Exploring Intrinsic Learning in an Augmented Reality App for Adults with Autism Spectrum Disorder

by

Jessica Clarkson

A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Arts

in

Education and Digital Technology

The Faculty of Education

University of Ontario Institute of Technology

December 2015

Abstract

Adults with autism spectrum disorder (ASD) display varying levels of social impairment that can manifest as difficulty with communicating, stereotyped behaviour, difficulty starting and maintaining relationships, and inflexible thinking (APA, 2013). The purpose of this study was to explore the relationship between learning and technology for adults with autism spectrum disorder. Specifically, to answer the research question: What are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? The transportation app was developed by the researcher and was grounded in theories of situated learning, communities, augmented reality, and authentic learning. In order to measure intrinsic learning, an ethnographic case-study was conducted to look at three participant's experiences with this app when asked to navigate TTC without the app and with the app. Participants completed three questionnaires to assess intrinsic learning as well as participated in a semi-structured interview. Both quantitative and qualitative data were analyzed for instances of intrinsic learning. The participants had different experiences from one another in regards to intrinsic learning, findings suggesting that participants displayed intrinsic learning when using the app. All participants viewed the app with some positivity and, when asked, stated that they would share it with a friend. Future research can improve on the functionality of the app as well as explore its use with other populations.

Acknowledgments

This thesis was a tremendous learning experience, for which I am eternally grateful. I owe tremendous thanks to the community at the University of Ontario Institute of Technology and the friends and colleagues that have helped me reach this milestone.

I would also like to thank my supervisory committee, most notably my supervisor Dr. Roland van Oostveen. I came to UOIT with a very narrow scope of what learning was and was not. This immediately changed as I worked with Dr. van Oostveen. I have had countless opportunities to grow as a facilitator, learner, researcher, and mentor; I can honestly say that I would not have had these opportunities if it were not for his incredible mentorship and inspirational view on learning. I would also like to thank Dr. Maurice DiGiuseppe and Dr. Meghann Lloyd for their invaluable advice, support, and feedback throughout my research project. Additionally, I would like to thank my external reviewer, Bill Kapralos for his willingness to lend his expertise and provide insight on this thesis. I owe another big thank you to François Desjardins for his advice and guidance as well as the Professors in the Faculty of Education. I am so grateful for the learning opportunities that you have provided me with.

This thesis could not have been completed without the partnership of the Game Development Lab at UOIT, including Dr. Andrew Hogue, Tassos Stamadianos, Rohit Moni, and Sedona Parnham. Additionally, thank you to my friends and colleagues in the EI Lab.

Lastly, I would like to thank my family for their unwavering love and support throughout my degree. Thank you to Andrew, for being the most patient, supportive, encouraging, and loving husband. Thank you to my parents, Jennifer and Paul, for being my biggest cheerleaders. Thank you to my sister and brother-in-law, Alyson and Andrew, for always being there for me and patiently listening to me vent. Finally, thank you to the Bains, Greenies, and Clarksons for their encouragement.

Table of Contents

Abstract ____ II

Acknowledgments ____ III

Table of Contents ____ IV

List of Figures ____ VII

List of Tables ____ VIII

Chapter 1 – Introduction ____ 1
- **Context** ____ 1
  - Autism spectrum disorder. ____ 2
  - Learning Environment. ____ 4
  - Digital Technology. ____ 6
- **Purpose of the Study** ____ 7
- **Methodology** ____ 8
- **Limitations** ____ 9
- **Ethical Considerations** ____ 10
- **Significance to the Field** ____ 10
- **Summary** ____ 11

Chapter 2 – Literature Review ____ 12
- **Autism** ____ 12
- **Autism and Digital Technology** ____ 15
  - Augmented reality. ____ 16
- **Learning Theories** ____ 19
  - Situated Learning. ____ 19
  - Authentic Learning. ____ 21
  - Communities. ____ 22
- **Theoretical Framework** ____ 24
  - Self-Determinism Theory. ____ 25
- **Summary** ____ 26

Chapter 3 – Methodology ____ 28
- **Setting** ____ 28
- **Participants** ____ 30
- **Transportation App** ____ 31
- **Procedure** ____ 34
- **Data Analysis** ____ 37

Error! Cannot open file referenced on page 39
- **Summary** ____ 42

Chapter 4 – Findings ____ 44
- **Quantitative Data** ____ 44
- **Qualitative Data** ____ 48
  - Aiden. ____ 48
    - App benefits and limitations. ____ 50
    - Autonomy. ____ 50
    - Competence. ____ 51

Relatedness. 52
Erik. 52
App benefits and limitations. 54
Autonomy. 55
Competence. 56
Relatedness. 56
Albert. 57
App benefits and limitations. 59
Autonomy. 60
Competence. 60
Relatedness. 61
Summary 62

Chapter 5 – Discussion and Implications 63
Aiden 63
Autonomy 63
Competence. 65
Relatedness. 66
Autonomy. 67
Competence. 68
Relatedness. 69
Albert 70
Autonomy. 70
Competence. 72
Relatedness. 73
App Benefits and Limitations 74
Conclusions 75

Chapter 6 –Future Research 78
Study Limitations 78
Recommendations for Future Research 81
Conclusions 83
Reflection 85

References 87

Appendix A 96
Participant Documents 96
Bus routes. 96
TTC map. 100
Participant instructions. 101
Briefing/Debriefing script. 103

Appendix B 104
Recruitment Documents 104
Recruitment poster. 104
Recruitment posting. 105
Communication script. 106
Letter of invitation. 108
Consent letter. 109

Appendix C 112
Data Collection Materials 112

Questionnaires. 112
Interview questions. 115
Observation list. 116

Appendix D 117

Data Analysis 117

Quantitative questionnaire responses. 117
Qualitative questionnaire responses. 119
Researcher observations. 122
Interview transcripts 125
Aiden. 125
Eric. 128
Albert. 130

List of Figures

Figure 1: Theoretical framework. 26
Figure 2: Transportation App. 32
Figure 3: Theoretical Framework. 33
Figure 4: Inclusive Design Development. 33
Figure 5: Research Methodology. 36
Figure 6: Autonomy Scores. 45
Figure 7: Competence Scores. 46
Figure 8: Relatedness Score. 47

List of Tables

Table 1: Quantitative Questionnaire Coding 39
Table 2: Qualitative Questionnaire - Questionnaire 40
Table 3: Qualitative data - Interview 41
Table 4: Autonomy Scores 45
Table 5: Competence Scores 46
Table 6. Relatedness Scores 47

Chapter 1 – Introduction

"Children with autism grow up to be adults with autism" – Roberts (2012)

Context

This thesis stemmed from my desire to help people and create change. My undergraduate degree is in psychology; this is where I started examining research on individuals with exceptionalities. I was very interested in learning about disabilities and education, as well as how students with disabilities are treated. Around this time, I read "The Curious Incident of the Dog in the Night-Time" (Haddon, 2004). This book provided insight into the world of someone with autism—the main character being a savant with Asperger's Syndrome who tries to solve the mystery surrounding his neighbour's dead poodle. This really sparked my interest in autism and how autism affects individuals.

However, I would soon learn that the book was full of stereotypes about autism and that the author did not do much research on the topic before writing the book (Haddon, 2009). I then started working as a community support worker for a company that provided housing for individuals with various disabilities. There, I was placed in a home with individuals who were fully dependent on the support workers in all aspects of their life. These individuals were nonverbal, and required aid for eating, drinking, hygiene, and mobility, and were unable to care for themselves in any way. However, these individuals still retained rights and freedoms, which staff members were expected to promote and defend. A list of rights posted in the house as a reminder included the right: "to be safe, to have relationships, to privacy, to say no, to make decisions, to respectful support, to grow,

to self-advocacy, to risk, to access, to be proud of who I am, to dream" (Community Living, 2003). This allowed individuals to have autonomy in their decisions and actions as much as possible, where autonomy occurs when individuals take control of their behaviours (Deci & Ryan, 1990).

Autonomy, however, may not be easy to achieve, as some individuals may depend on others for aid and support in their daily lives. That lack of autonomy, essentially, is what drove this research project, the development of a learning environment where individuals can gain some autonomy. More specifically, I wanted to examine a population of individuals with autism spectrum disorder (ASD) and how their autonomy could be increased. Often individuals needing support rely on caregivers or support workers for transportation, limiting their ability to obtain a job, attend school, or other activities independently. The transportation app was selected as it can act as a first step in achieving autonomy. This led to the development of a digital/mobile transportation application (app), which is hypothesized to increase autonomy in individuals with ASD. This research project will explore the potential outcomes of using the transportation app by individuals with ASD.

Autism spectrum disorder.

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that typically manifests in children and is sustained over an individual's lifetime (American Psychological Association [APA], 2013). Individuals with ASD often display varying levels of social impairment, including difficulties in reciprocal social interaction, difficulty communicating in verbal and non-verbal ways; restrictive,

repetitive, and stereotyped patterns of behaviour; difficulties developing and maintaining relationships; and inflexible patterns of thinking and understanding. Additionally, individuals with ASD may display resistance to change and the desire to strictly follow routines (APA, 2013). Recent changes in the American Psychiatric Association's principal manual for classifying and diagnosing psychiatric conditions, the "Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition" (APA, 2013), have included a reorganization of the criteria for Autism Spectrum Disorder, eliminating the previous diagnoses of Asperger's Disorder, Pervasive Developmental Disorder - Not Otherwise Specified, Rett's Disorder, and Childhood Disintegrative Disorder. This change has increased the range of symptoms found on what is known as the "autism spectrum", as well as the degree in which individuals are affected (APA, 2013). As ASD is a "spectrum disorder", individuals can have varying symptoms and severity of those symptoms (APA, 2013). Individuals who are higher-functioning may need minimal to no supports in their life, while individuals who are lower-functioning may need increased supports (APA, 2013). Unfortunately, most adults with ASD are dependent on their families for support (Howlin, Goode, Hutton, & Rutter, 2004). It is important that these supports are available to individuals in order for them to be able to fully participate within society while maintaining their rights and autonomy (Community Living, 2003). Likewise, for adults with ASD, it is important for them to have these supports in place in order to fully participate in higher education as well as within the workforce. Unfortunately, adults with ASD do not have access to as many programs and opportunities as their younger counterparts, making supports and tools limited

to them (Gerhardt, n.d.). On top of that, each case of ASD is very unique, making "one-size-fits-all" supports nearly impossible.

This research project focuses on the adult population for these reasons, and aims to create a transportation app that will increase intrinsic learning in this population, where intrinsic learning is learning that is self-motivated, and measured by assessing an individual's autonomy, ability to interact within the community, and ability to demonstrate learning (Deci & Ryan, 1990). It is hypothesized that when using the transportation app, the individual's level of intrinsic learning will increase. This is due to the design of the transportation app as it is inclusive for all learners, as well as the guiding theories, and the learning environment that was created. The interaction will be explored throughout this chapter.

Learning Environment. Traditional approaches to learning tend to be based on behaviouristic principles established by psychologists such as Watson, Thorndike, Skinner, and Pavlov (Feldman & Dinardo, 2012; Vygotsky, 1978). These approaches are common in professional training workshops where learning is assessed on the basis of what individuals can recall (Wenger, 2009). Also, in such training programs, collaboration can be viewed as cheating, while teamwork is often praised in professional practice (Wenger, 2009). There is much criticism against behaviourism as it focuses solely on observable changes and largely ignores what is occurring in the individual's mind (von Glasersfeld, 1987). Additionally, the emphasis is placed on the outcome, rather than the journey, and teaching, rather than learning (Desjardin & vanOostveen, 2008). Consequently, this promotes individual work rather than collaborative teamwork and memorization rather than

learning (Desjardin & vanOostveen, 2008). Based on these limitations, other pedagogical theories have been formed that attempt to bridge these gaps, including constructivism. This process of criticism leading to alternative theories is the foundation of science and has occurred with subsequent theories (Popper, 2002).

From a constructivist perspective, learning occurs by actively challenging thoughts or schema (von Glasersfeld, 1989a), where schemata are mental representations of concepts or information (Piaget, 1965). This means that learning occurs when individuals construct new knowledge and understandings as their schemata are continually challenged. This indicates that learners are responsible for their own learning, taking control of what they learn in an active manner (von Glasersfeld, 1989a). In this way, learning shifts from being outcomes-based to process-based and teacher-driven to learner-driven (Desjardin & vanOostveen, 2008), and educators move from being teachers to being facilitators who challenge learners to re-evaluate their schemata (Savin-Baden, 2007). Such challenges may lead to cognitive dissonance where learners hold two opposing ideas in their mind simultaneously (Piaget, 1965).

Constructivism also promotes the notion that learning occurs through interactions with others (Scardamalia & Bereiter, 2006; Vygotsky, 1978; Wood, Bruner, & Ross, 1976). However, individuals with ASD often have difficulties communicating and interacting with others (APA, 2013), potentially limiting their learning. This learning can occur through scaffolding, or the use of supports for learners (Wood, Bruner, & Ross, 1976). Additionally, learners may be assisted by a "more knowledgeable other" who helps them accomplish more than what they

could accomplish on their own — a difference known as the Zone of Proximal Development (ZPD) (Vygotsky, 1978). Learning with peers is also promoted with knowledge building, where learners create their own knowledge or understanding of a concept rather than about a concept through interactions within a community as well as idea improvement (Scardamalia & Bereiter, 2006). This focus on social interactions is instrumental to learning and the foundations of constructivist theory.

