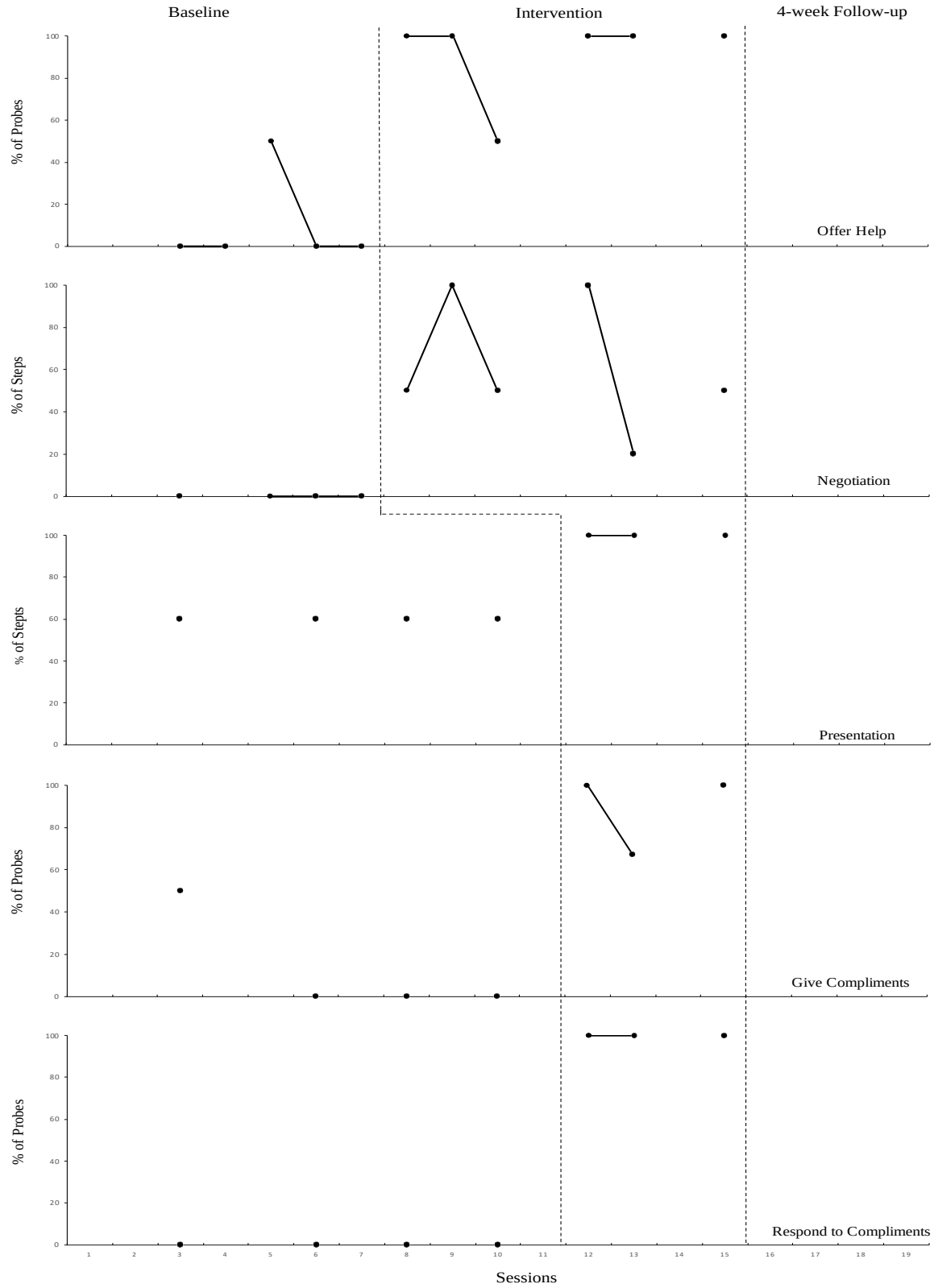
Bill demonstrated presentation for a mean of 40.0%, 100%, and 100% of steps displayed correctly during baseline, intervention, and follow up conditions. Bill has shown a stable level of presentation skills with 3/5 incorrect steps during each session in the baseline. During the in-suite training and follow-up condition, Bill's performance in the presentation was nearly perfect. He demonstrated compliment skills for a mean of 9.5%, 75.1%, and 83.5% of opportunities

during baseline, intervention, and follow up conditions, respectively. Bill exhibited a low and variable level of giving compliments and responding to compliments in the baseline. Satisfactory levels of performance were assessed in training and 4-weeks follow-up conditions. This outcome showed functional control over the direct effects of teaching.

Lee

Figure 9 shows the target skills performance of Lee. Lee demonstrated helping skill with a mean of 10.0% and 91.7% of opportunities and negotiation skill with a mean of 0 and 61.7% of steps displayed correctly during baseline and intervention conditions. Lee exhibited low levels of initiating help and complete absence of negotiation skills during baseline. Lee met the mastery criterion after one session of teaching for offering help skills and two sessions of negotiation skills. However, he demonstrated a variable level of negotiation skills during the in-situ training condition. He learned to express his demands and the rationality of the request but found it difficult to make a compromise. And Lee did quite good on offering help during in-situ training condition. He was more willing to offer help when he was asked to change the game settings in the virtual world. When he was asked to help build something he was not interested in, he learned to express himself politely. He used to say “you are wasting my time” before learning these skills.

Lee demonstrated presentation skills with a mean of 60.0% and 100% of steps displayed correctly; compliment skills with a mean of 6.3% and 94.5% of opportunities during baseline and intervention conditions. He exhibited a stable level of presentation skills with 2/5 incorrect steps each session, low level of giving a compliment and a complete absence of responding to compliments skills during baseline. Lee was able to attain the mastery criterion after one session



- In-Situ training probes

Figure 9: Percentage of opportunities/steps with correct performance for target skills across sessions for *Lee*

of teaching. His performance in the presentation was nearly perfect, and he learned quickly compliment skills by observing others during the in-suite training. This outcome showed functional control over the direct effects of the intervention.

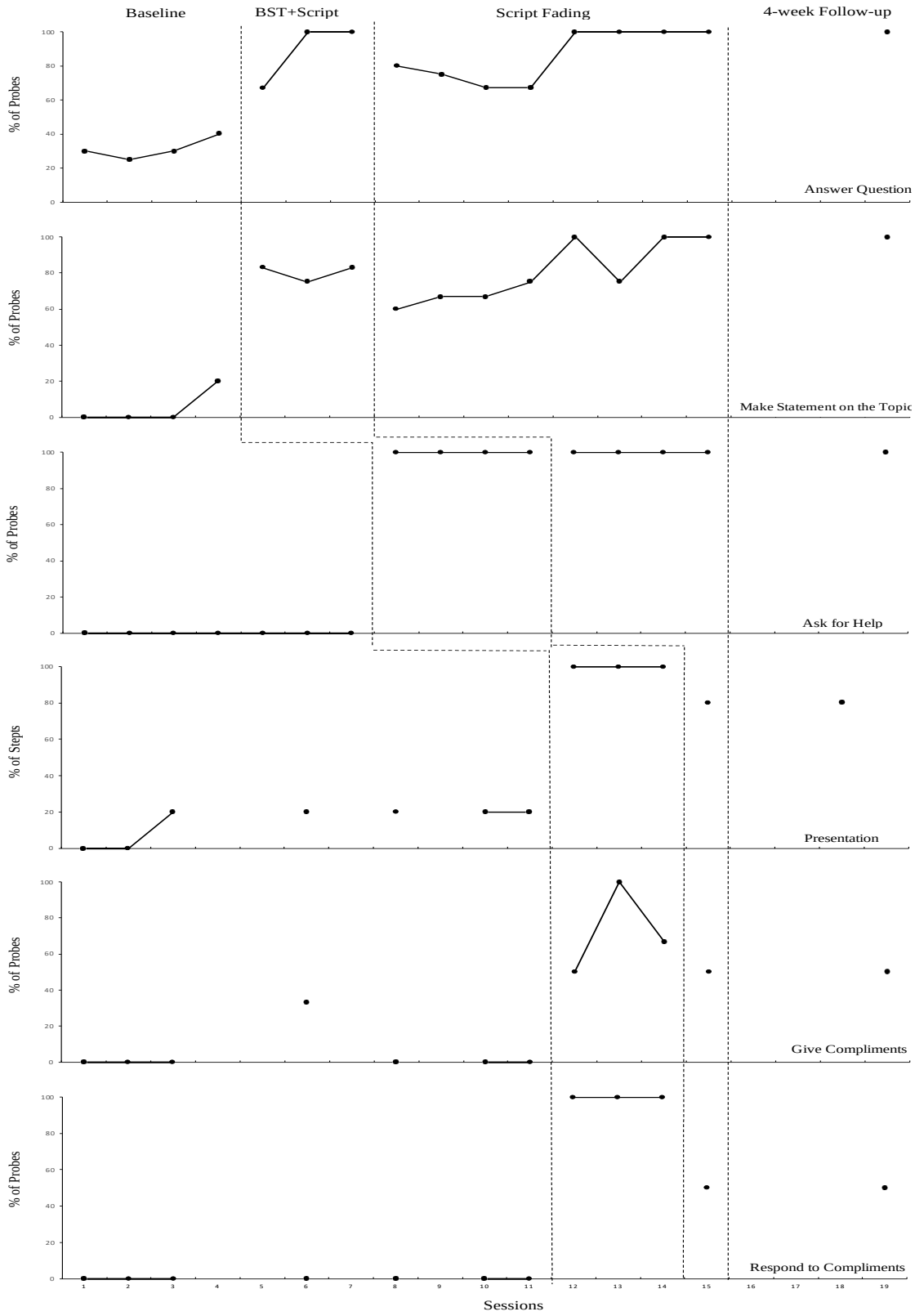
Lee was absent in two warm-up group activities during baseline. Nevertheless, there still were at least four baseline data for his targeted skills of offering help, negotiation, presentation, giving compliments and expressing thanks when responding to compliments. Lee also missed two training sessions and the follow-up measurement.

Ray

Figure 10 shows the target skills performance of Ray. Ray showed a noticeable change across four sets of target social interaction skills with mean turn-taking in conversation skills of 19.2%, 83.5%, and 100% of opportunities; mean helping skills of 0, 100% and 100% of opportunities; mean presentation of 20%, 95% and 80% of steps displayed correctly; and mean compliments of 2.8%, 78.4%, and 25% during baseline, intervention, and follow up conditions.

Ray has a low and variable level of answering questions and initiation skills during baseline. Due to his limited language proficiency, Ray could only emit one or two words when answering questions or repeating the question, and almost remain total silent during the conversation initiated by the researcher in the first two baseline activities. Maybe by observing other group members, Ray's conversation skills continued to improve prior to the intervention. Ray also exhibited a low and stable level of presentation skills with 1/5 incorrect steps during 4/5 sessions and complete absence of asking for help and responding to compliments in the baseline.

Ray's target skills remained at high levels during the teaching condition and could sustain during the script fading condition. Ray met the mastery criterion for conversation skill and give



- In-Situ training probes

Figure 10: Percentage of opportunities/steps with correct performance for target skills across sessions for *Ray*

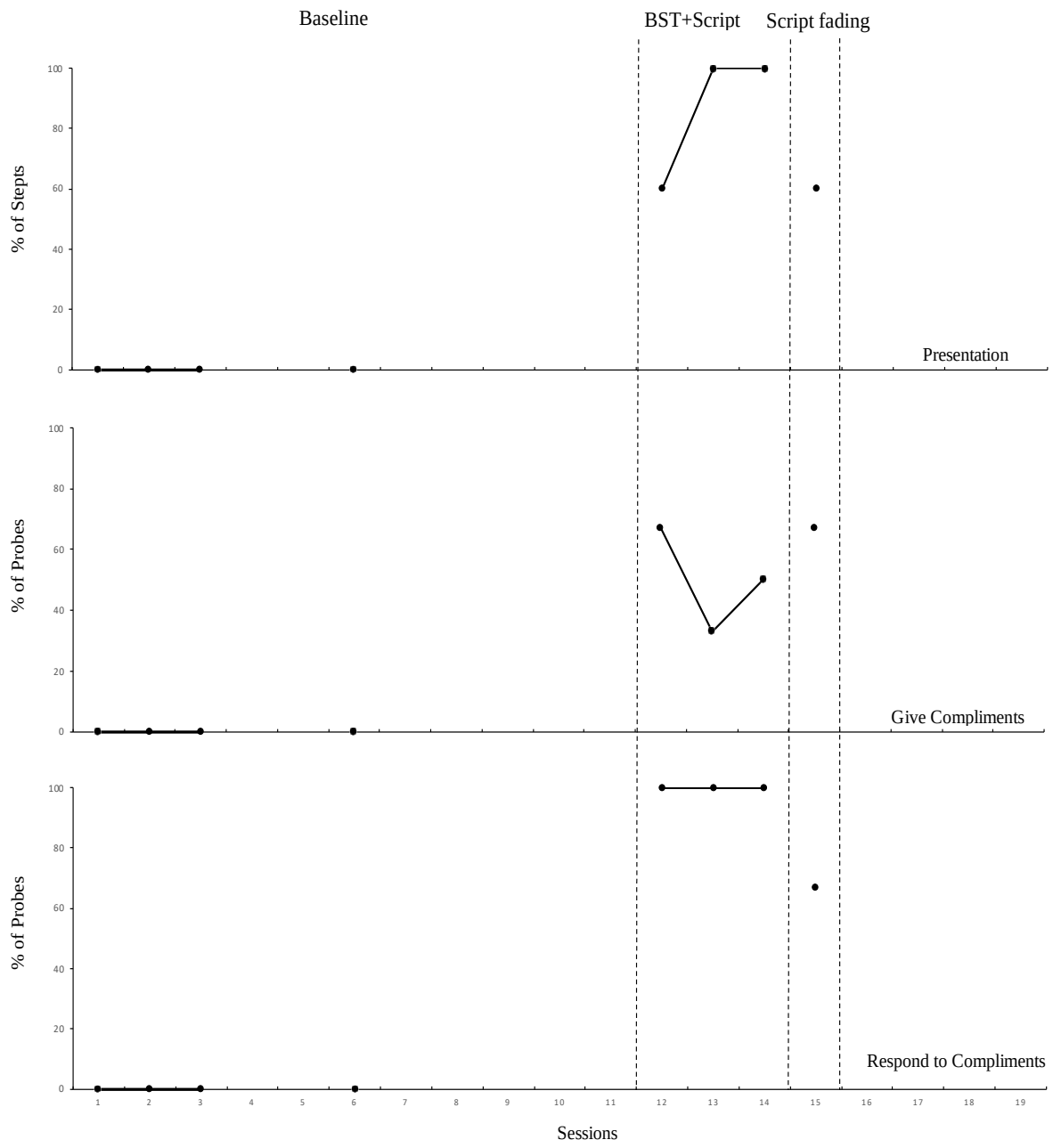
compliment skill after two sessions, and ask for help, presentation, responding to compliment skills after one session with each skill in the role-play intervention. A rapid increase across all target skills was observed in script prompt and BST procedure. Following the teaching sessions, the researcher removed the script prompts when all skills were occurring at a satisfactory level. Ray's turn-taking conversation skills of asking for help and presentation remained at a high and stable level during script fading in-suite training. However, with the increase in the number of statements made, interruptions began to reappear during the last couple of training sessions. The requirement of giving a compliment was only limited to providing general compliments.

Ray performed at a high and variable level of giving a compliment and a high and stable level of saying "thank you" when responding to compliments during the teaching of BST procedure with script prompt. He exhibited a low level in script fading and need continuous feedback for non-response than the teaching phases.

Ray did not care too much about the token. The preferred activity of Minecraft itself was enough as a reinforcer for Ray. Consequently, Ray demonstrated a high and stable level of conversation skills, ask for help, and presentation skills in the four weeks follow-up when the token was removed. However, Ray's compliment skill was not as good as the other skills during the follow-up phase. He could only give compliments in 1/2 opportunities and failed to express appreciation when receiving compliments.

Louise

Figure 11 shows the target skills performance of Louise. Louise missed the entire four sessions of "asking for help" training and missed four conversation skills in-situ training sessions. Thus, the researcher only graphed his last two sets of presentation and compliment skills.



- In-Situ training probes

Figure 11: Percentage of opportunities/steps with correct performance for target skills across sessions for *Louise*

Louise showed no presentation skills during baseline with mean levels increased to 86.6% and 60% of steps displayed correctly during teaching and script fading conditions. He actively asked for opportunities to introduce his work during baseline, but what happened was that he only

wanted to continue playing during the presentation activity. An immediate improvement in presentation skill was observed in script prompt and BST procedure. Similar to his presentation skill, Louise showed no compliment skills during baseline with mean levels increasing to 75% and 67% during teaching and script fading conditions. Louise exhibited a complete absence of compliment skills in the baseline. Given the incorrect and limited conversation skills shown in baseline, the requirement of giving compliment was only limited to providing general compliments. Even though Louise refused to participate in the role-play activity for the first session after he returned to the group, he met the mastery criterion for responding to compliments after two sessions, whereas he did not meet the mastery criterion for giving a compliment. Louise did not demonstrate a high level of giving compliment skill because he was satisfied with receiving just one token for one give compliment. There was only one session for script fading-suite training that Louise performance without script prompt could not maintain at the same level as in the previous phases. There was no follow-up data for Louise since he was not able to attend the group activity after four weeks.