Additionally, for some workshops and job training programs available to individuals with ASD, learning occurs in a non-contextualized environment that is far removed from the actual workplaces where students will actually use the skills they have learned (Hendricks, 2010). Situated learning theory, which is rooted in constructivism, suggests that learning occurs when individuals actively acquire knowledge through their experiences within an authentic, "real-life" environment (Wehlage, Newmann, & Secada, 1996; von Glasersfeld, 1989b). This perspective is learner-centred, not teacher-centred (Lave & Wenger, 1991). The notion of authentic experiences has also been promoted by authentic learning theory, which identifies that learning occurs when activities are similar to those they would be doing in the future work; simplified to learning by doing (Wehlage et al., 1996). This research study focuses on situated learning involving the use of a transportation app by individuals with ASD.

Digital Technology. The increasing use of digital technology in education is a very apparent trend, given the growing use of online learning tools, learning management systems, MOOCs, social media, games, devices, and apps in the classroom. When examining the use of technology in education, it is important to

focus on the educational implications of each tool. Technologies are not all created equal, since some focus on learning "from" the tool while others focus on learning "with" the tool, which is an important distinction that describes who is in control of learning (Jonassen, Peck, & Wilson, 1999). If technology is used as a tool to learn from, then learning becomes prescriptive, and the technology acts as a content delivery system; if, however, technology is used as a tool to learn with, then the technology acts as a facilitator of learning which supports knowledge construction (Jonassen et al., 1999). This perspective has significant implications for tool design and approach to learning, especially for individuals with ASD (Grynszpan et al., 2014).

The transportation app used in this study was developed using the theoretical framework presented in Chapter 2. The transportation app was developed for an Android device and programed by undergraduate students at the same university where this research was conducted. The transportation app works on the Toronto Transit Commission (TTC), in Toronto, Canada, and provides users with turn-by-turn navigation paired with notifications of when to exit a transit vehicle. This research project is a pilot study on the transportation app and it is hypothesized that the design of the transportation app will have a positive effect on individuals with ASD.

Purpose of the Study

The purpose of this research is to study the intrinsic learning of adults with ASD when asked to navigate Toronto Transit Commission (TTC) routes using a transportation app that makes use of augmented reality, where augmented reality

provides additional information to users as a digital layer to the non-digital world (Azuma, 1997). The research question being addressed is: What are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? It is hypothesized that individuals with ASD will have increased levels of intrinsic learning when using the transportation app under study.

As previously discussed, individuals with ASD tend to exhibit restricted or repetitive behaviour, follow strict routines, have social impairments, and tend to resist change (APA, 2013). These limitations can significantly affect an individual's ability to function and participate in society. For example, if an individual wants to work in his or her community but is unable to navigate transit, then that individual will have limited autonomy. Additionally, using traditional, classroom-based teaching methods can limit an individual's ability to transfer their learning to new situations while a more contextualized learning environment may help individuals transfer newly developed knowledge and skills to new settings and situations (Brown, Collins, & Duguid, 1988). Another goal of this research is to determine whether the provision of a more contextualized learning environment helps improve the intrinsic learning of individuals with ASD.

Methodology

An ethnographic pilot study of the effectiveness of the transportation app used in this study was conducted using both qualitative and quantitative methods. Ethnographic study focuses on a specific population and their societal interactions; the researcher collects data and is actively involved in this experience (Hammersley & Atkinson, 2007). This research method was selected to provide a rich description

of the relationships of the participants with the transportation app, the researcher, and their community environment. Three participants (n=3) were looked at as independent case studies, in order to provide contextualized information about their experiences when navigating two TTC routes, with and without the transportation app. Each route had three increasing levels of difficulty, challenging the learner to make transfers between streetcars and buses. Participants were asked to complete questionnaires, which rated their self-reported levels of intrinsic learning, before navigating, while navigating between routes, and after navigating. Additionally, participants were asked to participate in a semi-structured interview that measured self-reported levels of intrinsic learning. During the study, the researcher made observations recorded as field notes to provide triangulation of data.

Limitations

As with most research, there are limitations to the design of this study. For this study, a new researcher-designed Android app was introduced. This study was a pilot study for the design and development of the app. Because of this, there is a lack of background information on the effectiveness of this particular app. Future studies are needed to conclusively determine the effectiveness of the app itself.

As ASD is a spectrum disorder, individuals vary in their symptoms and how it affects their lives. For this study, participants were limited to those who had ASD, and were verbal, high functioning, older than 18 and younger than 30, and had some experience navigating TTC routes. These criteria were used to identify participants who (a) would be able to understand how to use the app, (b) be able to

communicate with the researcher, and (c) would not be overly anxious in using the TTC. Therefore, the sample is not representative of the entire population of adults with ASD, as each individual experiences this differently. Additionally, since participants navigated two different TTC routes as part of pre-test and post-test measurements (once with the app and once without the app), they may have benefitted from these repetitive trips on the TTC and not necessarily from use of the app; this limits the study's internal validity.

Ethical Considerations

This study went through rigorous ethical review prior to the beginning of the research study. This included approval by the University of Ontario Institute of Technology (UOIT) Research Ethics Board (REB). An application was submitted to the REB that included the rationale of the study, data collection procedures, recruitment methods, description of the participants, risks and benefits, and data storage methods. The UOIT REB strictly adheres to the principles of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2). The researcher completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS 2: CORE).

Significance to the Field

Participants in this study received many benefits based on the use of the transportation app employed in the study. Being able to navigate transit systems effectively has many benefits, including the ability to get to school and/or work autonomously. Additional benefits could include increased knowledge of digital tools, including the use of smartphones and applications. By using the app,

participants may have increased their intrinsic learning and their ability to transfer their learning to new and alternative situations and settings. Furthermore, the theoretical framework used in designing the app may assist in the development of different apps for users with a variety of conditions.

Summary

This research project attempts to answer the question of whether a transportation app involving situated learning, authentic learning, communities, and augmented reality will influence intrinsic learning in adults with ASD. This was selected as the focus of the research because of the reported lack of supports for adults with ASD (Gerhardt, n.d.) and the history of positive influences of technology on these individuals (Grynszpan et al., 2014). The study was designed using a theoretical framework that focuses on the learning environment as well as tools, which will be explored in Chapter 2. Following that, the methodology and development of the app and findings of the study will be addressed as well as discussed.

Chapter 2 – Literature Review

This research project attempts to explore the effects of a transportation app on intrinsic learning in adults with autism spectrum disorder (ASD), in attempts to answer the research question: What are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? In order to establish a need for this research, a review of significant and current literature was conducted. Although the scope of research surrounding learning and autism is high, this literature review focuses on major themes of digital technologies and augmented reality, situated learning, authentic learning, and communities. These theories correspond to the theoretical framework that is used throughout this research project. The theoretical framework for this project will also be introduced and discussed.

Autism

Autism spectrum disorder is a pervasive neurodevelopmental disorder (APA, 2013) affecting 1 in 68 children in the United States (Autism Speaks, 2014). Unfortunately, Canadian prevalence data is not available at this time as there is no government monitoring of ASD prevalence rates. However, Health Canada is reported to be implementing a system to do this later in 2015 (Autism Speaks, 2014). A diagnosis of ASD requires an individual to meet the following diagnostic criteria:

A. Persistent deficits in social communication and social interaction across multiple contexts.

B. Restricted, repetitive patterns of behavior, interests, or activities.

C. Symptoms are present in the early developmental period.

D. Symptoms cause clinically significant impairment in social, occupational, or other important areas of current functioning.

E. Disturbances that are not better explained by intellectual disability or global developmental delay. (APA, 2013, p. 50-51).

Comorbid diagnoses, or having more than one diagnosis, are commonly made with ASD, with 70% of individuals having one comorbid disorder and 40% having two or more comorbid disorders (APA, 2013). Because of this, individuals with ASD can have a range of symptoms from mild to severe. The American Psychiatric Association (APA) has put forth indicators of severity for individuals with ASD, ranging from Level 1, requiring support, to Level 3, requiring very substantial support (APA, 2013). An individual requiring Level 1 support may only have difficulties in social situations, but is able to communicate and engage in conversation, whereas an individual requiring Level 3 support may not have the verbal capacity to communicate with others or only respond to very direct social interactions (APA, 2013). In regards to this research project, the focus will be on high-functioning individuals with autism, or those that may fit into Level 1 criteria. This is due to the nature of the methodology and will be further discussed in Chapter 3.

A review of the literature has pointed to many limitations that individuals with ASD face on an ongoing basis. In a study conducted by Cheng, Moore, McGrath, and Fan (2005), individuals with ASD were likely to have limitations related to social relationships, communication, and rigidity of thought. Additionally, these

individuals were likely to have impairments in their ability to "mind-read", as discussed in Theory of Mind (Cheng et al., 2005). Where Theory of Mind relates to one's ability to understand that others have thoughts, beliefs, ideas, feelings, or cognitions, and that these thoughts might be different than their own (Korkmaz, 2011). These limitations have also been discussed in research conducted by MacKay, Knott, and Dunlop (2007), who also noted that difficulties with social interactions and understandings could prevent individuals with ASD from understanding and forming friendships or relationships. These barriers in relationships and well-being can be diminished with access to social supports, advocacy, autonomy, education, and employment (Schalock, 2000).

Individuals with ASD are less likely to live and work independently or complete their schooling (MacKay et al., 2007). This loss of autonomy has been highlighted in other studies examining chronic disabilities, stating that individuals with ASD can have both a loss of social participation and autonomy (Sibley et al., 2006). Furthermore, recent studies show that 50% – 85% of working-age individuals with ASD do not have paying jobs (Gentry, Lau, Molinelli, Fallan, & Kriner, 2012; Hendricks, 2010). This may be due to the limited number of jobs that are available to those with ASD or due to their particular needs in the workplace, with individuals with higher needs being less likely to obtain employment (Hendricks, 2010). Also, individuals with ASD may not have an ability to get to their job or schooling, with limited social supports and transportation options (Schalock, 2000). Strategies for work-place success for these individuals include special supports, which may include clearly defined tasks, checklists, structured time and

breaks, and reduced environmental stimuli (Hendricks, 2010). This supports the need for additional tools for individuals with ASD, including the digital transportation app developed in this study. The relationships between autism and digital technologies will be explored below.

Autism and Digital Technology

Digital technologies are being increasingly used as a tool for individuals with ASD. More and more digital apps are being introduced that offer assistance to individuals with ASD, from the costly, yet popular, Proloquo2Go app to the Samsung LOOK AT ME app that is both popular and free of charge. The former has been extensively used to increase communication skills for individuals with ASD (McLester, 2011) and the later is being marketed to help increase emotional reciprocity for individuals with ASD; however, this has not yet been verified by research (Samsung, 2015). There is evidence that some other mobile digital apps may increase the quantity and quality of social interactions and decrease behavioural and social issues (Escobedo et al., 2012).

In a case study conducted by Gentry et al. (2012), three adults with ASD were provided with an iPod Touch to assist them in their vocational tasks. In all three cases, individuals were able to improve their work performance; have fewer behavioural challenges; and, in most cases, have a reduction of direct supervision. Interestingly, Escobedo et al. (2012) found that these changes were also shown in individuals who are “neurotypical” (NT), meaning individuals who are not on the autism spectrum. This may be due to the inclusive design of the tool used, since inclusive design aims to support those at the extreme ends of the spectrum,

ensuring that the wide range of human diversity is included (Inclusive Design Research Centre [IDRC], 2015). Other mobile tools have had success in reducing work place anxiety when individuals are required to wait (Campillo, 2013). Likewise, tablet-based tools have been used to assist individuals in vocational settings by providing prompting and video modeling (Burke, Allen, Howard, Downey, Matz, & Bowen, 2013). Effective digital tools tend to have clear and focused goals for individuals, with users benefiting from tools that had real-world applications (Putnam & Chong, 2008). These successes with digital technology have been demonstrated and are not limited to the mobile environment, with benefits stemming from computer programs, tangible-user interfaces, multi-touch tabletop tablets (Escobedo et al., 2012; Gal et al., 2009; Golan & Baron-Cohen, 2006; Hourcade, Bullock-Rest, & Hansen, 2011; Sitdhisanguan, Chotikakamthorn, Dechaboon, & Out, 2011). The use of augmented reality as a digital technology tool for individuals with ASD will be discussed below.

Augmented reality. Augmented Reality (AR) can be used in both mobile environments as well as through software programs available for desktop and laptop computers. AR can be described as an enhanced view of reality that (a) combines real and virtual information, (b) is interactive in real time, and (c) must fit into the real world (Azuma, 1997; Feiner, MacIntyre, & Seligmann, 1993). Although AR is similar to Virtual Environments, such as Virtual Reality, AR allows individuals to interact with the real world, adding supplemental information rather than replacing it (Azuma, 1997; Kaufmann & Schmalstieg, 2003). This means that AR works to (a) provide the user with additional information that was not previously

available, (b) help users perform tasks, and (c) enhances users' perception and interaction with the real world (Azuma, 1997). Additionally, AR can be used to remove information from the environment by blocking or reducing stimuli (Azuma, 1997). This particular feature could have applications for environments that are over-stimulating. For example, AR could be used to filter out harsh or irritating lights that may be overwhelming for individuals with ASD. AR is not restricted to visual information; it can be used to stimulate other senses, including audition and tactility (Azuma, 1997; Feiner et al., 1993). A recent and popular example of a tool that uses AR is Google Glass, a wearable device created by Google that provides users with information through a head-mounted display (Google Glass, 2015). Google Glass provides users with information ranging from text messages to annotations in maps (Google Glass, 2015). Although the consumer division of Google Glass has recently shut down, there are still business solutions available to users, and ongoing research projects (Glass at Work, 2015). Specifically, research studies are planned for studying the use of AR and Google Glass in individuals with autism (Autism Speaks, 2015).

Augmented Reality has been used in educational research spanning a wide variety of media and genres including books, maps, authorship, games, and mathematics (Billinghurst & Dünser, 2012). The use of AR in classrooms has been linked to increased levels of student engagement, as well as increased excitement (Billinghurst & Dünser, 2012; Di Serio, Blanca Ibáñez, & Delgado Kloos, 2012; Escobedo et al., 2012). In one case study, students were provided with AR images of Italian renaissance art that provided additional text, audio, video, and 3D

information (Di Serio, Blanca Ibáñez, & Delgado Kloos, 2012). In this study, students displayed high levels of engagement, excitement, and concentration, and, interestingly, they spontaneously formed discussion groups to analyze information provided to them in more detail (Di Serio et al., 2012). This not only shows that the students were engaged in their learning, but also indicates that they became more self-directed and reflective learners. A study on AR in digital games, by Morrison et al. (2009), provides support for these interactions as collaboration, negotiating, and problem solving between individuals increased. Additionally, these results are not limited to individuals who are NT, since research supports increased the quality and quantity of social interactions of individuals with ASD when using augmented reality (Escobedo et al., 2012). In fact, individuals with ASD have also displayed increased collaboration with NT individuals when receiving clues and prompts or scaffolding through AR (Escobedo et al., 2012). Therefore, there is evidence to support the idea that AR provides users with learning opportunities, including opportunities for collaboration, self-directed learning, and engagement. There are, however, some considerations that need to be taken into account when using AR or other digital technologies as learning tools, including the design of the tool, the ability of the user, and the users' comfort level (Hourcade et al., 2012; Sitdhisanguan et al., 2011).

The design of a tool is incredibly important and must align with a user's level of knowledge, skill, and ability. A user's skills and abilities have an impact on the development of the tool. For example, individuals who are low-functioning, and with decreased fine-motor skills, benefit from tangible user-interfaces and show more

engagement with this design (Sitdhisanguan, Chotikakamthorn, Dechaboon, & Out, 2011). Additionally, it is important to consider an individual's activity in different settings, because, while engagement levels might appear small, they could be very large changes in comparison to other contexts (Hourcade et al., 2012). It should also be noted, that given an autistic individual's rigidity of thought and resistance to change, it is important for these individuals to feel comfortable with the technology before they engage in more challenging tasks (Hourcade et al., 2012). This research project and the transportation app employed, were designed with this in mind in order to provide a suitable learning environment.

Learning Theories

Situated Learning. Situated learning involves learning that occurs in an authentic environment where students actively acquire knowledge through experiences (Wehlage et al., 1996). This view of learning was a key consideration in the development and design of the transportation app used in this research project. In general, situated learning environments provide real world contexts in which social and cultural constructed characteristics assist in transferability (Brown, Collins, & Duguid, 1988; Lave, 1991). This approach to learning conflicts with traditional views of education where abstract knowledge impedes transfer (Brown et al., 1988). Lave and Wenger (1991) propose that every activity that individuals engage in is a situated activity, since even general knowledge must be situated in order for it to be meaningful. Lave and Wenger (1991) further highlight the need for learners to engage in a process called "legitimate peripheral participation" in which they become active within the community in which learning is occurring. Situated

learning explains an individual's ability to know what a tool is, but not how to use it (Brown et al., 1988).

Situated learning has been studied to assess its effectiveness as a learning model, and it has been shown that it is useful for individuals in improving knowledge transfer and performance on authentic tasks (Griffin, 1995), increasing reflection and collaboration (Herrington & Oliver, 2000). In one study, students were assessed on their ability to read and comprehend maps after learning in a traditional environment and a situated learning environment (Griffin, 1995). In this study, the students were assessed on two different tasks, the first being a written test and the second being an authentic navigation task (Griffin, 1995). There was no significant difference between the two groups on the written test performance, which was expected, since the written test focused on memorization only. However, students who participated in the situated learning activities performed significantly better than their counterparts on the navigation task, leading the researchers to conclude that situated learning provides more useful and robust knowledge (Griffin, 1995). Furthermore, the notion of situated learning stimulating the development of robust or even contextualized knowledge has been supported in Herrington and Oliver's (2000) study. In this study, students were provided with an educational multimedia project, designed with a situated learning framework, and were observed and interviewed exploring the environment. In this research study, it was found that students were able to add culturally relevant information to their knowledge base (Herrington & Oliver, 2000). Additionally, it was conjectured that situated learning environments lead to students engaging more effectively in

reflection, scaffolding, and actively seeking social learning opportunities out for themselves (Herrington & Oliver, 2000). Situated learning has been shown to bridge the gap between "knowing" and "doing" (Griffin, 1995; Herrington & Oliver, 2000; Kuo et al., 2013). Elements of situated learning were incorporated in this research project as participants were tasked with navigating actual TTC routes within the City of Toronto.

Authentic Learning. Authentic learning is learning that is real or genuine, rather than artificial and learning occurs in environments that are true to the real world and in activities that are similar to those that individuals participate in within their community (Wehlage et al., 1996). Furthermore, authentic learning occurs when there is:

(a) Construction of knowledge, when knowledge is produced rather than reproduced, (b) disciplined inquiry, when learners to use prior knowledge, aim for an in-depth understanding, and use elaborate communication to express their learning, and (c) value beyond school, when individuals can demonstrate their knowledge outside of traditional learning environments (Wehlage et al., 1996). Disciplined inquiry, in particular, requires learners to not only discover the solution to a problem, but also determine what the nature of the problem. Furthermore, problem seeking requires the learner to determine the difference between their current situation; their desired situation; the resources they have available to them; their prior knowledge; the role they have; and any obstacles that might be involved (Desjardins & vanOostveen, 2008).

According to Herrington and Oliver (2000), and Kearney and Schuck, (2006), individuals who participate in authentic learning environments seem to be better able to reflect, assist in scaffolding the learning of others, collaborate, and engage in learning in meaningful ways. Authentic learning has been shown to enhance initiative, and increase an individual's level of engagement in learning (Kearney & Schuck, 2006; Nicaise, Gibney, & Crane, 2000). Additionally, authentic learning has been shown to increase an individual's understanding, and confidence in their knowledge (Nicaise et al., 2000). Authentic learning can also increase an individual's self-satisfaction and pride in their work (Kearney & Schuck, 2006). This may be due to the fact that the learner is in control of his or her learning in a rich environment, rather than in a more impoverished, traditional classroom environment. As with situated learning, authentic learning helps increase transferability, since the individual is learning by doing (Wehlage et al., 1996). There is, however, a lack of research on authentic learning and individuals with ASD. This supports the need for this research study to help fill this gap in the literature.

Communities. In the above discussion surrounding situated and authentic learning, the ideas of social learning and collaboration were brought forward. Social learning is not a novel idea. In fact, learning with, and from, others is a fundamental aspect of social constructivism (Scardamalia & Bereiter, 2006; Vygotsky, 1978). For the purposes of this research study, communities are considered to be the social environments that individuals are a part of. Unfortunately, individuals with ASD often have difficulties interacting with others, and, therefore, also with their communities (APA, 2013; Cheng et al., 2005; MacKay et al., 2007).

Social learning includes Communities of Practice (CoP), which are formed by learners who are engaged in collective learning, and who share knowledge through active participation within a domain (Lave & Wenger, 1991). CoP is driven by the idea that learning is a social phenomenon that occurs through legitimate peripheral participation, moving from an apprentice member of the community to one who is a master (Lave, 1991; Lave & Wenger, 1991). Where legitimate peripheral participation occurs when an individual engages within a community, participating as an apprentice and learning from masters within the community; apprentices will begin to mentor new community members as they move to a master role (Lave & Wenger, 1991). An example of this occurs in Alcoholics Anonymous (AA), as with most apprenticeship programs, individuals come into AA without knowledge of the program and are influenced and mentored by individuals who are experts, those who are non-drinking alcoholics; the interactions and the sharing of knowledge and stories allow for the apprentice to develop and shift their own perspective (Lave, 1991).

Studying communities provides evidence to support the argument that communities can increase an individual's ability to learn. Studies provide support for use of communities within learning environments (Gal et al., 2009; MacKay et al., 2007; O'Donnell & Tobbell, 2007). Additionally, studies have focused on, and provide support for, the use of CoP for individuals with autism spectrum disorder (Gal et al., 2009; MacKay, Knott, & Dunlop 2007). In one study, individuals with ASD were placed into groups and met weekly as a community for a period of 12-16 weeks (MacKay et al., 2007). In this study, both participants and parents reported

that learning had occurred with an increase of socially acceptable behaviours, social competence, and functioning (MacKay et al., 2007). These findings were corroborated in a study conducted by Gal et al. (2009).

An important consideration to note is that individuals with ASD must feel like they are a part of the community, as some individuals who were able to gain knowledge from others, sometimes felt a reduction in their legitimacy by regulations and academic procedures (O'Donnell & Tobbell, 2007). This supports the notion that communities should have a "flat-level" hierarchy and that all learners, including teachers and facilitators, are equal. This aspect of the learning environment was significant in this study, since great efforts were made in structuring the learning environment in a way that provided the individuals with autism greater control of their learning.

Theoretical Framework

Theoretical framework is critical in the development of educational research as it allows for the organization of concepts, variables, and relationships that will be studied in the research project (Desjardins, 2010). The theoretical framework is based on the literature reviewed and theories explored, providing clear definitions and rationales of all aspects of the research problem (Desjardins, 2010). In this research project the framework was developed to illustrate the research problem and discuss the associated variables and concepts. This was then used to develop the design of the research study, including the development of the transportation app, the methodology, as well as the instruments used in data collection (see Chapter 3).

This framework discusses the interactions between concepts, independent and dependent variables. This study examines the effects of a digital transportation app on intrinsic learning in adults with ASD, the app employed in the study was designed with the following conceptual factors in mind: communities, augmented reality, situated learning, and authentic learning. Each of these factors, discussed earlier, may act as a variable potentially affecting the intrinsic learning experiences of the study's participants. It is hypothesized that these variables, acting together in complex ways, will result in intrinsic learning. Furthermore, the learning environment created by the interaction of these four variables should lead to intrinsic learning that may be assessed through use of the Self-Determinism Theory proposed by Deci and Ryan (1990).

Self-Determinism Theory. Deci and Ryan (1990) argue that learners are more likely to engage in learning tasks when they are motivated to learn. Additionally, intrinsic motivation, where individuals are motivated by internal desires rather than external rewards, is the most effective method of motivation (Ryan & Deci, 2000). Intrinsic learning can be measured by the individual's level of (a) autonomy, an individuals desire to take control of their behaviour and actions, to determine their own behaviour, (b) relatedness, when individuals are motivated to be part of a community by relating to and caring for others, and (c) competence, when individuals are motivated to reach a level of proficiency in a task or subject (Deci & Ryan, 1990). This need to relate to others and to feel involved within the social world can be connected to community of practice (Lave, 1993). This

theoretical framework (see *Figure 1* below) will be revisited in chapter 3, where the methodology will explain the development of the transportation app.

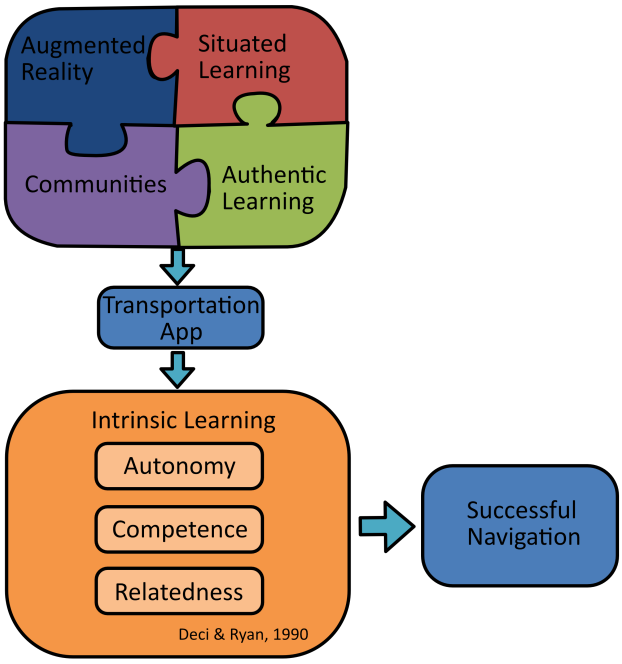


Figure 1: Theoretical framework. Identifying variables and concepts

---

Summary

In this chapter, I provided a review of relevant literature, which, in particular, showed that there is a strong need for research into ways in which certain digital technologies may assist individuals with ASD enhance their learning experiences. As a result, the research study involved in this thesis attempts to answer: What are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? On the basis of the literature reviewed, it was hypothesized

that the transportation app would have a positive effect on intrinsic learning in these individuals. The following chapter will outline the methodology of this study.