Summary Measurement

Table 7 provided a summary of all participants' performance across all targeted skills. Across all the targeted skills, Bill and Lee only began demonstrating the skills correctly after the implementation of the BST procedure to teach the skill. This improvement suggested that this procedure was responsible for the improvement in performance as seen in the two participants. For Ray and Louise, besides the BST procedure, a social script was also used to prompt the correct response. They demonstrated a clear change after receiving the BST and social script training package and demonstrated all skills at a high level during the script fading conditions

Table 7: Target Skills Acquisition and Intervention Effect

	Bill			Lee			Ray				Louise			
	baseline	In-suite training	Follow-up	baseline	In-suite training	Follow-up	baseline	In-suite training		Follow-up	baseline	In-suite training		Follow-up
								BST+Script	Script fading			BST+Script	Script fading	
Answer question	-	-	-	-	-	-	M=31.7 % (25%-40%)	M= 89% (67%-100%)	M=86.1% (67%-100%)	M=100%	-	-	-	-
								1.0*	1.0*	1.00*				
On-topic statement	M= 34.5% (20%-60%)	M=72.5% (60%-80%)	M=75%	-	-	-	M= 6.7% (0-20%)	M= 78.3% (75%-80%)	M=80.5% (60%-100%)	M=100%	-	-	-	-
		0.82*	1.0*					1.0*	1.0*	1.0*				
Wait appropriately	M=35.75 % (20%-50%)	M=70.8% (50%-80%)	M=67%	-	-	-	-	-	-	-	-	-	-	-
		0.82*	1.0*											
Ask for help	-	-	-	-	-	-	M= 0	M=100%	M=100%	M=100%	-	-	-	-
								1.0*	1.0*	1.0*				
Offer help	M= 16.6% (0-50%)	M=83.5% (67%-100%)	M=67%	M= 10.0% (0-50%)	M= 91.7% (50%-100%)	-	-	-	-	-	-	-	-	-
		1.0*	1.0*		0.83*									
negotiation	M= 10% (0-40%)	M=67.5% (50%-100%)	M=100 %	M= 0	M=61.7% (20%-100%)	-	-	-	-	-	-	-	-	-
		0.86*	1.0*		1.0*									
presentation	M= 40%	M=100%	M=100 %	M= 60%	M=100%	-	M= 20%	M=100%	M=80%	M=80%	M= 0	M=87% (60%-100%)	M=60%	-
		1.0*	1.0*		1.0*			1.0*	1.0*	1.0*		1.0*	1.0*	
Give compliment	M=11.9 % (0-50%)	M=71% (50%-100%)	M=67%	M= 12.5% (0-50%)	M=89% (67%-100%)	-	M= 5.5% (0-33%)	M=72.3% (50%-100%)	M=50%	M=50%	M= 0	M=50% (33%-67%)	M=67%	-
		0.75*	1.0*		1*			1.0*	1.0*	1.0*		1.0*	1.0*	
Respond to compliment	M= 7.1% (0-50%)	M=79.3% (50%-100%)	M=100 %	M= 0	M=100% (0-100%)	-	M= 0	M=100%	M=50%	M=50%	M= 0	M=100%	M=67%	-
		0.75*	1.0*		1.0*			1.0*	1.0*	1.0*		1.0*	1.0*	

*PND, percentage of non-overlapping data between conditions, effect size scores. ≥ .90 strong effectiveness; .70 ~ .89 moderate effectiveness, .50 ~ .69 debatably effective, and ≤.50 not effective.

and with corrective feedback in-situ training. Additionally, the token economy was used to maintain the performance for all the participants during the intervention. This suggested that the combination of BST procedure with other strategies was both effective and practical.

Three of the four participants met the criteria for their target skills. The only exception is Louise, while not reaching mastery criteria during the teaching of giving compliments for not engaging in the behavior at a higher rate during teaching. Most participants performed better than baseline on their target behaviors during in-situ training. Both Lee and Louise did not have follow-up measures, but Bill and Ray could maintain and generalize the skills that they have learned with novel peers in the follow-up condition.

PND calculation for presentation and compliment revealed a substantial effect for all participants. BST is more effective on specific and structured skills (such as presentation and offering help skills) than flexible and complex skills (such as conversation and negotiation skills), and most of the participants took slightly shorter time in acquiring behaviors targeting structured skills. Taking presentation skills as an example, all the participants scrambled to present their work, but they all missed the part of interacting with the audience, such as greeting the audience and thanks them for listening at the end. And Bill, Ray and Louise could not stop playing during the presentation. After the structured skills were introduced, all the participants could learn and adjust their behavior fast. Although the magnitude of change between the baseline and intervention condition for conversation skills was not as large as those for the other skills, a noticeable improvement could still be observed.

5.3.2 Social Validity

The participant satisfaction questionnaire results indicated that all the participants enjoyed the

social interaction skills training group. The group mean satisfaction rating across all participant was 2.75 out of a maximum score of 3. (mean rating range of 2.50 to 3). The questions that yielded the highest mean score indicated that the participants thought the social interaction skills group was fun; the activities were helpful and presented the lessons in a way they like to engage. Three out of four participants commented that as a result of participating in the training, they have made new friends. When asked what they have learned from the training, they all responded with the rules set up for virtual world playing, such as "respect others' work," and the new things they have learned to build in Minecraft. No one answered with their target social interaction skills.

All parents responded with the positive ratings for the group. The group mean satisfaction rating across all parents was 4.42 out of a maximum score of 5. (mean rating range of 3.50 to 5). Parents were either very satisfied or somewhat satisfied with the procedures implemented, the target skills selected, as well as the results of the study. 75% of parents agreed that generalization of the skills taught was occurring outside the group. All the parents would like to use this teaching method at home and suggested to apply the format of this research in school. Finally, write-in parent comments indicated that they would like to continue the training and receive more suggestions on how to generalize the social interaction skills to a natural environment and day-to-day life.

5.3.3 Social Engagement in Minecraft Affinity Space

The four participants had high levels (generally higher than 0.8; see Figure 12) of engagement in both physical group activity and virtual group in-game playing for most of the structured play sessions. At the first group game playing time, both Ray and Louise showed lots of disruptive

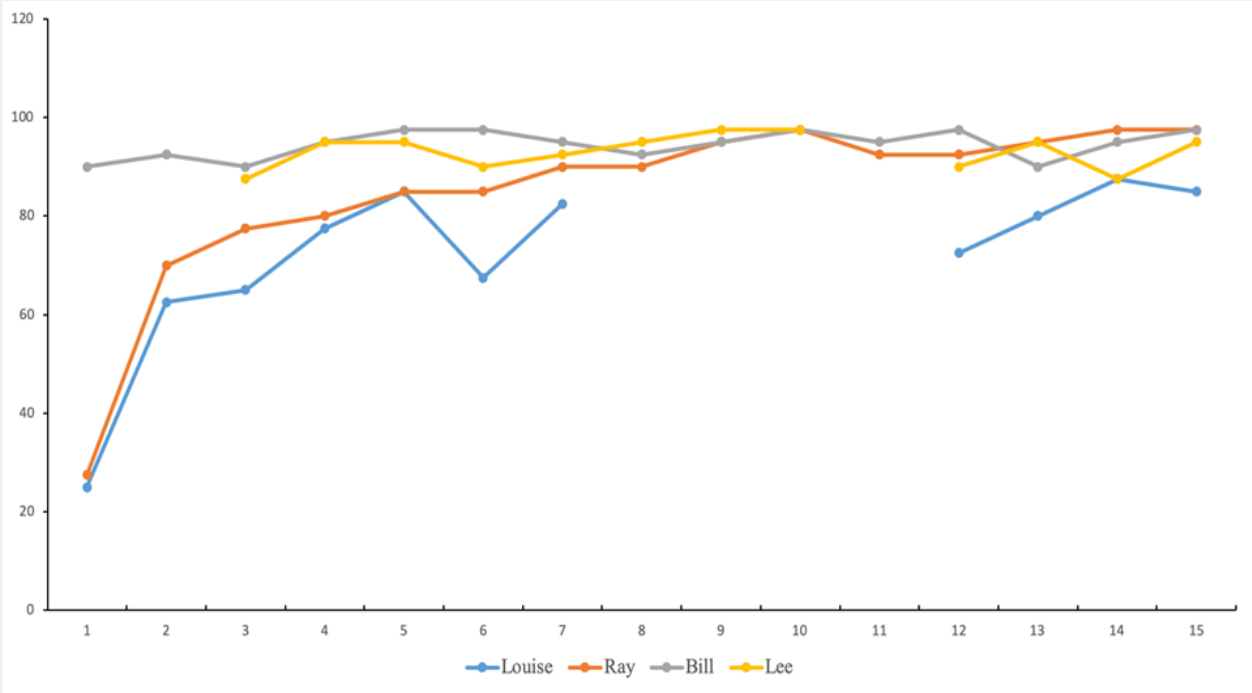


Figure 12: Social engagement in the Minecraft affinity space

behaviors in the virtual world – spawning monsters and destroying objects. They enjoyed the instant gratification just as when they were playing this game alone by themselves. However, there was a dramatic increase in engagement for Ray and Louise at the second group game playing time. During the group discussion time, it was difficult for Louise to wait and listen when other group members were speaking. His on-task behaviors gradually improved as he was familiar with the procedure of the group activity. Ray initially struggled to involve in the group discussion, but his engagement gradually increased after the intervention strategies were implemented. Participating in group play could improve social behaviors because participating in shared goals meant that the individual has to make and respond to social bids. The benefit of creating a rich social space where children can engage in shared play meant it could help children with ASD socialize.

5.3.4 Social Interaction and Relationship Development

While the target skills performance and the level of engagement provided a glimpse of the social behavior change of the participants, a close review of the participants' interactions revealed another level of social development - the richness and quality of social play throughout the group intervention sessions.