Chapter 3 – Methodology

This research project is focused on understanding the effects of a transportation app, developed using guiding theories of situated learning, authentic learning, augmented reality, and communities, on intrinsic learning in adults with Autism Spectrum Disorder (ASD). The research question to be addressed is: What are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? In order to measure the effects, an ethnographic case study was conducted that focused on a small group of high-functioning adults with ASD. A digital transportation app was developed, using the theoretical framework discussed in Chapter 2, in order to provide the authentic and situated intervention for participants. During this intervention, participants partook in two activities, navigating the transit system without then with the developed transportation app. During this time, qualitative and quantitative data was collected using questionnaires, interviews, and observations by the researcher.

Setting

As this study uses situated learning as a guiding theory, the setting for this study was based in a real, messy, and contextualized environment, the Toronto Transit Commission (TTC) in Toronto, Ontario. Situated learning states that learning takes place in an authentic environment and that learning is easily transferred to other situations if they are contextually similar (Wehlage et al., 1996). This is the premise of the theoretical framework that argues a situated and authentic learning environment combined with augmented reality and communities will foster

intrinsic learning for the individual. Therefore, it is necessary for this research study to be completed in an authentic environment.

The researcher designed a transportation app that would be used to navigate bus or streetcar routes using the TTC. Streetcars, subways, light-rail trains, and buses comprise the TTC. It covers Toronto as well as the Greater Toronto Area, and is the third-most heavily used transit system in North America, boasting 69 stations with 2.76 million daily passengers in 2012 (Toronto Transit Commission, 2015). This major transit system provides transit data in the form of General Transit Feed Specification (GTFS) files that can be used to gather information about routes and schedules for third-party apps (Open Data, 2015). Route information and schedules are also available for public viewing on their website (http://www.ttc.ca). Using this information as well as personal knowledge, the researcher mapped out transit tasks in the core of Toronto, containing routes that are frequently, determined by their centralized location, have constant TTC activity, and were in safe areas (determined using http://www.torontopolice.on.ca/statistics/stats.php crime map to find low crime areas). The maps with the TTC routes can be found in Appendix A. Participants also spent time on the streets of Toronto, walking from one TTC stop to the next, these were a short distance from each other with the participant needing to cross the street to reach the next stop. Additionally, participants completed interviews at Union Station in Toronto, which is the major stop of the TTC (Union Station, 2015). All data collection components were completed during the daytime, between 10:00 am-3:30 pm, avoiding rush hour traffic times as determined by TTC (2015). This was arranged in order to minimize potential stressors for participants.

Participants

As this study is an ethnographic case study, recruitment focused on a small group of individuals from a very specific population. The ethnographic case study was selected to provide a rich and descriptive account of the participants' experiences throughout the tasks. This highlights the individual experiences that the participants had, providing a detailed description of those experiences. The study is focused on adults with ASD; the researcher looked for participants aged 18 – 30. The cut-off age range was put in place to focus on participants who were very comfortable with digital technology use and those who would use it on a very regular basis. Although digital technology use is not limited to those under 30, the cut-off was used as inclusion criteria to narrow the scope to those who may use technology more, as 25 – 34 year olds are the largest group of Canadians who access the internet from a smartphone (Ipsos MediaCT, 2013). Additional criteria for participation included the use of a smart-phone on a regular basis, the use of TTC on a regular basis, verbal communication skills, limited behavioural issues, and a diagnosis of ASD. Recruitment for potential participants was done using purposive sampling, meaning that individuals elected to participate in the research study rather than selection from a random sample, recruitment posters and postings were sent to community organizations that focus on ASD, networking through the researcher, posts through social media (Twitter, Facebook, and Reddit), as well as word of mouth (see Appendix B for recruitment materials). Potential participants were instructed to e-mail the researcher where the individual would then be screened using the aforementioned exclusion criteria. If successful, participants

were then sent a letter of invitation with a consent letter to follow (see Appendix B for recruitment materials). Three participants qualified for the research project, these participants were all male and had some post-secondary education. As this is an ethnographic case study, the participants will be examined independently, providing a rich and detailed account of their individualized experiences,

Transportation App

The development of the transportation app used for this study was based on the theoretical framework provided as well aspects of inclusive design, which argues that development should be designed for the entire range of individuals (IDRC, 2015). The researcher worked with their supervisor and other faculty members to generate ideas for the app, which was then refined by the researcher. The researcher then worked with a team of undergraduate students at the university to develop the app for an Android device. The transportation app works similar to Google Maps, where the user inputs a starting location (or selects current location based on GPS signals), a destination location, and preferred method of travel. The app then provides a route according to the user's specifications, instructions to travel the specific route, updates using GPS signals to provide turn-by-turn navigation, and auditory and tactile signals, making use of Augmented Reality (AR). The app indicates when the user should get off of transit, based on the destination. The app has options to select routes based on the safest route, the quickest route, and the fewest transfers. The user is also able to set the time of the trip, in order to plan trips in advance. These added features provide users with an opportunity to tailor the experience to their needs, see *Figure 2* below.

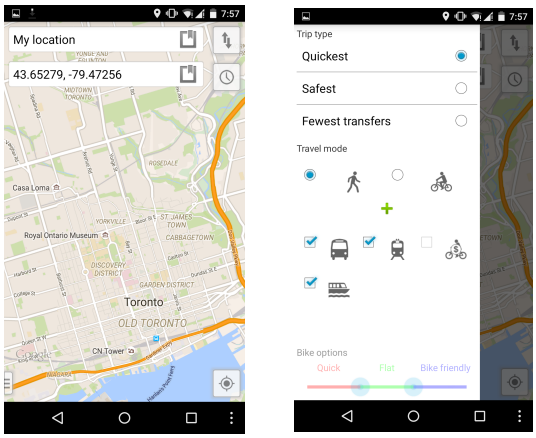


Figure 2: Transportation App. Screenshots of the transportation app home screen (left) and customized options screen (right)

Initially, the app included many other features, including the ability for users to add information to the app by tagging locations on the map. Other desired features included adding media to the app to act as a tool to reduce unwanted anxiety, i.e. users could play their favourite song in a moment of stress. Additionally, it was hoped that customized messages could be adding to the app, acting as a reminder for the user. Unfortunately, the app development process did not go as planned, with many delays and technological limitations that affected the design. The effects of these will be discussed in Chapter 6. The app is used within a situated and authentic environment, providing opportunities for individuals to interact with the community as an apprentice-expert role (Lave & Wenger, 1991) as the user has the opportunity to learn with the technology provided (Jonassen, Peck, & Wilson, 1999). This corresponds to the guiding theories as discussed in the theoretical framework (*Figure 3*).

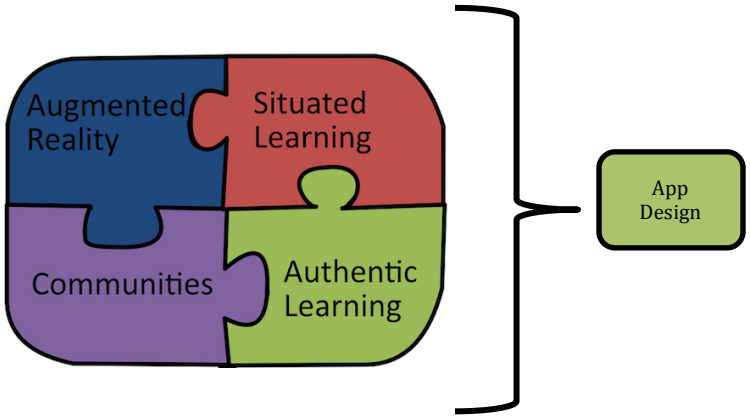


Figure 3: Theoretical Framework. Theories that formed the app development, leading to the formation of methodology

---

Inclusive design, as proposed by the Inclusive Design Institute, is made of three dimensions, including recognition of diversity and uniqueness, inclusive process and tools, and broader beneficial impact as seen in *Figure 4* below (IDRC, 2015).

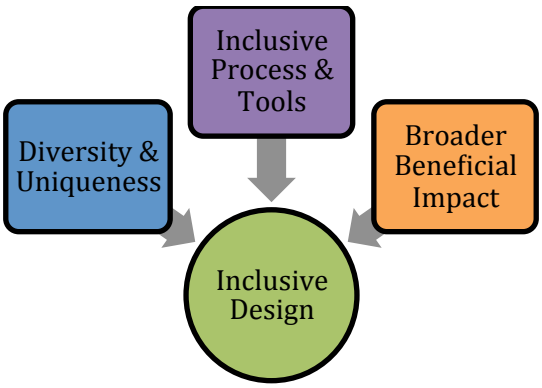


Figure 4: Inclusive Design Development. Design for the development of the transportation app (IDRC, 2015).

The design ensures that the full range of human diversity is included with respect to all forms of human differences, such as age, gender, and others (IDRC, 2015). The app was designed with this perspective in mind, allowing for individuals with ASD to access information in a manner that respects them as a person. This differs from Universal Design for Learning (UDL), as Inclusive Design focuses on creating objects that can be used by all in the digital environment, rather than focusing on tailoring objects for individuals with disabilities (IDRC, 2015). The app is designed for adults, rather than using patronizing, juvenile designs and user-interfaces. Additionally, the app does not display any identifying information surrounding its use; there is no mention of ASD to allow users to retain privacy. Furthermore, because it is on an Android device, users will not stand out against other smartphone users as Android held a majority of the US market shares in 2014 (Whitney, 2014).

Procedure

The researcher distributed recruitment materials over the course of eight months to recruit participants. The recruitment materials can be found in Appendix B. Potential participants contacted the researcher who used a scripted communication that made use of inclusion criteria to screen participants. As previously mentioned, three participants were deemed appropriate to participate in the research study and were sent a letter of invitation, along with a consent form. Participants then communicated with the researcher to determine a time and date that the individuals could participate in the study. Once this time was established, the researcher sent a second email, including the consent form, to ensure clarity for participants.

Participants met with the researcher at a predetermined location in Union Station. Once there, the participants were briefed using the briefing/debriefing script, filled out the consent form, and were provided with a list of instructions. Additionally, they were provided with transit materials, including route information and maps. These documents can be found in Appendix A. Participants were also told in advance that they could bring a caregiver or guardian to participate in the research activity with them. This was done to help reduce some anxiety that the individual may face. Of the three participants, one participant brought a parent to wait at Union Station with them, while the other two individuals travelled to Union Station alone. The researcher discussed any questions that the participants had in regards to transit, routes, or tools and showed participants how to use the transportation app. The participant then filled out the first questionnaire (Q1), using a numerical code provided by the researcher, to assess a baseline level of intrinsic learning. The participants were provided with a TTC Day Pass and the participant and researcher then set out for the situated research intervention.

The intervention was divided into two components, navigating transit without the transportation app, as well as with the transportation app developed for the study (*Figure 5* below). In the first activity, individuals were provided with a map and instructions for three different travel plans, ranging from easy to medium to hard. The levels of complexity were determined by how many transfers were in each route, assuming that transfers increased navigation difficulty. The easy plan had participants navigating a route that had zero transfers, the participant and researcher travelled from Point A to Point B. The medium plan had participants

travelling through a route that had one transfer, going from Point A to Point B to Point C. Similarly, the hard plan had participants travelling with two transfers, moving from Point A to Point B to Point C to Point D. These routes and maps can be found in Appendix A. During this time, the researcher made observations and recorded those on an iPad. After this activity was completed, the participant filled out the second questionnaire (Q2).

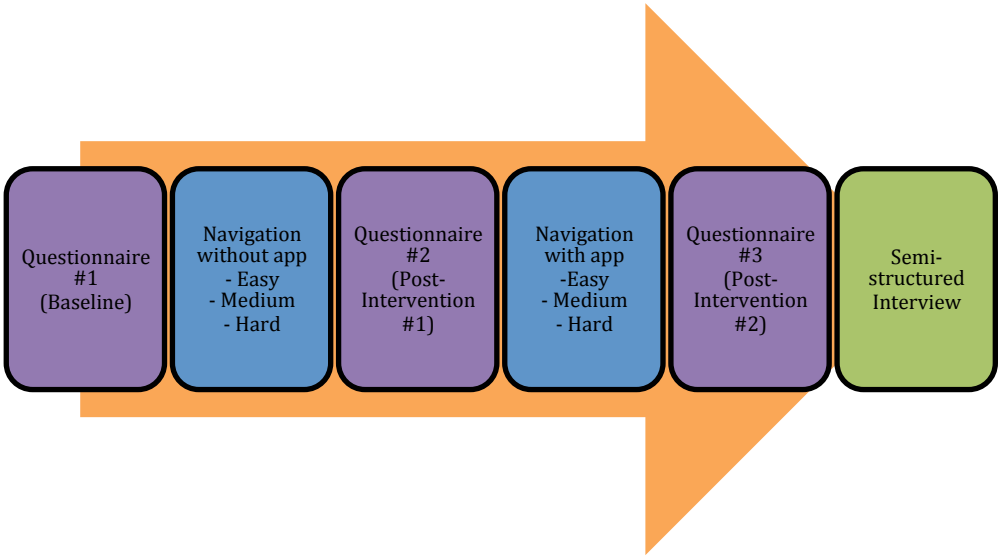


Figure 5: Research Methodology. Methodology for navigation tasks and data collection

---

After completing the second questionnaire, the participant was instructed again on how to use the transportation app, providing an additional opportunity for the participant to ask any questions on the app use. The participant was provided with a new route as well as a map with instructions. The participant was told that they could input the addresses in order to navigate with transit and that they could use any additional tools on the phone, as they would have access to this outside of

the research study. The phone was equipped with Google Maps, Google Chrome Internet browser, as well as an electronic copy of the transit apps that they were provided with. In the second activity, the participant was to navigate new tasks, based on the same route criteria as the first activity, with the assumption that one activity was not more challenging than the other. The tasks had the participant and researcher end at Union Station, in order to ensure the participant could get home the way they had arrived. Afterwards, participants were asked to complete a third questionnaire (Q3) through SurveyMonkey, as well as participate in a video-recorded interview, using the questions and script found in Appendix C.

Data Analysis

Prior to the start of data collection, the questionnaires and interview questions were constructed in attempts to elicit responses that would provide insight into the participants' self-reported levels of intrinsic learning. This was used in conjunction to the researcher's recorded observations to expand on how the transportation app may have influenced individuals' learning. Individual participant responses to the questionnaires, interview transcripts, and observations of each of the participants can be found in Appendix D. Both qualitative and quantitative data was collected during the research intervention. All identifiers were removed and the pseudonyms Aiden, Erik, and Albert were used during analysis. The questionnaire was completed on a secured iPad, on a secured network. The survey software used for this questionnaire was SurveyMonkey, which was accessed through a secure account that only the researcher had access to. SurveyMonkey uses servers that are located in the United States of America, which means that the data is subject to the

Patriot Act; to combat this, all data stored on the server is anonymous so there are no privacy threats to participants. The responses were then downloaded and stored on a secured local computer on a password-protected mountable disk image that only the researcher had access to. The researcher's observations were also stored on this disk image as well as data from the interviews.

Data from the questionnaires was transposed into Microsoft Excel 2011 for Mac version 14.5.3. Data was analyzed to look for differences between the three questionnaires, providing some insight into the participant's self-reported scores. This was combined with the information from the interviews and researcher's observations to examine potential relationships. The questionnaires were coded prior to data analysis by the researcher, based on indicators of autonomy, competence, and relatedness (see *Table 1* and *Table 2* below).

Table 1: Quantitative Questionnaire Coding. Data coding used for quantitative questions on intrinsic learning questionnaire

Quantitative Questionnaire Coding		
Question #	Question Text	Associated Variables
1	I feel confident in using TTC by myself	Autonomy
2	I feel confident in using TTC with another individual	Autonomy
3	I could give someone directions for TTC	Competence, Relatedness
4	I would use TTC by myself	Autonomy
5	In the past month, I have used TTC effectively	Competence
6	I have been able to navigate TTC without any help	Autonomy, Competence
7	When using TTC, I am able to reach my destination as planned	Competence
8	Sometimes I need to ask others for help riding TTC	Competence, Relatedness
9	I feel comfortable in asking for help when I am riding the TTC	Autonomy, Relatedness
10	I look up directions before I use the TTC	Autonomy, Competence
11	I feel comfortable making transfers from one bus to the next	Competence
12	I know what to do if a route gets changed or cancelled	Autonomy, Competence

Table 2: Qualitative Questionnaire Coding. Data coding for qualitative questions on intrinsic learning questionnaire

Qualitative Questionnaire Coding		
Question #	Question Text	Associated Primary Variables
13	Using the space below, explain how you would currently manage if a bus route was cancelled?	Competence
14	Using the space below, explain how you might currently ask for help on the TTC?	Relatedness
15	Using the space below, explain how you normally plan your bus route	Autonomy

For example, the researcher looked at the Aiden's responses for the baseline questionnaire and determined a mean score for autonomy, competence, and relatedness. These scores were determined for all participants across all questionnaires. The scores were then used to generate a clustered bar graph to visualize the changes that occurred. The recorded interviews were transcribed by the researcher using Microsoft Word and QuickTime Player version 10.4. The researcher used NVivo 10.1.3 to analyze the data for emerging themes related to intrinsic learning, see *Table 3* below.

Table 3: Qualitative data coding guide for interview transcripts

Qualitative Data Coding			
Variables	Code Description	Keywords	Example
Autonomy	Individuals are intrinsically motivated to engage in autonomous behaviours (Deci & Ryan, 1990). Autonomy can be described as an individual's desire to take control and ownership of their behaviour and actions, to determine their own behaviour (Deci & Ryan, 1990).	I wanted to do, I was responsible for, I was responsible for navigation, I determined, I am confident, I prepared, I decided, I mapped out, I did this by myself	"I was responsible for navigating transit" "I think I had quite a bit of confidence in that one" "It feels sort of like a safety net" "I looked up schedules" "I researched"
Relatedness	Individuals are intrinsically motivated to be part of a community by connecting to and caring for others (Deci & Ryan, 1990). This need to connect to others and to feel involved within the social world can be connected to community of practice (Lave, 1993).	I talked to, I would help, I am involved, I spoke with, I would share, I would recommend, I would tell, I wouldn't help, I would ask for help, I am comfortable asking for help	"I would recommend this to a friend" "I would not talk to anyone" "I wouldn't give someone directions" "I would tell my friends about it"
Competence	Individuals are intrinsically motivated to reach a level of proficiency in a task or subject (Deci & Ryan, 1990). Competence is achieved when individuals are able to understand and influence new information (Deci & Ryan, 1990).	I completed, I understood, I created, I succeeded, I planned, I researched, I know, I am comfortable, knowledge, learning, creating, telling	"I was successful" "you have to plan stuff out" "knowing what route will be serviced" "I was comfortable" "
App - Benefits	Discussion surrounding the app adding a beneficial aspect to navigation	Useful, helpful, beneficial, I would recommend it, I liked, I enjoyed	"I liked using the app" "I would recommend it to a friend" "paper is less effective"
App - Limitations	Discussion surrounding the app being difficult to use, or not helpful	Worthless, broken, did not work, went wrong	"It needs to be polished" "It does not accept addresses" "It told me to go the wrong way"

The researcher made five passes through the transcript when coding, first for any statements pertaining to autonomy, then for relatedness, then competence, then both app benefits and limitations, and finally a fifth pass to ensure that nothing was missed. When coding, the researcher did not limit a specific statement to only one variable, responses could be coded for multiple variables. A lab colleague was used to test the coding process for inter-rater reliability. The researcher provided the colleague with the data coding spreadsheet and instructions on how to use NVivo. The colleague then coded the transcript for the first participant, Aiden, for instances of autonomy, relatedness, and competence. Afterwards, the researcher compared the two coded transcripts to determine the percentage of coder agreement by looking at the excerpts that were coded the same and differently between the researcher and the colleague. The overlap of the coding was found to be 78% between the two samples of coding. The questionnaires as well as the interview questions have not been tested outside of this study for validity and accuracy.

Summary

An AR transportation app was designed to answer the research question: What are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? To explore this, three participants, Aiden, Erik, and Albert were recruited for this study. Participants were given two navigation tasks for the TTC transit system and were instructed to navigate one task without the transportation app, and other task with the transportation app. Participants filled out three questionnaires to assess their self-perceived levels of intrinsic learning and participated in a semi-structured interview. Researcher observations

were also recorded throughout the activity. This data was analyzed using the coding system presented above in *Table 1, Table 2,* and *Table 3*. These findings will be presented in the following chapter.

Chapter 4 – Findings

This research study is focused on a small population of adults with autism spectrum disorder (ASD), in order to explore the question: What are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? As previously described, participants in this study were asked to navigate Toronto Transit Commission (TTC) transit system by using a paper map and following that, with the transportation app. Data was collected using a variety of instruments including: (a) a questionnaire, that was given before and between the interventions, (b) a semi-structured interview, focusing on questions pertaining to the participants' experiences, and (c) observations collected by the researcher. This research project is heavily grounded in the theoretical framework discussed in chapter 2. This provided a strong basis for the methodology as well as the creation of the questionnaires and interview questions that were used. This also led to the analysis process used within this study. The following will outline the present findings of this work.

Quantitative Data

After analyzing the questionnaire responses for each participant, an Autonomy Score (AS) was calculated for each participant across the three questionnaires. These scores can be found in *Table 4* below.

Table 4: Autonomy Scores (AS) across all questionnaires for all participants as a mean score.

	Autonomy Scores		
Participant	Baseline (AS1)	Without App (AS2)	With App (AS3)
Aiden	2.43	2.57	2.71
Erik	2.71	2.86	2.71
Albert	1.86	2.29	1.71

Note. 3-point Likert scale, 1 = disagree 2 = neutral 3 = agree

These means were then used to generate a graph to show trends, see *Figure 6* below.

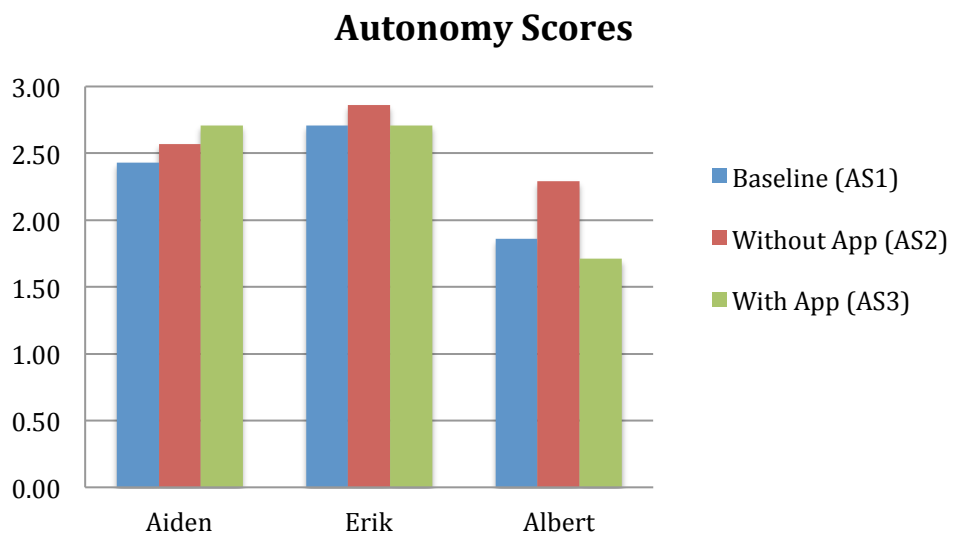


Figure 6: Autonomy Scores. Autonomy Scores (AS) for each participant across all questionnaires, on a Likert scale of 1 = disagree, 2 = neutral, 3 = agree

Similarly, Competence Scores (CS) were determined for all participants across the three questionnaires, found below in *Table 5*.

Table 5: Competence Score of participants across all questionnaires as a mean score.

	Competence Scores		
Participant	Baseline (CS1)	Without App (CS2)	With App (CS3)
Aiden	2.13	2.38	2.75
Erik	2.63	2.75	2.63
Albert	1.63	2.25	2.00

Note: 3-point Likert scale, 1 = disagree 2 = neutral 3 = agree

A clustered bar graph was generated to view data trends, see *Figure 7* below.

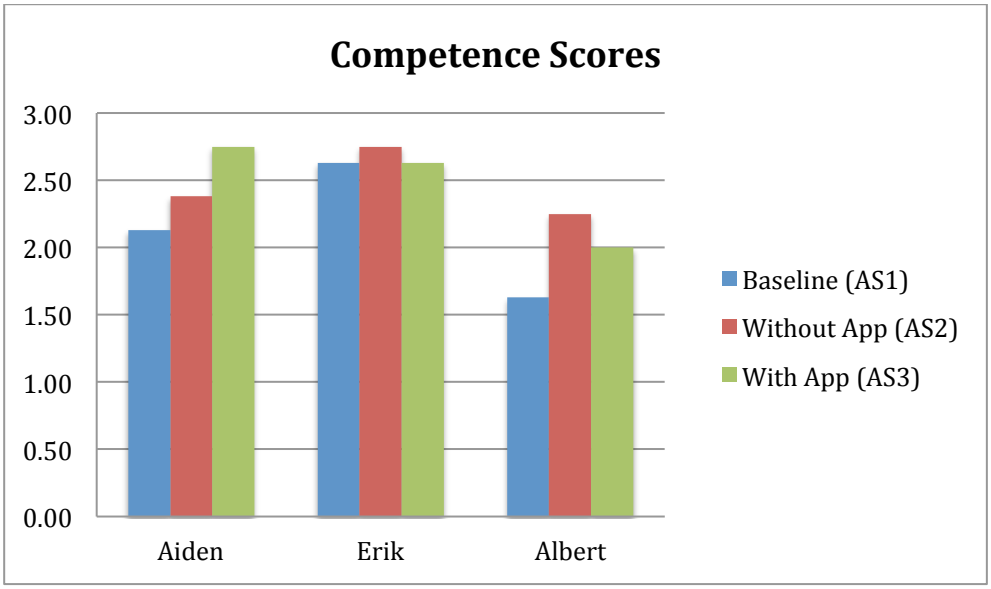


Figure 7: Competence Scores. Competence Scores (CS) for each participant across all questionnaires, on a Likert scale of 1 = disagree, 2 = neutral, 3 = agree

Scores on relatedness were determined across all questionnaires for each participant. These scores can be found in Table 6 below.

Table 6. Relatedness Scores (RS) across all questionnaires for all participants as a mean score.

Relatedness Scores			
Participant	Baseline (RS1)	Without App (RS2)	With App (RS3)
Aiden	1.67	1.67	1.67
Erik	2.00	2.00	2.00
Albert	1.67	2.33	2.00

Note: 3-point Likert scale, 1 = disagree 2 = neutral 3 = agree

This data was then used to generate a clustered bar graph in order to visualize trends; this can be found below in *Figure 8*.