Improving Imitation and Observational Learning

The participants have shown great interest in others' avatar and work in the virtual world. They paid attention to what the other group members were doing; they visited each other and imitated each other's work. At the first group playing session, both Ray and Louise behaved badly. They spawned monsters, hit each other, and created all kinds of troubles. However, they showed a keen interest in the construction activities of other group members and tried to imitate their work. After the first group activities, they both borrowed books of Minecraft to take home to read. In the second group session, Ray and Louise began to build objects of their own. Children's exploration of the virtual game environment takes time, and we must learn to wait patiently and provide guidance. Ray is interested not only in the interaction of the avatars in the virtual world but also in the group discussion. He tried to learn what other group members were talking about. Later on, when the participants got to know about each other's preferred activities, they will try to accommodate each other and played the favorite activity of the other members instead (e.g., Figure 13 Bill reproduced Lee's airplane). This process of imitation offered rich opportunity for acquiring help skills and learning from each other.

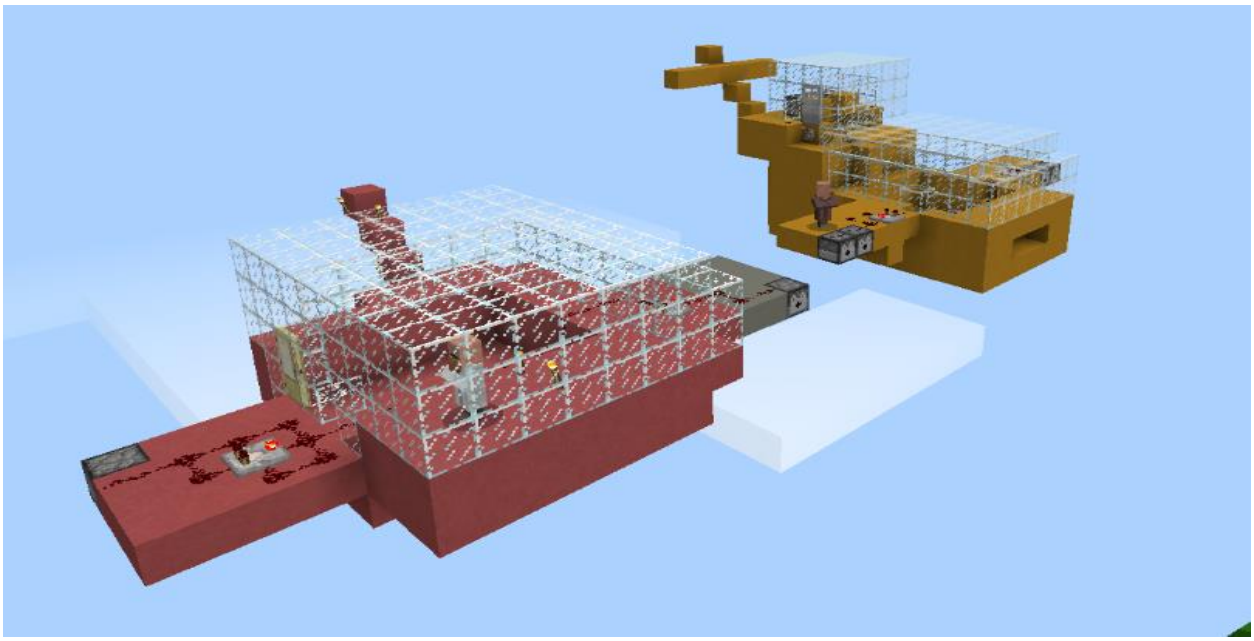


Figure 13: Bill reproduced Lee's airplane in Minecraft

Improving Collaboration, Negotiation and Compromise

Gameplay was often collaborative. Structured gameplay activities may be particularly well suited for social interaction skills interventions because the structure of the gameplay can be designed to mimic social rules (e.g., Baker et al., 1998; Wainer, Ferrari, Dautenhahn, & Robins, 2010). In the Minecraft group, the process of creating or constructing something was often used as a conduit for social play. Even the act of destruction may sound socially inappropriate, it could elicit a social response and lead to subsequent group discussion. The participants used to play alone and seldom have the opportunity to play with other people in the same virtual world. There was a magical transition from playing in single-player mode to playing in multi-player mode. All the participants preferred to play in the same server with other people. With the proper organization and guidance, collaboration would happen naturally. Cooperative play was meaningful in a variety of settings. Lee excitedly told the researcher that it was more efficient to

build with others than building alone after he has a first taste of collaborating with others in multi-player mode. Lee now seldom see others as obstacles to his individual gameplay. Lee has advanced game skills and he usually collaborated with Bill because they were at a similar skill level of Minecraft. During game playing, Lee and Bill would talk to each other about what they were doing at that moment. It was just like what typical children would do when they are playing games. When there was a conflict with Bill, Lee would initially choose to play alone or shout to others loudly. But after learning the negotiation skill, they would try to make compromises so that they can play together.

Relationship Development

The Minecraft interest group for children with ASD provides opportunities for collaborative play. It offers an environment that enables the development of positive social relationships and solving some of the more challenging social aspects of autism. It is a place where children can come together and work on social development, make connections through a shared interest, and interact with each other through structured and unstructured activities. This group is not just about in-game playing. It is a multifaceted approach that uses a Minecraft as a tool to create learning moments, instill a sense of belonging, and improve social interaction skills. A supportive atmosphere is especially important given that children with ASD often have a long experience with negative, sometimes even hostile, social interactions.

Learning appropriate social interaction skills can be an important first step in creating friendships (Burleson, 1994). The development of positive peer relationships should become an important focus of intervention. Three of four participants reported that they had made new friends in this group. This type of group gameplay could provide opportunities for new friendships to be

formed, enabling children to socialize and play with others, and thereby extending their social group. The potential for developing social ties suggested that it could be beneficial to draw in participants with the same interest who would not necessarily have already known each other. Minecraft social group is not just about playing the Minecraft game together, with Minecraft as a token concession to the children's own interests. Shared interests form the foundation of friendship and group membership. A game can facilitate interaction between two people, it can even enable communication between whole generations.

5.4 Discussion

The results of sub-study two demonstrated a clear improvement of target social interaction skills for all the participants immediately after the introduction of Minecraft interest group with the behavioral social interaction skills intervention package. All the participants have demonstrated a high level of social engagement during group activities. A functional relation between the BST package incorporated with the common interest of Minecraft and the acquisition of targeted social behaviors have been established during the single case research design. Even though more data could have helped to prove the effectiveness, the follow-up data from *Louie* and *Lee* indicated that the treatment effects had been successfully maintained. The most significant improvements in skill acquisition were noted in the more structured behaviors and smaller improvements were found in the turn-taking in conversation skills. More information is needed to understand why the intervention could produce such a rapid behavior change for *Ray*. The results of this study offered important contributions to previous researches and could lead to future investigations.

5.4.1 Implications for Research

Children with ASD require additional motivating factors to evoke the complex social behavior since the natural consequence of additional social interaction (e.g., conversation) may not be a reinforcing consequence for them (Sarakoff, Taylor, & Poulson, 2001). In this research, a common interest of all the participants – a virtual world game called Minecraft - is used to motivate and maintain the performance of skills and is much more than just a reinforcer to induce behavioral changes. All the participants in this study are more willing to engage in interventions that incorporate their interests - Minecraft. Conducting BST using a preferred virtual world game was different from previous studies where the preferred activity was only used as a generalization context or reinforcement (Kornacki et al., 2013). Most of the previous researches taught conversation skills in a fixed pattern and assessed the acquisition of the skills in an isolated situation rather than in the natural context of a conversation in which multiple skills should occur (leaf et al., 2012). Nuernberger et al. (2013) taught conversation skills in a fixed sequence that was dependent on conversation partners discussing the same topics of interest. Although Hood et al. (2017) considered that limiting to topics of interest is unlikely to result in successful participation in conversation with an unfamiliar person, they also arranged conversation patterners for participants with some common interests (e.g., video games and school activities) during the training. This study expands the skill training to a more flexible conversation setting, and interest group gameplay was a more natural environment to teach such skills. The Minecraft interest group provides enormous teaching opportunities for instructors/facilitators to set up evocative situations to motivate the participants to perform and practice their target social interaction skills. Using the game characters in the dialogue script for role play is a lot more attractive to the participants. Intervention based on interest is more

suitable for improving conversation initiation skills. Boyd et al. (2007) suggest that embedding interests in play situations with peers can be used to increase initiated social interaction for children with ASD. From this study, *Ray* has made rapid progress in making statements during the discussion regarding the game group activity. *Bill* has only made a moderate change in waiting appropriately and answering questions on the topic because all the participants were very eager to share. It is probable that incorporating restricted interests into intervention would not be very effective for behaviors that need restraining, such as interruption and perseverative speech. For those cases, a neutral objective or environment would be more suitable. In addition, sharing of information, ideas, and interests with peers through effective communication may lead to the development of friendships. Hood et al. (2017) suggested that future research should continue to evaluate procedures to teach individuals to identify shared interests and to use those topics in conversations with peers. The structure of the Minecraft group can easily incorporate the children's interests and can be designed to mimic social rules. The researcher observed that friendship development goes beyond common interests and viewed that one should go beyond the fundamental target social skill set in this research when the goal is to establish relationships. This study believed that it is possible to increase observational learning from peers in a group instructional format for this target population. Typically developing children often learn social interaction skills through casual observation, children with ASD lack the behavior repertoire necessary to engage in socialization and often require direct teaching to learn from others (Kornacki et al., 2013). However, group instruction would provide efficient, immediate and natural opportunities for participants to practice newly learned social interaction skills with peers (Barry Klinger, Lee, Palardy, Gilmore & Bodin., 2003). For example, *Lee* learned quickly to adjust his response to compliments after observing the researcher provided similar feedback to

other group members, hence supporting the benefit of group instruction. Plavnick et al. (2013) stated that it is possible for a participant to acquire target skills by observing peer models within the group. Evocative situations usually have to be set up artificially to teach conversation during one-to-one instruction. However, during group game playing, the evocative situations would just appear (White et al., 2007). In this study, during skills training and practicing in group gameplay activities on and off the screen, a high level of social engagement is measured across the intervention sessions for all participants. Although the pull-out group-based social interaction skills intervention was criticized for its poor generalization to naturalistic environments and limited effect in maintaining the learning gains over time (White et al., 2010), social interaction skills intervention group incorporated with interest was found to increase motivation and opportunities for social interaction, reduce isolation, and could continuously strengthen positive social experiences which may help transfer the social interaction skills to general conditions. This study also adopted a single-case experimental design which expands the limited and valuable exploration of the methodology and teaching practice.