Figure 8: Relatedness Score. Relatedness Score (RS) for each participant across all questionnaires on a Likert scale of 1 = disagree, 2 = neutral, 3 = agree

The questionnaires also provided insight into the participants' perspectives by using questions leading to qualitative data collection. These questions can be found in Chapter 3, *Table 2*, or as part of the full questionnaire in Appendix C. The

responses to these questions will be discussed, along with the interviews and observations, below.

Qualitative Data

Qualitative data was collected for all participants in the form of observations, questionnaires, and interview questions. The findings are organized by participant name and each variable will be explored. This is to provide detail and depth to each participant's experiences as individual case studies, as this study aims to look at the interaction between the participant, the app, and the community, including the researcher. Researcher observations will be outlined with an explanation of the contextual setting that they occurred in.

Aiden. Aiden met with the researcher at Union Station in Toronto, Ontario. The researcher explained the methodology, consent forms, and tools that Aiden could use during the experiment process. Aiden was familiar with the TTC, using the subway to navigate to and from school regularly. He had experience with a smartphone, as he has used a Samsung Galaxy Note on a regular basis, and displayed confidence when using technology.

During the study, when Aiden navigated transit without the app, the participant almost missed the first stop. The researcher prompted the participant by letting him know what stop they were at and the participant quickly exited the bus. Aiden made use of the map provided on the route information regularly, even after he was told that there was an electronic copy of the route information on the smartphone. Aiden did not have any questions about the route and was able to navigate without any further issues. Additionally, he was actively engaged in

conversation, even discussing different locations on the transit routes, throughout the task.

In the second part of the research study, Aiden was provided with a brief reminder of how to use the app, along with a paper copy of the route information. During the first route, Aiden typed in the address information and looked at the directions; he then put the phone in his pocket and started to navigate the route. After the easy route, he had difficulty programming the addresses, as the app was not recognizing locations addresses. He was able to program the app using intersections, which were available to him on the route information sheet. Aiden mostly used the paper map provided to navigate the routes, although he did continuously enter destination addresses into the app. He was able to successfully navigate these routes without issue and appeared confident when doing so. Aiden was engaged in conversation with the researcher and answered questions about the route when asked, for example "We are going east, right?" and "What stop are we getting off at?"

During the research study, Aiden was asked to complete three questionnaires, one as a baseline measurement, one after navigating without the app, and one after navigating with the app. The qualitative questions that were asked can be found in *Table 2*. When asked how he would manage if a bus route was cancelled, Aiden said that he would "look up [an] alternative route on [the] phone". When asked how he might currently ask for help on the TTC, he responded that he would "look up information on [TTC] website". When asked how he normally plans his bus route, he responded by saying that he "look[s] up directions on Google maps

prior to travel". These responses did not change during the additional questionnaires. Afterward arriving back at Union Station, Aiden participated in a semi-structured interview with the researcher. These responses were analyzed using the method discussed in Chapter 3 and are presented below.

App benefits and limitations. Aiden made a few statements regarding benefits and limitations of the app. Benefits included that "it did have very good directions on the app, once you put the right location in for the destination" and that "Uh, yea I do [feel more comfortable with the app]. It feels sort of like a safety net". Additionally, Aiden stated that he "like[d] having my app with me, Google maps or something to know what is going to happen" and he would like to see the app include a notification for obtaining transfers as "that would definitely help". In regards to limitations, Aiden found "for the particular purpose, the app was a bit quirky. It didn't work well with addresses, but if you were going to a particular neighbourhood or area it would work pretty well". Additionally, he stated that the app could be "more polished and [work] a bit better".

Autonomy. During the interview, the researcher found statements that related to indicators of autonomy. When asked who was responsible for navigating transit, Aiden responded "I think I was [responsible]" and that "I do believe I would… [be able to use the app by myself]". Additionally, he had a perception of confidence, stating, "I had quite a bit of confidence in [the multi-stop route]. Because it did have very good directions on the app, once you put the right location in for the destination". He also thought it "would make it more interesting if it were a more complicated route to different areas of the city". Within the interview, the discussion

of bus transfers came up, which is when an individual must ask the bus driver for a transfer slip when wanting to change buses during a trip. Aiden stated he would be "very uncomfortable with obtaining and using transfers because I am not sure if I might get a transfer from the wrong time or area".

Competence. Aiden discussed feelings of competence the most compared to other indicators during the interview. Aiden had discussed his competency with the app by stating that he would be able to navigate transit independently with the app. He stated that this experience "is fairly similar to my usual experience with transit". He also stated that he liked knowing what was going to happen and where he was going, "there's a certain certainty that I like, knowing exactly what route is going to be serviced, when". He also responded that he was confident navigating transit, which is why he did not use the app as much as he could have. When asked if he would provide someone with directions, he started "I find if I have to look up something, it doesn't seem like I know much about what I am talking about, so I don't want someone to take directions that they might not think that they can be confident it". When asked about the routes, he discussed the difficulty level,

> I found that even the difficult routes were a bit easy, like it was mostly the downtown area; there wasn't really a lot of long routes… It definitely would make it more interesting if it were a more complicated route to different areas of the city.

He also discussed his limitations with transfers, which were not part of this research project, stating "… that is the main reason I use a Metropass, I don't want to deal with transfers. I just show my card and then I am done".

Relatedness. When asked questions pertaining to his perceived level of relatedness, Aiden had fewer responses. When asked if he would communicate with individuals on transit, he stated that "um, I really only communicate during the bus ride if I know them and travelling with them. Like, even if I meet someone I know by coincidence on transit, only sometimes I will interact with them." When asked if he would talk to people more if he knew where he was going, he stated, "um, I would say when I know where I am going" but when asked if he would provide someone with directions when he knew where he was going, he stated,

> um, it doesn't really help in that regard. I find if I have to look up something it doesn't seem like I know much about what I am talking about, so I don't want someone to take directions that they might not think that they can be confident in.

However, when asked if he would recommend this app to a friend, he responded, "I think I would".

Erik. The second participant, Erik, met the researcher at Union Station and the same methodology, discussed above, was followed for the preparation of the study, as well as navigating the first route. Erik had some experience with TTC, however he had more experience with Durham Region Transit (which serves the Durham Region, part of the Greater Toronto Area) and GO Transit (which serves the GTA and Hamilton area). He also had experience with technology, using a smartphone on a daily basis. Erik navigated the first route well without the transit app. He needed to be reminded of the current stop, a few times, by the researcher. During those times, he was engaged in discussion with the researcher. Erik

consistently checked the paper map when using the transit system, when approaching stops, after exiting the bus or streetcar, and when the bus or streetcar was approaching. Erik appeared very confident during this research study. During this time, Erik was approached by two strangers, one asking for a donation for a sports team and a second time by a stranger asking for money for bus fare. In both instances, Erik gave money to these individuals and talked to them briefly. After the study, the researcher tried to give Erik money to cover what he gave these individuals, however he refused stating that he would have given them money whether he was participating in a research study or not.

During the second part of the study, Erik and the researcher experienced some technical difficulties as discussed in Chapter 3. Because of this, Erik had limited use of the transportation app, but had access to an app that is functionally similar in that it provides route information and turn-by-turn navigation. Throughout the task, Erik used the phone often, checking for updates regularly. He programmed the routes into the app and watched the phone as the bus arrived and when he was on transit. He was able to answer questions about the tasks, such as "What stop are we getting off at?". He was able to navigate transit without issue and appeared confident. Erik also determined that he did not need to exit the bus between routes 1 and 2, as it was the same bus. Erik needed to end the research project early due to time constraints, as discussed in Chapter 3. However, he was still able to participate in the interview.

Erik participated in all questionnaires, with the qualitative responses provided below. When Erik was asked how he currently manages if a bus route was

cancelled, he responded, "Look up online or via nearest information source for alternate routes to the same destination within the same approximate time frame." This question was asked again on the questionnaire after navigating without the app and his response was "Look up online with the nearest information source what the best alternate route would be in the same period of time." He responded on the third questionnaire, after navigating with the app "Look up alternative routes and methods to each the same desired destination within a similar time frame." There were not many changes between all three responses. When asked how he might currently ask for help on the TTC, his responses did not differ much between the three questionnaires. The foundation of the responses were similar to his response on the first questionnaire, "Approach a fellow passenger to seek any help, or try approaching conductors for any support or guidance needed." Additionally, his response to the final question did not differ much between the three questionnaires. The final question asked how he normally plans his bus route and he responded, "usually plan it a day in advance or earlier the same day I plan to use it by looking up the schedules and routes from their websites" on the first questionnaire. Erik then participated in the interview portion of the research study.

App benefits and limitations. After transcribing the data and analyzing it using the method discussed in Chapter3, it was found that Erik discussed benefits of the app; he did not mention any limitations with the app. When asked if he liked having the app with him, he stated that the app provided information that he would not have previously had, "[route information] is not necessarily information that I

would have form looking up the different routes and that." When asked what he normally does to access transit information, he discussed the benefits of an app

> Yea, for transit usually, whenever I have it I look at where I want to go and look it up the day before, and what the different schedules are and the timeframes are and, or if it is a spur of the moment type thing, I will either look it up on my phone and at the same time look at the schedules or just determine what route that would get me in terms of destinations and what time frame I would need to be there.

But that this was the first time he had used an app for transit, as he normally visits websites and takes screenshots or bookmarks the pages. He stated that he would use the app again, "so I will [be better to] manage how long it will take me to get to various routes and just keep track of what my usual routes would be to cross reference to compare to future dates." He also stated that he would share this app with his friends, "Oh definitely, if it would be beneficial to them in any way."

Autonomy. Erik made statements throughout his interview that were indicators of autonomy. Erik was asked who was responsible for navigating the bus routes, he stated, "So I am going to have to say between myself and the app? I would say definitely me mostly because the app would tell me but I would ultimately need to know what to do in order to have the app do it." When asked what his usual routine is, he illustrated the steps he typically goes through in order to obtain bus route information, "I usually just use websites and go based on any news or what their last updates schedules are." Erik was also asked about his confidence levels during the two bus routes (without the app and with the app) and he responded,

"Um, I don't think my confidence really changed between the two personally. The app was good to have but it didn't change my knowledge of what the routes were and where they were going." But he felt independent when travelling, which, he said, was not different than what he typically experiences.

Competence. In regards to competence, Erik made fewer statements throughout the interview. Erik displayed competence when discussing how he typically prepares for using transit, stating,

> I usually just use websites and go based on any news or what their last updates schedules are… I usually either keep the webpage that it is on bookmarked or take a screenshot of it so I can have it on record, or I will have just a photo of it or have it written down from the previous time.

He also stated that his confidence did not really change between the two navigation tasks, "The app was good to have but it didn't change my knowledge of what the routes were and where they were going." This statement was further supported when asked if his comfort level change, as he responded, "Again, for me personally my comfort level didn't change much with not having the app or having the app."

Relatedness. Lastly, Erik discussed indicators of relatedness the least. When asked if he would provide someone with directions when using the app, Erik responded,

> Um, if I had the app, I would probably use it to get as close, as best directions that I could for them. But also, at the same time for how much I was able to, I found I need to have an understanding of the area that I am in so I would know what streets are what. For the most part. So I would still use the app to

> try to get them the best directions, well better than what I know from the top of my head.

Additionally, when asked I Erik would talk to someone on transit, he stated that he would not usually talk to anyone, especially if it was a random stranger. When asked if he would share this app with a friend, he agreed, stating "Oh definitely, if it would be beneficial to them in any way."

Albert. Like the other two participants, Albert met with the researcher at Union Station where he filled out the consent form and was briefed by the researcher. Albert had experience with TTC, although his experience was not as robust as the previous participants. He stated that he had a lot of experience with Durham Region Transit, which he used primarily to get to and from school. He has had experience with technology, as he has a smartphone. However, his smartphone does not have a data plan so he is limited to using it only with Wi-Fi.

During the transit routes without the app, Albert started with confidence, arriving at the first bus stop. However, Albert was very talkative during the research process, often ignoring his surroundings. Albert did not take a very active role in the navigation process; he often waited for researcher cues to determine if the bus stop was coming up. He rarely used the transit route maps to determine where he was or where he was going. After encouragement from the researcher, Albert did use the map more often, as well as taking a more active role in the navigation process. During this process, a stranger who was asking for directions stopped Albert. Albert did not respond and instead turned to the researcher to respond to the individual.

After navigating without the app, the researcher provided a recap on how to use the app. Albert appeared to have a substantial learning curve with the transportation app. He asked numerous questions about the app, which were outside of the scope of the research process. After the researcher answered these questions, Albert attempted to program addresses into the app. Albert had difficulties programming the address, there appeared to be a combination of technical difficulties with the app and technical challenges with Albert. Albert had many complaints about the user-interface of the app and took up a lot of time asking questions about the app, which limited the time that Albert and the researcher could navigate the bus route. Albert was able to put in the first address with help from the researcher and the app provided directions that were not practical. During this time, Albert complained about the app being buggy and having a lot of issues. After completing the easy route, the researcher noted that Albert appeared stressed from the task, so the researcher and Albert discussed ending the study early. On the way back to Union Station, Albert provided the researcher with a large number of suggestions to improve the app, including: displaying which side of the road the bus stop is on, providing visual information about bus stop, increasing the accuracy of the GPS, and providing a static map if the signal is lost, as well as some other impressive ideas which are out of scope for this project, including taking pictures of a location so the app can determine where you are. Additionally, on the way back to Union Station, Albert attempted to navigate using just the paper bus map with some success after being told where he was and what direction he was facing by the researcher.