Appropriately initiating and maintaining social interaction/communication requires multiple speaker and listener skills and other complex skill sets (Nuernberge et al., 2013). Besides the experimental exploration of basic social interaction skills that consisted of an isolated response to a specific stimulus, researchers have paid attention to more complex social interaction skills, a series of social interaction skills, or both (Pierce & Schreibman, 1995; Nikopoulos, Nikopoulou-Smyrni, 2008; Plavnick et al., 2013; Jung, 2015). In this study, a total of 5 sets of social interaction skills - turn-taking in conversation, helping, negotiation, presentation, compliment- were taught to four participants. These skill sets are complex social behaviors and each skill set requires aspects of initiations and responses to facilitate ongoing social interaction. Both social

initiation and response are important for addressing meaningful and maintainable complex social interactions. However, the dominating studies only target social interaction initiation. This study pairs the social interaction skills into four skill sets, which include reciprocal interactions of initiating and answering questions, asking and offering help, giving and responding to compliments. BST is effective in teaching complex social interaction skills and structured skills by using task analysis to breakdown the skills into small steps (Archer & Hughes, 2011). The researcher objectively and operationally defined each step of the target skills with vocal and non-vocal description based on the deficits of the participants and previous studies. Even though BST focuses on teaching new skills, when we look at Bill's interrupting behavior and perseverative speech, we should not only look at how we can get them to stop, we should also try to understand those behaviors and highlight the environmental variables, such as "when" to speak out.

BST has been proved to be an effective procedure to teach a new skill, and BST is usually implemented with other strategies based on the individual case in order to achieve a better outcome (Ng, Schulze, Rudrud & Leaf, 2016). Many studies evaluated BST package used in conjunction with several other strategy components. Ng et al. (2016) incorporated BST with visual representation; Hood et al. (2017) used a textual prompt; *Superhero* program incorporated BST with multiple strategies (social script, self-monitoring card) to improve achievement and generalization of social interaction skills (Radley et al., 2014). In this research, social script was used for the two participants with language developmental delay or limited conversation skills. However, scripts might not be an ideal tool for teaching flexible conversational response (Nuernberger et al., 2013). Script fading procedure was implemented after the participants have met the criterion during role play probes. The current study also used self-monitoring strategy to

help Bill generalize the skill of waiting appropriately during turn-taking conversation to a natural classroom environment in the future. During typical feedback of behavioral skills training, praise is used as positive social reinforcement for correct responses. Many studies would use additional reinforcement to acquire and maintain behavior performance. Ng et al. (2016) used a token economy as additional reinforcement when teaching conversation skills; Nuernberger et al. (2013) provided a preferred item/activity after the previous intervention session which served as an external consequence on desired target behavior. However, the researcher claimed that he did not know if the BST would have the same effect when the reinforcement component was absent (Nuernberger et al., 2013). Plavnick and Ferreri (2011) found that included preferred consequences was functionally related to the achievement of the target behavior but might not be necessary to maintain. Different from previous research, Hood et al. (2017) argued that when the reinforcement contingencies were removed, responding returned to baseline levels. In this study, a complicated effect of the token economy was observed during the training process, but not from the experimental result. Two participants adjusted their behavior in order to get more reinforcers, and it is assumed that the desired target behavior would not be maintained without the reinforcement. The other two participants had demonstrated improvements during the BST prior to token delivery, but that is probably because the game itself is already a reinforcer itself and playing with other group members functioned as a natural reinforcing consequence. It was hard to distinguish whether all or only some of the components were result in behavioral change in training and generalized setting when multiple strategies were included. Many studies have focused on confirming the effectiveness of a particular set of treatment procedures, Plavnick et al. (2013) stated that the use of combined strategies would strengthen the efficacy of specific intervention procedure, and the studies with large effect outcomes usually use a combined

treatment approach (Goldstein, Lackey & Schneider, 2014). This study combined BST procedure with social script, self-monitoring and token economy into a training package to address the needs of different individuals, and the combined behavioral components appeared to have generated positive outcomes.

5.4.2 Implications for Practice

The research participants in most studies were of comparable homogeneity which is difficult to achieve in practice. In this study, two participants with language delay and two without were grouped together by their common interest - Minecraft. The study showed how the interest group could be successfully applied to individuals who differed in social difficulties, language development and experience in Minecraft. Comprehensive measurement is necessary because social interactions are complex and built up by multiple skills that (Hood et al., 2017). This research gathered qualitative information across a range of social interaction difficulties exhibited by four children with ASD via direct and indirect assessments. The researcher incorporated parents' concerns allowing a tailored assessment and intervention for each participant. For example, Bill's parents mentioned that Bills always interrupted the teacher's talking in the classroom. Parental engagement during the assessment process is vital to identify significant social skill difficulties. Direct assessment allowed an objective measure of impairment identified before as well as undesirable behaviors that may not have been noticed or reported by the parents. As a result, the target skills for each participant were slightly different. Moreover, this study allows flexibility in modifying the BST procedure to accommodate individuals' needs and simultaneously provide a framework for addressing incorrect conversation patterns such as the use of social script for Louise and *Ray*. Practitioners should contemplate how

to match the type of social skill difficulty with the specific behavioral component in order to produce positive results.

Without any systematic instruction in place, children with ASD often do not obtain meaningful social experience and benefit from inclusion solely from exposing to typically developed children in an inclusive setting. These children attending mainstream school need social interaction skills training. There exist many intervention procedures addressing social behavior; however, school-based practitioners may not utilize evidence-based practices for social interaction skills training due to lack of knowledge, availability of required resources, time constraints, or availability of required technology (Leaf et al., 2009). Minecraft interest group with evidence-based behavior skills training procedures is well suited and relatively easy to operate by the practitioners and teachers for teaching complex social interaction skills for individuals with ASD. This study has found that children with basic conversation skills can benefit directly from this program and modifying or altering treatment packages for children with weak language skills needing social prompts may also serve to increase the effectiveness of the intervention.

The process of this study can provide a reference for other practitioners. Effective group instructional settings are especially meaningful for school-aged children with ASD because insufficient resources for this age range limits the use of one-on-one instructional methods (Plavnick et al., 2013). A group format run by an educator in school provides a social platform for naturally occurring peer interaction. The instructor to student ratio of 1:4 is manageable and the training time of 1.5-2 hour per week lasting one semester could likely be implemented within school settings. It is entirely possible to implement Minecraft social interaction skills group as an after-school activity. This could promote broad gains across multiple social behaviors. In this

study, in addition to skills and social validity measurement, parents were also invited to participate throughout the intervention sessions.

5.4.3 Limitations and Recommendations for Future Research

Although the study has practical uses for other practitioners, the result of the study must be viewed with several limitations in mind. Even though this research demonstrated the positive effect of the BST package to teach social interaction skills, it is difficult to analyze which intervention component is most effective for a specific group of children with ASD. For children with limited conversation skills, the addition of social script produced a marked improvement in social response. Token economy and social interactions in the Minecraft interest group functioned as reinforcement to motivate the participants. It is hard to conclude that children with language delay were progressing solely because of the BST procedure, or script strategy, or observing from peers, or training incorporated with his restricted interest or interaction of all the teaching components. But the behavior changes continued during the script condition. Moreover, the effect of the token economy on each participant was also different. Thus, it is unlikely that any single component alone was responsible for all the improvements. Future studies may shed light on which procedure would be most effective according to students' characteristics, intervention process, and targeted social interaction skill. More researches need to be conducted to understand which strategy works best and why.

Autism refers to a wide spectrum of individuals with varying abilities, but no participant in this study has cognitive impairment. Given the range of language and communication challenges that an individual may experience, the study needs to demonstrate effectiveness for a wide range of skills. Due to the group instruction format, the five sets of target social interaction skills were

introduced in the same order for all four participants. As such, it is not sure whether certain skills are prerequisite for the acquisition of skills that follow. The multiple baseline design is weakened by the unknown impact of delayed training of the prerequisite skills on the next skill. Future research may address this limitation through counterbalancing treatment sequence across multiple groups.

Although the participants have exhibited the use of social interaction skills with their group members and novel peers, and parents have reported that generalization was somewhat occurring, the generalization data of this study was still limited to the game setting. Direct observation of target behaviors outside of the group in other social contexts was not available, such as at the participant's school, home, or community environments. Studies that look at the generalization of intervention outcomes to a more naturalistic environment are needed. Majority of other researches only did generalization sessions in another nearby room and interacting with novel people. Future research could take a more direct assessment of generalization of response across environments lie Radley et al. (2014) who presented pullout social interaction skills training resulting in generalization to recess periods in the school setting. An extension of the current study in school and community-based settings should be considered in future studies. In addition, the follow-up data for Bill and Ray were collected four weeks later. As such, conclusions regarding the long-term maintenance of mastered social interaction skills were limited. Future research could consider collecting maintenance data over a longer period, such as after several months, or even years.

Although future studies should continue to explore the generalization effect of group-based social skill intervention, failing to generalize to non-training settings may likely due to the pull-out contexts in which the social interaction skills were often taught. There is evidence to suggest

that skills learned within contrived social interaction skills groups tend to have decreased efficacy outside the group context (Bellini, Peters, Benner & Hopf, 2007). Generalization can be problematic for individuals with ASD since the transformation of skills learned from teaching situations to non-teaching situations involve different places and people (Radley et al., 2014; Camargo et al., 2014). Social interaction skills training conducted in the environment where the student will use the skill allows higher maintenance and generalization effects (Bellini et al., 2007). Although this study has already adopted several generalization strategies including the individualized selection of skills, parent involvement, and novel peers in the group, it is still best to apply and evaluate social interaction skills interventions in the natural context outside the group. Future research should pay more attention to the implementation of playing Minecraft with their classmates or peers in the same community that may have a greater meaning to them and can help them develop a stable and long-term relationship.

This study made use of a shared interest in Minecraft, the capability of the tool to connect the virtual and physical world, best practices in behavioral intervention strategies, and a group training format to enhance the social interaction skills of four children with ASD. Future research could consider adding typically developed children to the mix to form an inclusive group. This study has only looked at Minecraft, and there are definitely other tools in the market that have the same educational value and potential.

Chapter 6 Discussion

The researcher of the current study investigated how to make use of the children's (those with ASD) interest in technology and the strengths of virtual world to educate them and how this would impact their social behavior development. Two sub-studies were conducted, one was in the school setting and the other one was in the small group setting. The findings were illustrated using the theory of affinity space and focusd on the benefits to children with ASD from a social development angle.

6.1 Main Findings for Potential Use of Virtual World for Social Interaction Skills Learning for Children on the Autism Spectrum

This study attempted to identify the potential of integrating a virtual world into the social skills learning of children on the autism spectrum. Firstly, Minecraft, as a tool, could be used in different learning contexts – classroom with different subjects, afterschool clubs, workshops of sub-study 1 and pull out small social group of sub-study 2. Secondly, students could play in the same virtual space with one another safely using a school or group based server. Thirdly, an elaborate education design is crucial in guiding the children to learn. The educators need to facilitate the collaboration process by helping the children set up goals, divide up the task, and allocate time. They need to grab the teaching opportunities when they appear and integrate with behavioral strategies wherever appropriate. The different applications in the study would hopefully inspire educators to further explore the new pedagogical approach of using the virtual world in the area of special education and to look for ways to overcome the challenges in implementation.

6.2 Key Findings for The Impacts of Using Virtual World on Social Interaction of Children on the Autism Spectrum

The impacts of using virtual world on social interaction of children on the autism spectrum were manifested in many ways, both at the individual level and at the group level. At the individual level, all the participants have mastered the social skills that were selected and taught individually during the group setting, including the basic communication skills and some advanced social skills such as negotiation or offering and accepting compliments. At the group level, a high level of social engagement in both the physical and virtual world was observed. Minecraft offered many opportunities for developing collaboration, teamwork, positive relationship, social imitation, and observational learning, simultaneously in the virtual and physical spaces for children on the autism spectrum. Both educators and parents have found the improvements in social interaction skills very satisfactory. These findings demonstrated that combining a virtual world tool like Minecraft with school instruction and group-based social skills training could significantly improve the learning outcomes.

6.3 The Implications of Bringing Together the Two Sub-studies

6.3.1 Nurturing Affinity Spaces for Children on the Autism Spectrum

The continuous interaction among the participants is motivated by their shared values and common interests (Bebbington, 2014). It is commonly known that children with ASD only focus on the things that they are interested in while ignoring opportunities to socialize with other people (Kanner, 1943). However, the intervention's negative view of repetitive behaviors and restricted interests was questioned for entirely ignoring their relationship to intelligence and motivation (Vellonen, Kärnä & Virnes, 2013). 'Social Motivation theory' (Chevallier, Kohls,

Troiani, Brodkin, & Schultz, 2012) suggested that difficulties in social interactions were caused by a reduced motivation to engage with others socially. Caldwell-Harris and Jordan (2014) proposed using a strength-based model to guide the development of educational and therapeutic programs and building on individual abilities and using special interests as a medium to learn other essential skills. The theory of affinity space advocated the searching for and processing of information that is relevant to the autistic child's interests. And their interests would provide the motivation on which the other education programs should be based. While it is essential to address the social deficits of children in the spectrum, it is equally important to identify their interests and strengths so that they can live up to their potential. This research illustrated the theory by encouraging and nurturing the autistic children's particular interest in Minecraft and helping them make the best use of their individual interests to improve their social interaction skills.

The researcher is not recommending using virtual world play to replace real-world or other models of play. Wright, Wright, Diener and Eaton (2014) reported that students with ASD might have a hard time participating in out-of-school activities and hence may find these activities less appealing. Many such activities (e.g., sports) may not be appropriate for students with ASD they are not able to understand the complex team dynamics. To help these children engage in social interaction, they must be allowed to participate in activities that they are interested in and in which they have a higher chance of getting positive feedback (Wright et al., 2014). Children on the spectrum have repeatedly shown a preference for virtual world play. This motivation naturally leads to active participation and allowing authentic learning to take place. Teaching via virtual world reduces student's inattentiveness in class (Plavnick, Sam, Hume & Odom, 2013). Social skills intervention done using Minecraft also addresses some of the shortcomings in other

social skills training programs. It is more natural and can be implemented with relatively less effort in a school setting. Of course, using virtual world to teach may not suit everyone. Like all other teaching techniques, their use must be tailored to each child's interests and needs.

The concept of affinity space would continue to evolve and shift when it was applied in new contexts (Duncan and Hayes 2012, p. 11), and current researches have not yet moved beyond descriptive studies (Lammers, 2012, p. 47). In this research, the author was interested in implementing affinity space in a traditional school setting and for the social interaction of children with ASD. Gee (2012) used the term "nurturing affinity spaces" to describe those which were inclusive and supportive. He believed that only affinity spaces that function in a nurturing way would be suitable for learning and human growth. However, the questions of how to achieve the desired results and make them last remain unresolved. MacCormack, Matheson, and Hutchinson (2015) believed that structured play and structured instruction could provide a safe and supportive environment for the development of social skills. In the two sub-studies, no matter whether Minecraft is being played in the classroom or a small group setting, the children are playing under supervision and with structured activities. Other research findings also showed that only when the instructions were structured and direct that game-based activity would be effective for social interaction skills interventions (Lindsay, Hounsell & Cassiani, 2017). In addition, both sub-studies have used a game server with restricted access and have set up rules for all the participants to follow. This is similar to the whitelisting of Autcraft. A safe and friendly environment was of paramount importance to a nurturing affinity space.

6.3.2 Combining Environment Adjustment with Skills Learning

Many social skills interventions were based on traditional biomedical models which view autism

as something that could and should be cured. Most educational programs for children with autism spectrum disorder are focusing on the social deficit of these children and make them follow the development trajectory of those who are typically developed (Mottron, 2011). Therapists and teachers, while they often acknowledge the social needs of individuals with autism, they tend to focus on a specific subset of social skills such as eye contact, facial expressions, developing relationships, etc. However, some researchers have pointed out that behavioral intervention should not be done focusing on just a discrete skillset since social interaction is a highly contextual experience (Strain & Schwartz, 2001). A structured-learning approach is widely used in these programs. During the training, social skills are taught directly and modeled by the therapist or teacher. The students can then practice the skills via role-playing and receive performance feedback (McMahon, Lerner & Britton, 2013). However, researchers have not demonstrated a consistent generalization of social skills learned under structured settings into varied contexts of life or self-reported social behavior (Gates, Kang & Lerner, 2017). Bellini and Peters (2008) suggested that social skills training programs that were best suited to meet the needs of children with ASD should be implemented in their natural environment (Bellini & Peters, 2008).

From a sociology angle, autism is a culture and is the result of one's interaction with the environment. We should be aware that linking the world of autistic people with the world of non-autistic people can pose many challenges. We can, on the one hand, choose to teach individuals with autism the necessary skills so that they can survive in this world of 'normal' people. On the other hand, we can also choose to embrace the culture of ASD, accept the differences, and adjust the environment to support these people's needs. More research is needed to uncover how self-motivation and environmental settings can be used to make social intervention more efficient (Ke

& Moon, 2018). While it is commonly accepted that learning is more efficient in a meaningful context, but precisely what types of contexts and what types of interactions within those contexts are best for teaching social skills to children with ASD is much less clear. Promoting social interaction through a virtual world environment may help fill the missing gap. The findings of this research demonstrate that Minecraft and the associated activities provide a motivating environment that triggers social interactions and teaches specific social skills effectively and naturally.