During the research process, Albert answered three questionnaires, each including three qualitative questions. These questions can be found in *Table 2*. When asked, on the baseline questionnaire, how Albert would currently manage if a bus route was cancelled, Albert responded that he would "Either change travel plans or find an alternative route." Albert indicated that this response was the same for the remaining two questionnaires. When asked how he might currently ask for help on the TTC, Albert responded "Identify the specific problem I have, then ask someone for assistance with that particular problem" for all three questionnaires. For the third question, Albert was asked how he would normally plan a bus route. He responded, "usually, I only use bus routes that I am somewhat experienced with, so planning a new bus route would involve finding a convenient route and then practicing it several times before using it." He stated that this response was the same for all three questionnaires.

Upon arriving back at Union Station after the final navigation task, Albert agreed to participate in an interview. Like Aiden and Erik, the data was analyzed for the themes found in *Table 7* using the aforementioned data analysis method.

App benefits and limitations. After the data was analyzed, there were instances of Albert discussing the benefits and limitations of the app, equally. During the interview, he stated that the app would be convenient, however discussed limitations of the app not working stating, "you wouldn't really be able to do anything more than a normal street map would do with the bus routes." He also discussed the importance of having a phone that has a data plan as he stated, "because without data, the map is kind of worthless… Like, bus route that I need to

get there, that would be useful. But as a constant, without data it's not very useful." As the phone used in the researcher process did have a data plan and access to data, Albert was discussing the limitations of his own phone. Overall, Albert saw potential in the app, "It seemed easy to use, if it worked. It was relatively intuitive, well to a certain degree. Like it was trying, but it didn't know the specifics… It is trying! It's trying but it's not necessarily doing the right thing." However, Albert highlighted limitations of the app, stating, "I don't think anyone was responsible [for navigating with the app]." Additionally, that the app was not ready to be used outside of this research project.

Autonomy. Albert made statements related to indicators of autonomy throughout the interview. When asked who was responsible for navigating transit, Albert said, "For [part] one, yea it was pretty much [the researcher] … For section two, I don't think anyone was responsible." However, when asked if he would be able to use a working version of the app, he stated, "Yea, I believe I could use that, yea." When asked how he currently navigates transit, he discussed his own method, "but whenever I use [transit], it's generally like a pre-determined route that I already researched." He does discuss his limitations, when asked about providing directions to an individual. Stating, "if someone is like 'hey how do I get to here' I go 'hey, I am not the person to ask, I wouldn't really know'."

Competence. It was found that Albert made more statements of competence compared to autonomy. Albert noted that he did not feel as though he was responsible for navigating the first transit route, without the app. He also discussed that he did not feel confident in giving directions to someone as, "Honestly I am not

the best person to ask for directions… if they are going to try to get directions from someone, it should be from someone who definitely knows." However, Albert discussed the ways in which he would deal with a mistake when taking transit, "So there are a lot more ways that it could go wrong [because the transit system is so large], but it is much easier to correct your mistakes and head back to where you would be going." He also discussed limitations of his knowledge in regards to making transfers,

> But in terms of like transferring, I generally don't do that because that adds a whole other layer of complexity, but it seems like the TTC would be a lot easier if I had enough time to prepare, or even just a map that let me know where all the bus routes are.

Some of these points were also coded as relatedness, focusing on how Albert interacts with others.

Relatedness. During the interview, Albert made fewer responses indicating relatedness within his interview. When asked if he would normally talk to someone on transit, Albert stated,

> I will talk to people I know, but not really. They are either listening to their music or they are reading something. Like you know, if you are on the bus you do not want some random person to be like 'hey-hey what are you…' If you are on the bus you are trying to get somewhere.

When asked if he would give someone directions, he stated that people generally don't ask him, and that he would not be the best person to provide directions. When

asked if an app with data would change that, he stated, “I guess it would to a certain degree, I don’t know.”

Summary

Both quantitative and qualitative findings were presented to explore the research question driving this study, what are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? Findings were presented for each individual and their experiences. These findings will be thoroughly discussed in the following chapter, connecting these to the research question.

Chapter 5 – Discussion and Implications

This research study focused on intrinsic learning in adults with autism spectrum disorder (ASD) when navigating the Toronto Transit Commission (TTC) with a transportation app using Augmented Reality (AR). Participants' intrinsic learning score was measured using questionnaires, researcher observations, and a semi-structured interview. From there, data was analyzed, looking for trends and individual changes. These results will be discussed with limitations of data being addressed. Future areas of research will also be examined.

The questionnaires were analyzed by generating a mean score for each variable of intrinsic learning, autonomy, competence, and relatedness, for each questionnaire, baseline, without app, and with app. The mean scores were calculated by taking the scores for questions that were coded for each variable. A breakdown of coding can be found in Chapter 3, *Table 1*. This left the researcher with an Autonomy Score (AS), Competence Score (CS), and a Relatedness Score (RS) for baseline (ex. AS1), without the app (ex. AS2), and with the app (ex. AS3). The interviews were analyzed by coding transcripts for themes associated with the theoretical framework, looking for indicators of autonomy, competence, and relatedness. These transcripts were then grouped by codes, in order for the researcher to get a rich description of the participants' experiences and perspectives.

Aiden

Autonomy In regards to Autonomy Scores, Aiden, started with an AS1 of 2.43 of a possible 3 points. His AS increased after navigating transit without the app

(AS2) to 2.57. Although this increase was not tested for statistical significance, it is interesting to see an increase of perceived autonomy from the participant without using the navigation tool. Aiden did have access to additional information in the way of paper maps, although this was not augmented or layered within the environment. When provided with the app, Aiden had an AS3 of 2.71, which shows an increase between the baseline and navigation task with the app. This promotes the idea that the app was beneficial for Aiden based on his perceived levels of autonomy. Aiden did have a lot of experience navigating TTC, which may have contributed to his perception of autonomy. Additionally, he was familiar with the specific routes that were taken, commenting on the locations during travel. Aiden also had the fewest number of technical "glitches" throughout the pilot test, which also may have contributed to this increased score. However, Aiden also had a high comfort level with technology and did not rely on the app for transit instructions. Although he did not rely on the app, Aiden stated that he liked that the app was a "safety net". During the navigation tasks, Aiden appeared independent as he led the researcher through the route. Throughout both tasks, Aiden maintained the lead when it came to travelling between each stops, however, he would position himself behind the researcher when it came to getting on and off the bus and would defer to the researcher when it came time to selecting seats. Aiden responded to the interview questions regarding autonomy in a manner that suggests that he felt autonomous when using the app. Additionally, Aiden stated that he would be able to use the map himself and in situations that were more difficult. This supports the change in the measurement of autonomy.

Competence. When looking at his scores on competence, a similar pattern was found. Aiden had a CS1 of 2.13, suggesting that he was somewhat neutral on his perception of competence when starting the task. After navigating without the app, his CS2 was 2.38. This change could suggest the effectiveness of the interaction between situated learning, authentic learning, and communities, as the participant was engaged in a real task and interacting with the researcher, who was part of the community. Additionally, Aiden was navigating in areas that were familiar to him, which could help to explain his perceived levels of competence. After using the transportation app, Aiden had a CS3 score of 2.75. This interpretation may illustrate how Aiden's competence was influenced by the app, as suggested by his perceived autonomy. This relationship can be explained by cognitive evaluation theory, in that the environment allowed Aiden to flourish based on his feelings of autonomy (Ryan & Deci, 2000). Qualitatively, Aiden did state that this experience was similar to past experiences and that the routes were easy for him, which could influence his feelings of competence. During the first task, Aiden made one mistake, while in the second navigation task, Aiden was able to navigate without making any mistakes. This suggests that the app did increase his competence. When discussing his experience in the interview, Aiden talked about feelings of competence the most. He stated that he did feel confident, was navigating transit with the app, although he did not use it for much of the trip. He did periodically check the app, to ensure that he was not going to miss his stop. One of the biggest indicators of this increased competence is that Aiden was able to respond, correctly, to questions asked by the

researcher. This could relate back to his statement that the app acted as a "safety net" for him.

Relatedness. Relatedness Scores were also generated for Aiden, which showed a RS of 1.67 across all three tasks. There appeared to be no changes in his perceived level of relatedness throughout the tasks based on his responses on questionnaires. However, the researcher observed multiple changes with Aiden throughout the study. Aiden spent much of the trip interacting with the researcher, discussing his relationship with his girlfriend as she worked in the area, his pet cat, as well as video games that he was interested in. Aiden discussed the fact that he had been working on his communication skills with the help of his girlfriend. He stated that this is why he was able to maintain communication throughout the navigation tasks. Aiden also responded to questions from the researcher throughout both tasks, providing information about the route and next stops. This shows, albeit the RS of 1.67, Aiden was able to show relatedness by interacting with the community, the researcher.

Aiden noted increased self-reported levels of autonomy and competence throughout the navigation tasks. Although Aiden had previous experience using the TTC, he discussed positive outcomes from the app, such as making him feel more confident as the app acted as a safety net. He also discussed potential features for the app, including information on transfers as he felt that he would benefit from that information. Aiden stated that he would use the app, once polished, to assist him in the future.

Erik

Autonomy. Erik had an AS1 of 2.71, out of a possible 3 points. After navigating transit without the app, Erik had an AS2 of 2.86, which indicates an increased level of perceived autonomy. Erik had few observed problems navigating transit, although he did not have experience navigating the specific routes that were travelled. Prior to this project, Erik would use screenshots of maps or transit routes in order to navigate on trips, which may have contributed to this high autonomy score, as this was similar to what was provided. However, after navigating the transit routes with the app, Erik had an AS3 of 2.71, suggesting that there is no appreciable change between the baseline and the use of the app. This is unexpected, but not surprising as Erik had a number of technical difficulties that influenced his experience. These difficulties could have influenced his perception of autonomy, since several external factors limited his ability to complete the task (Ryan & Deci, 2000). These factors included technical difficulties with the app as well as time constraints due to traffic. Additionally, challenges outside of Erik's perception of control could have contributed to an external locus of control, decreasing his self-reported autonomy levels (Ryan & Deci, 2000). His responses in interview questions provide a bit more insight into the basis for his perspective, as he felt he was responsible for navigating transit with the app. Interestingly, he stated that "the app would tell me [where to go] but I would ultimately need to know what to do in order to have the app do it." This type of thinking is congruent with Jonassen et al.'s work focusing on learning with or from technology, as Erik appeared to be learning with the app rather than from it (1999). Additionally, Erik felt as though his confidence

did not change throughout the navigation tasks. The researcher noted that during the navigation tasks, Erik appeared confident throughout both tasks. Erik initially followed the researcher instead of leading through the navigation tasks; however, he started taking more initiative as the day progressed. Erik was also able to express his concern with the timing of the research activity to make sure he left to attend a meeting on time, showing some autonomy. Throughout the task, Erik focused on the paper map and used the app as a supplemental tool. Erik also stated that this was similar to what he had experienced in the past, in regards to his perceived independence. Erik said that he was used to using screenshots of transit screens to navigate to different locations, which is very similar to the maps provided. This may mean that he was more comfortable with his previous tools in comparison to the information provided by the transportation app, which could increase his perceived level of autonomy. This could also point to a discrepancy between what the questionnaire is measuring in comparison to the interview.

Competence. Erik's patterns for CS followed closely with his scores for autonomy. He had a baseline CS1 of 2.63 that increased to a CS2 of 2.75 after navigating transit without the app. This score then decreased to 2.63 for CS3 app, indicating that he did not have a perceived change in competence. When navigating the transit system without the app, Erik also displayed his highest level of autonomy, which could be related to his feelings of competence. The researcher did note that the participant appeared confident when navigating the transit system. As the day progressed, Erik took more initiative in leading throughout the transit activities. Erik also made fewer mistakes as the day progressed, which could be due

to the addition of the app. Erik responded to questions about the route when using the app. He expressed that the app was difficult to use because of technical challenges, but stated that he found the app helpful despite that. Throughout the navigation, he consistently used the paper map throughout the task and used the app as a supplement, checking it periodically. This is similar to what he has used in the past, using a screenshot or bookmarked webpage with transit information on it. This could have had an influence on his increased competence without the app, compared to no change with the app. Additionally, Erik stated that his knowledge of the routes did not change when using the app, which is supported by the scores. This perception may have been influenced by the fact that there were many difficulties associated with the app, impacting Erik's perception of competence. However, it may be a result of a preference for what he has used in the past and what he felt confident in using, as he may be resistant to change. This result can support the theoretical framework used in this study, for the most part, as the individual's perception of competence increased when in a situated environment.

Relatedness. In regards to relatedness, Erik had a consistent RS of 2.00 across all three tasks. This type of pattern is in line with literature, as individuals with autism spectrum disorder often have difficulties communicating within their environment or display discomfort in doing so (APA, 2013). Although it was hypothesized that the participants may feel more connected to their community when using the app, however it appears that this was not supported with Erik's reported score. It was supported in Erik's interview responses as he stated that he would not be the one to provide directions to strangers, as he did not have enough

knowledge to do so. When a stranger approached Erik for directions, he defaulted to the researcher when navigating without the app. However, Erik supplied the researcher with questions surrounding their area and the route in question when navigating with and without the app. Erik also spent much of the time talking with the researcher, discussing activities he was involved in to help support his community as well as other interests. Despite his low perception of relatedness, Erik also stated that he would recommend the app to friends, or in his case, other individuals within the Autism community, displaying relatedness.