Students with ASD are facing a variety of academic and social challenges. We need to develop intervention strategies that are research-supported and focus on the individual needs while at the same time, provide a motivating environment that can effectively induce learning. If they are not motivated enough to socialize, they will not perform the skills even if they do possess them (Barakova, Bairacharya, Willemsen, Lourens, & Huskens, 2014). The researcher acknowledged the importance of environmental setting in social interaction but also believed that learning social skills through practice was necessary. The best outcome can be achieved if the learning was accompanied by environmental adjustment and with a meaningful context.

6.3.3 The Positive Impact on Complex/Advanced Social Interaction Skills Learning

There is an increasing amount of literature on the intervention of social difficulties experienced by children with ASD. However, few have addressed the issue of more complex social skills (Nikopoulos, & Nikopoulou-Smyrni, 2008). These children need to build the necessary foundations of social communication first before moving on to more complex skills, such as friendship. Further studies are needed to focus on building genuine, meaningful, and life-enriching relationships for children on the autism spectrum. It is not easy to measure or evaluate

social behavior changes. A high-quality and more comprehensive measurement of social skills is a crucial first step for the success of social skills training programs (McMahon, Lerner & Britton, 2013). Social skills are a set of complicated constructs, and it can be difficult to assess their progress accurately. So, we may want to consider social knowledge and social performance when evaluating the effectiveness of social interaction intervention (McMahon, Vismara & Solomon, 2013). This study focused on the evaluation and intervention of social performance. Various types of assessments, such as direct observations, rating scales provided by teachers and parents, and self-reporting tools, have all been used to gather the necessary data. A defined set of social behaviors and advanced social interaction skills such as negotiation, complimenting, and collaboration was evaluated in the study.

Virtual world is a promising tool for social training, especially for children with ASD (Nikopoulos, & Nikopoulou-Smyrni, 2008). People have made many assumptions when applying virtual environments to social interaction skills training, some of them have been experimentally validated, and some have not. Seely Brown (2008) suggested that immersion could transform the learning landscape. Virtual worlds could offer that level of immersion that enable people to learn, alongside with other learners, in the virtual space. These virtual worlds enable a high level of anonymous social interaction without the burden of complex linguistic and social-behavioral processing. Minecraft-based learning activities trigger a high level of positive social engagement both in the classroom or in the after-school group setting. The game offers children with ASD a safe and natural environment in which to learn, practice and make a social connection with their peers.

Evidence-based strategies and multiplayer group format also contribute to the positive outcomes in this research. Minecraft-based learning affinity space provides enormous opportunities for

teachers to set up evocative situations that can motivate the participants to perform and practice their social interaction skills, while at the same time receiving timely feedback and support from their teachers or tutors.

6.3.4 Going Beyond the Virtual World

Liliana and Lucila (2007) pointed out "*digital learning environments consist of technological, human and methodological elements, including the entire socio-historical context making up a systemic whole, and not only an aggregation of elements that can be individually isolated*".

Choosing Well-designed Tools That are Ready to Use

Gee (2012) argued that educators and scholars must think beyond the features of the software to the actual social practices. Not all virtual worlds can facilitate social interactions, and there is room for discussing specific ones. People always criticize how technologies - from TV to the internet, social media, video games, and smartphone - have made us less social. On the other hand, more and more researchers have started to focus on the positive impact of these technologies. The argument will continue, and we should appreciate the views from both sides. At the meantime, we should analyze the existing technologies so that they could be used appropriately, matching the child circumstances and needs. The findings of this research showed that Minecraft has many built-in features that make it an excellent learning tool.

Most virtual environments used for research are not available for clinical/educational use. The most economical and practical way of using virtual world for training purposes is to look at what is available in the market. The main focus of academic study, up to this point, has been on games that have an ostensibly educational focus. Non-educational games are perceived to have limited

value and receive little attention or serious analysis from an educational stance (Smeaton, 2017). Minecraft is a game that transcends commercial and educational boundaries (Gershenfeld, 2014). While Minecraft is being played in a virtual digital world, many game-related activities are also happening in the physical world. This hybrid nature characterizes most Minecraft interest groups as children interact with each other both online and offline. We do not see virtual interactions as something can replace their physical counterparts but as a way of making them richer. We advocate a moderate, balanced, and supervised approach to the use of technology. As Edirisingha, Nie, Pluciennik and Young (2009) suggested that group learning activities using virtual environment technology must be balanced with experience in the real world for them to be effective. During the research, we observed that even though often it was the specific features of Minecraft that trigger the interactions, the group activity was not limited to on-screen play, there is abundant interaction both on and offline.

Teacher's Role as a Facilitator

Damiano, Mazefsky, White, and Dichter (2014) discussed that the involvement of key people would have positive effects on the child's social development. Educators working with children on the spectrum should understand that the children's interests and strengths are crucial and should consider how to incorporate them into any intervention strategies that address their social and communication deficits. Technology solutions that are based on these children's strengths and can actively engage them should be employed (Vellonen, Kärnä &Virnes, 2013). During the two sub-studies, the participants have a chance to play the role of teachers because they all possessed different skills. They could learn from each other to further develop their design which then led to even more opportunities for cooperation.

Nevertheless, Coleman-Martin, Heller, Cihak, and Irvine (2005) claimed that it was too early to rely entirely on technology alone and concluded that teacher, when added to technology training, was slightly superior to technology alone (Coleman-Martin et al. 2005). This research concluded that structured play under guidance was essential for students with ASD. Teachers or tutors need to pay attention to instruction design, set up the appropriate tasks and themes beforehand, and also rules of play that every participant has to follow both in the virtual and physical environments. This strategy encourages the participants to engage in an environment that promotes positive social interaction actively. In this scenario, the instructor acts as a facilitator rather than an authoritative figure (Kovalchick & Dawson, 2004). If the teacher wants to get involved in the virtual world activities, then they would need to participate but as a knowledgeable player and not someone who is there to give orders. Some researchers claimed that teachers need to be familiar with the video games in order to use them to enhance their teaching (Hsu & Chiou, 2011). However, according to the research findings, educators who do not possess advanced knowledge of Minecraft can also guide the students to learn. The teachers ' teaching experience, their care of the students, and the learning activities design are more important than their interest and skills in video game playing. Students with ASD are greatly motivated by virtual word game like Minecraft, but they also need strict behavior management from the teacher. When computer games such as Minecraft or others fail as a teaching tool, it could be due to the lack of preparation and activity scaffolding by the teacher, and not a failure of the game itself.

6.4 Limitations

The participants in this research are all male, some of them have normal intelligence, and some

have mild intellectual disability. Variability is a key feature of children with ASD. The social deficits and strengths of these children can vary depending on their age, their severity of ASD, their overall intellectual and linguistic abilities, other disorders and difficulties that they may have, as well as with their personality and social and non-social upbringing. One area that is worth further exploring is whether virtual world is also suitable for children with ASD that have severe intellectual disability, and if so, how the game can be adapted to facilitate their learning.

A strict procedure of sample-to-population generalization based on only a handful of cases is not realistic. However, in the early 1900s, the American education scientist Firestone proposed "case-to-case transfer" as a kind of generalization. It was defined as whenever a person in one setting considers adopting an idea that he or she has learned from another setting (Firestone, 1993). This type of generalization is related to one of the quality criteria as proposed by Lincoln and Guba (1985) – transferability (Steenhuis & de Bruijn, 2006) or usability (Swanborn, 1996; Poortman & Schildkamp, 2012). They emphasize the essential quality of applied research - that the results should be usable to the client.

The generalization of social skills learning is always challenging. There are two aspects that we need to consider, generalizing the skills learned from the virtual world to real life and generalizing the skills acquired from group-based gameplay activities to other life situations, such as school, home and community. The researcher has tried to prove that the meaningful social connection experienced, and the social interaction skills gained in the virtual world could translate into real-life benefits for the participants. For instance, the teachers in sub-study 1 and 75% of the parents in sub-study 2 reported that the students have generalized the social skills into real-life situations. However, since this study has not performed any direct assessment in other situations, the claims could not be validated.

In a multi-tiered system of supporting children with difficulties in school, a small group setting is used in the secondary or tier-two level. A small group arrangement is more suitable for children who are attending school, especially when the school has limited resources, and one-on-one service is almost out of the question. Non-inclusive school and group settings are used in this study since an individual with ASD is not molded by socialization to the same degree as people without ASD, and many of them are searching for an identity. Future research should explore how virtual world could help students with ASD in a more inclusive environment.

Researchers have shown that parents behaved positively towards the use of new technologies in improving the lives of their children (Marsh et al., 2005). The importance of parental engagement was also highlighted in this study. As noted by other researchers, appropriately involving and training the parents can help improve skill generalization and maintenance of their children (Mitchell, Regehr, Reaume & Feldman, 2010). However, this research has not examined the parents' attitude and knowledge of the virtual world and has not provided any formal training on the tool to the parents for potential school/home collaboration.

6.5 Conclusions and Moving Forward

Conclusions

This research illustrates the potential of using the shared interest in a virtual world game - Minecraft - to facilitate social interaction in children with ASD. The findings in this study have demonstrated that virtual world could be integrated into different learning contexts. When playing the Minecraft game, the children are motivated to learn and interact within both the virtual and physical affinity spaces, making their online and offline experiences an integrated whole.

The results of this research have confirmed the potential of using a virtual world game such as Minecraft to intervene, support and facilitate the social development of children with ASD, which can result in a high rate of social engagement and positive effects on basic and advanced social interaction skills.

This research has also shown that guidance and support from educators are crucial. The experience of the teachers and their careful planning of the learning activities are critical to the success of such an intervention program. Using an evidence-based approach and a group training format can also lead to promising results.

Researchers and educators should embrace the interests of the students to motivate them to learn; they should be aware of the potential benefits of integrating a well-designed virtual world into their education program, and they should explore the many different ways these tools can be applied to facilitate the social development of children with ASD.

Future Avenues of the Research

Social training outside the subject's natural settings should be cautioned against because of the difficulties in generalization. In order to obtain the best results, educators should plan to implement the intervention procedures across a variety of settings and subjects. We should continue to examine the application of virtual world in an inclusive education setting to promote the social interactions between children with special education needs and their typically developed peers. Follow-up studies can also explore the effect of social interventions when they are combined with formal and systematic parental training. More researches can be done on other population who may also find normal social interaction demanding (e.g. children with ADHD). To understand how we can make the best use of their interests in virtual world to

improve their social interaction skills. Other than Minecraft, virtual world tools such as Roblox and Second Life could also be explored as different tools may suit users with different behavioral characteristics and age groups.

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Appendix A: Interview Guideline (English)

1. What is your professional background?
2. How long is your teaching experience?
3. Are you personally interested in technology and virtual games?
4. How do you know Minecraft and start to use it in your class or school?
5. How do you use Minecraft inside the classroom?

   (For what subjects? Which specific part of the class?)
6. How do you use Minecraft outside of classroom?
7. How do you evaluate the learning outcome of using Minecraft in your class or school?
8. What are the benefits of using Minecraft for your students with autism spectrum disorder?
9. What are the challenges and limits you faced?
10. What supports you think are critical of applying Minecraft into school?

訪談大綱 （中文）

一、您的專業背景？

二、您從事教學工作的時間？

三、您個人對科技和虛擬世界遊戲感趣嗎？

四、您如如何了解到 Minecraft 並開始應用在您的學校或班級裏的？

五、您是如何在課堂教學中使用它的？（科目，主題）

六、在課堂教學以外的活動中您又是如何使用它？

七、您如何評價在學校中應用 Minecraft 帶來的學習成果？

八、對您班上的自閉譜系障礙學生有什麼益處？

九、您在學校中的應用遇到哪些挑戰與限制？

十、您認為什麼樣的支持對學校中應用 Minecraft 很關鍵？

Appendix B: Social Validity Questionnaire (Parents)

Please fill in the following questions based on your observations and understanding of the Minecraft social group". Please try to avoid neutral options.

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Overall you are satisfied with the skills taught	5	4	3	2	1
Overall you are satisfied with the teaching procedure	5	4	3	2	1
Overall you are satisfied with the result	5	4	3	2	1
You think it's important to teach your child to speak in turn in group discussion	5	4	3	2	1
You think it's important to teach your child to ask for help	5	4	3	2	1
You think it's important to teach your child to offer help	5	4	3	2	1
You think it's important to teach your child to present his work to the audience	5	4	3	2	1
You think it's important to teach your child to give compliment	5	4	3	2	1
You think it's important to teach your child to respond to compliment	5	4	3	2	1
You think it's important to teach your child to negotiate with others	5	4	3	2	1
You are satisfied with the results of teaching turn-taking in conversation.	5	4	3	2	1
You are satisfied with the results of teaching how to ask for help	5	4	3	2	1
You are satisfied with the results of teaching how to offer help	5	4	3	2	1
You are satisfied with the results of teaching how to present his work to the audience	5	4	3	2	1
You are satisfied with the results of teaching how to give compliment	5	4	3	2	1
You are satisfied with the results of teaching how to respond to compliment	5	4	3	2	1
You are satisfied with the results of teaching how to negotiate	5	4	3	2	1

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Your child has demonstrated target behaviors outside of the group since the group has begun	5	4	3	2	1
You think your child will maintain the target behaviors after the ending of teaching	5	4	3	2	1
You would like to try the teaching procedure at home	5	4	3	2	1
you will propose to use the teaching procedure in community and school activities	5	4	3	2	1

Please write down your specific comments and suggestions:

社会效度问卷

（家长）

请您根据对本次“我的世界社交小组”的观察与了解填写以下题项。请尽量避免中立选项。

	非常同意	**同意**	**一般**	**不同意**	**非常不同意**
总体来说，您对所教授的技能感到满意	5	4	3	2	1
总体来说，您对教学流程感到满意	5	4	3	2	1
总体来说，您认为这种教学对孩子有帮助	5	4	3	2	1
您认为教授您的孩子“聆听他人“很重要	5	4	3	2	1
您认为教授您的孩子“轮流讲话“很重要（发起，回应，等待对话）	5	4	3	2	1
您认为教授您的孩子“寻求帮助”很重要	5	4	3	2	1
您认为教授您的孩子“提供帮助”很重要	5	4	3	2	1
您认为教授您的孩子“给予他人正面评价”很重要	5	4	3	2	1
您认为教授您的孩子“表达感谢”很重要	5	4	3	2	1
您认为教授您的孩子“协商解决问题”很重要	5	4	3	2	1
您对“聆听他人”技巧的教学效果满意	5	4	3	2	1
您对“轮流讲话”技巧的教学效果满意	5	4	3	2	1
您对“寻求帮助”技巧的教学效果满意	5	4	3	2	1
您对“提供帮助”技巧的教学效果满意	5	4	3	2	1
您对“给与他人正面评价”技巧的教学效果满意	5	4	3	2	1
您对“表达感谢”技巧的教学效果满意	5	4	3	2	1
您对“协商解决问题”技巧的教学效果满意	5	4	3	2	1
孩子在小组之外的其它环境也表现出目标社交技巧	5	4	3	2	1
活动结束后，您认为孩子会维持目标社交技巧	5	4	3	2	1
您愿意在家里尝试使用该社交技巧教学策略	5	4	3	2	1
您建议在社区或学校使用该项目的干预形式	5	4	3	2	1

请您写下具体评论与建议：

Appendix C: Social validity Questionnaire (participants)

Minecraft Interest Group Activity Survey:

			
1. I like to take part in this event.	Agree	Neutral	Disagree
2. I think this activity is helpful to me.	Agree	Neutral	Disagree
3. I think this is an interesting event.	Agree	Neutral	Disagree
4. I made new friends in this event.	Agree	Neutral	Disagree
5. I'm looking forward to joining the event again.	Agree	Neutral	Disagree

6. In the event, my favorite part is:

Because:

7. In the event, the part I do not like is:

Because:

8. In the event, I learned:

社会效度问卷

（学生）

《我的世界》兴趣小组活动调查：

			
1. 我很喜欢参加这个活动	非常同意	一般	不同意
2. 我觉得这个活动对我有帮助	非常同意	一般	不同意
3. 我觉得这个活动很有趣	非常同意	一般	不同意
4. 我在这个活动中交到了新朋友	非常同意	一般	不同意
5. 我期待可以再次参加这个活动	非常同意	一般	不同意

6. 在活动中，我最喜欢的部分是：

因为：

7. 在活动中，我不喜欢的部分是：

因为：

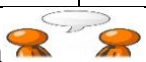
8. 在活动中，我学到了：

Appendix D: Token Economy

Name： _____

I can：

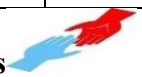
1. Active listening 

2. Turn taking during conversation 

3. Appreciate other's work and give positive compliments

4. Appropriately Respond to compliments

5. Ask for help or suggestion 

6. Offer help to others 

小组代币系统（中文）

姓名：_____

我可以做到：

1. 聆听他人 

2. 轮流发言 

3. 欣赏他人的作品/行为，并给予正面评价

4. 接受他人的欣赏

5. 向他人寻求帮助或征求意见 

6. 向他人提供帮助 

Appendix E: Observation Form for Social Engagement in the Minecraft Interest Group

Date: _____ Observer：_____

Target behavior: Positive Social Engagement (+):

Discussion time: active listening; following instructions; responding to questions; asking questions; taking turns to speak; sharing of activities or materials with peers; making positive comments on other people's works or behaviors.

Structured play time: creating theme-related items with other team members in the same world; or discuss with other team members during the construction process; asking questions or answer questions; initiating invitations or accepting other people's invitations; asking for help or providing help. Negative Play was excluded: breaking other people's buildings; blocking others from building things; frequently placing creatures (animals or villagers) in other group members' buildings or public areas; killing creatures other than monsters; building objects that are unrelated to the theme; and leaving the same sever.

Target behavior	Activities	Group members	Discussion										Play time										Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Positive social interaction	Discussion phase 1 and phase2	Bill																					
		Lee																					
		Louis																					
		Ray																					
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	Structured play	Bill																					
		Lee																					
		Louis																					
		Ray																					
Total		Bill																					
		Lee																					
		Louis																					
		Ray																					

1-minute interval