Erik's self-perceived scores did not change from the baseline questionnaire compared to the third questionnaire. However, the researcher noted that Erik made fewer mistakes when using the transit app, appeared confident, and shared knowledge during the trip. This discrepancy may indicate that Erik's perception of his competency level may be lower than displayed by his actions. It could also mean that the questionnaire is not particularly accurate in capturing indicators of competence. Erik discussed the implications of this app, stating that he would use it again and would share the app with a friend. As Erik previously used static screenshots of transit routes, using the app would provide updated information to him in real-time.

Albert

Autonomy. When looking at Albert's Autonomy, he had an AS1 of 1.86 of a 3 possible points. This score falls below 2, or a neutral autonomy score before starting the research project. This may have been influenced by his transit experience, as Albert stated he had more experience with Durham Region Transit

compared to TTC. However, his AS2 was to 2.29, suggesting that he felt more autonomous after his experience without the app. Previous to this study; Albert had not used a transportation app as he does not use a smartphone with a data plan which, according to him, limits his ability to use a navigation tool. This relative lack of experience may contribute to the fact that, compared to his AS1 score, his AS3 score decreased to 1.71. Albert had technical and competency difficulties with the app, which may have contributed to these changes. This could be explained in regards to the relationship between competence and autonomy, as having low competency can decrease an individual's feelings of autonomy (Ryan & Deci, 2000). Albert's responses to interview questions also point to a low perception of autonomy. When asked who was responsible for navigating transit, Albert stated the researcher was when navigating without the app and that no one was responsible for navigating with the app, suggesting that he did not feel autonomous when using the app. These responses are in agreement with the low levels of self-perceived autonomy displayed in the questionnaire. His previous experience of transit includes a well-researched route, which he did not experience in this study. The transit routes were not provided to participants in advance, this could have influenced Albert's perception of autonomy; specifically, why he had a low baseline score. It is, however, interesting to note that although he felt the researcher was responsible for navigating without the app, his autonomy score did increase. Additionally, when returning to Union Station without the app, Albert took it upon himself to try to navigate back using the paper-map provided. This type of intrinsically motivated task could also illustrate an increased feeling of autonomy

(Ryan & Deci, 2000). Although the tool itself did not appear to be effective for Albert, the authentic task and environment may have been effective, as he appeared to have benefited from navigating without the app.

Competence. Albert's competence scores were similar to his autonomy score; with his baseline CS1 of 1.63 indicating a potential lack of perceived competence. When navigating without the app, his CS2 was 2.25, while only increasing to 2.00 for CS3. Albert's increased score when navigating without the transportation app could be explained by the situated environment influencing his learning. Although Albert stated that he thought the researcher was responsible for navigating transit, he appeared to have an increase in competence. This is consistent in his interactions with the researcher as he was engaged in a community of practice with the researcher, as discussed within the theoretical framework. Within this community, Albert may have viewed the researcher as an experienced member, or More Knowledgeable Other, from whom he could learn (Lave & Wenger, 1991; Wood et al., 1976). This is supported by the researcher's observations that Albert would wait for clues from the researcher about when to exit transit. Although, this is not what the researcher had intended to happen, it parallels nicely with the community integration that the framework is based on as he interacted with the researcher in taking learning cues, with the researcher acting as a more knowledgeable other. Albert made mistakes when navigating and largely relied on the researcher throughout the tasks. It would be interesting to see if this behaviour would continue as Albert gained more experience with the app and the routes. It is hypothesized that Albert would have increased competence with increased use and

interactions with the researcher, based on social learning theory. However, the lack of competence in navigating transit with the app supports the researcher's observations in Albert's difficulties with the app itself. The app was not working as well as it could have, providing directions that were not the most effective. This, in conjunction with Albert's limited ability to use the app, created a difficult learning environment. Albert appeared frustrated, which could be a result of low competency and low autonomy. Additionally, Albert's frustrations with the app started when he first used it, before the navigation tasks. Albert appeared to have a negative view of the app, which may have influenced his competency with the app as well as the frustrations that he had.

Relatedness. In regards to Albert's Relatedness Scores, he did display differences between his baseline score (RS1 = 1.67) and his scores after navigating without the app (RS2=2.33) and with the app (RS3 = 2.00). These scores illustrate that Albert did experience a change in relatedness with both navigation tasks. When Albert was navigating through the tasks, he was very talkative with the researcher. Albert spent a large amount of time discussing interesting movies, shows, and aspects of video games he enjoyed. This constant talking may have influenced his ability to concentrate on the task at hand, as he appeared to be distracted. However, he did interact with the researcher when asked questions about the route, but appeared to lose concentration quickly. Although he interacted with the researcher, Albert stated that he would not provide directions if someone asked, as he did not have enough knowledge. This situation occurred during navigation, as a stranger asked Albert for directions and Albert deferred to the researcher. It appeared that

Albert had increased interactions with individuals he knew, versus strangers, which is consistent with his ASD behaviours. This is supported as Albert stated that he would share the app with a friend, despite some of the app's technical limitations.

Although Albert suffered from many technical difficulties and challenges when using the app, he was able to have limited use with the app. Albert's self-perceived autonomy score decreased when using the app, however his self-perceived competency and relatedness scores increased. Albert did rely on the researcher for cues when navigating transit, which is supported by the theoretical framework. Albert also provided a list of app benefits and limitations as well as future design recommendations.

App Benefits and Limitations

Each of the participants were interviewed and subsequently the interview transcripts were analyzed to find emerging themes. The researcher highlighted app benefits and limitations as discussed by the participants. Albert found that the app was convenient and more effective than a normal street map. However, he was concerned with using the app without access to data on the phone or a wireless connection as Albert, with his present technology, has been limited by data connections and can only use Wi-Fi connections to access most apps. Unfortunately, this app has not been tested without data, although some apps can track using GPS without Internet access. Albert did point out that the app seemed intuitive and easy to use, when it was working properly. He did however, have additional comments that he made in order to improve the app; these will be further discussed in implications and future research. Aiden stated that the app was beneficial to him,

providing a sense of security. Aiden did not use the app often, however, which may have influenced his perspective. Aiden did have some technical difficulties with the app, as it was not searching for addresses, instead only showing neighbourhoods. As this was a limitation he discussed, with more work done to the app this may be addressed. Erik enjoyed his experience, stating that having information on hand was very beneficial, although it was his first experience using an app for transportation. He also discussed the benefits that this app could have for his friends, suggesting that he did see potential despite technical difficulties.

Conclusions

Data collection included participants' self-reported measures of intrinsic learning, including autonomy, competence, and relatedness, a semi-structured interview, and researcher observations. Data analysis shows that self-reported autonomy increased from baseline measures for Aiden, stayed the same for the Erik, and decreased for Albert when using the transportation app. However, when navigating without the transportation app, all three participants displayed an increased self-reported autonomy score compared to baseline measures. Similarly, self-reported competence scores increased for one participant, stayed the same for the second participant, and decreased for the third participant when using the transportation app compared to the baseline scores. Again, all three participants had an increased self-reported competence score compared to baseline measures when navigating without the app. Lastly, self-reported relatedness scores did not change for two of the participants across all three questionnaires, although one

participant had increased relatedness scores for both navigating with and without the app compared to the baseline measurement.

Responses to interview questions suggested that Aiden had positive experiences with the app, using it mostly as a supplemental resource. Additionally, Aiden displayed a high amount of autonomy when navigating through the tasks, often leading the researcher to the next location. Aiden displayed competence through the navigation tasks as well, making use of the paper map and app provided. He also had displayed high interactions with the researcher, answering questions and sharing knowledge throughout the tasks. This supports the hypothesis that the app can lead to increased autonomy, relatedness, and competence. Erik supports these conclusions as he displayed a high level of autonomy when navigating. Erik did not fully rely on the researcher to indicate what stops they were to take, often checking the paper map and app for more information. Erik was also able to answer questions regarding route information and displayed competence. Although he had a bit of difficulty when navigating, he was successful in the tasks that he attempted. Additionally, Erik displayed high levels of relatedness when interacting with the researcher; however, he did not appear to participate in community interactions when asked by a stranger for directions. Finally, Albert displayed reliance on the researcher when navigating transit, limiting his autonomy. This may be due to his difficulty using the app or lack of experience with transit. He showed a lack of competency with both navigation tasks, however he appeared to be determined to navigate using the paper map. In regards to relatedness, Albert displayed a high amount of interaction with the

researcher; yet he did not provide directions for another member of the community when asked. This may be due to his comfort level with the researcher compared to a stranger.

Participants appeared to prefer navigating with a paper map, rather than the transportation app. This is consistent with what the participants' previous experience had been, as all participants previously used paper maps, directions, or static screenshots compared to a real-time application. This may be remedied in future studies by allowing participants to interact with the app for a longer period of time, working through any difficulties. Future research is needed to solidify the theoretical framework and methodology of the study, including measurement tools. Additionally, the app needs to be further developed and tested to determine its effectiveness; this will be discussed in detail in the following chapter.

Chapter 6 –Future Research

Throughout this research study, there were many areas that could be improved or expanded on in a future research project, if this was to be undertaken. Although the research project resulted in some interesting findings, there are still some holes that could be filled. Specifically, the framework and methodology of this project and the app development and implementation will be discussed.

Study Limitations

Although the research study was conducted under best practices of the researcher and under supervision of the researcher's supervisor, there were still limitations that may have affected the outcomes of this study. Recruitment was challenging, which limited the number of potential participants. This was a pilot study, the app was not thoroughly tested by multiple individuals. Although these limitations were accounted for in the design of the study, it does limit the scope of the findings. Likewise, the measurement tools used by the researcher (questionnaires, interview questions) have not been tested for accuracy and reliability; future testing is required for this as well. The sample size was based on a number of factors, as the potential participant pool was limited due to the difficulty of recruiting adults with autism to participate in research. Individuals in this population can have difficulties with social settings as well as limited communication abilities, leading to individuals not feeling comfortable to participate in research studies (APA, 2013). This may be amplified for this study as the participants were recruited without prior interventions with the researcher,

which could be an unwanted change for potential participants (APA, 2013). Additionally, the researcher had limited contacts with individuals who have autism, or work with individuals who have autism, which limited the network of individuals who were contacted for participation in this study. The sample was also limited in diversity, as all three participants were males under the age of 25, who were high functioning, verbal, and had experience with technology.

Another characteristic of individuals with ASD is that they can be resistant to change (APA, 2013). This has the potential to impact the research study as the participants were provided with an app designed to assist in navigating the Toronto transit system, something that the participants might not do on a regular basis. The three participants did have previous experience with some mobile technologies and the use of apps, attempting to minimize potential stress due to change for the participants. It may be beneficial to provide the participants with the app in advance in order for them to have an increased level of comfort. Additionally, route information was not provided to participants ahead of time so each task would be new and equally as difficult to minimize any biases; this approach may need to be modified for future research in order to minimize anxiety in participants by providing them with additional time to adapt to the app or modifying the app to the participant's habits.

Other challenges that the researcher faced were with the development of the app. Initially, the app was supposed to have a greater number of features that would allow for more customization. Some features included a high-contrast setting, audio turn-by-turn navigation (compared to the visual navigation provided), a feature that

allowed individuals to 'tag' information to routes (sharing knowledge with other users), providing a timer for an estimation of the arrival time of the bus, and features that would allow for custom notifications. Additionally, the researcher had wanted a tool that could track how often/long the app was being used. The initial development of the app was to take approximately four months containing all of the above features. This time was repeatedly extended by the programming team as the individuals were trying to balance school work with other commitments. The delay, combined with other technical imitations, impacted the features that were available. Likewise, these delays impacted the amount of testing that the programming team completed and lead to last minute revisions and minimal time to fix bugs. As such, the app was temperamental and did not always communicate with the servers. The development process did not follow a design model, like Analyze, Design, Develop, Implement, Evaluate (ADDIE) or AGILE, which likely had an impact on the issues surrounding app development. Had the app been working perfectly throughout the research process, there may have been different results in regards to perceived competency and autonomy of the participants. These changes could increase the participant's competence and in turn increase their autonomy, as they would not have to look to the researcher to troubleshoot the app. Additionally, participants mentioned that they were more likely to provide directions to someone if they were confident in their own directions.

Environmental challenges were in place as well for participants. When Aiden was travelling, the weather was a very cold winter day, which may have impacted results. There were fewer individuals on transit than normal allowing for more

decision making time. During Erik and Albert's travels, the weather was an average spring day, however there were a lot of transit delays due to construction in Toronto. At the time of data collection, the city of Toronto was doing construction work on major roads in the downtown core. Data collection was supposed to occur within one and a half to two hours, at a maximum. Unfortunately, due to traffic delays and time limitations (and technical difficulties in Albert's case), Erik and Albert's data collection was cut shorter than anticipated. This decrease the total volume of data collected, as participants were not able to finish the routes, however, the participants were able to experience the two of navigation tasks. Both the participants and the researcher were confident in the time spent for data collection for these individuals.

Recommendations for Future Research

There is potential for some of the aforementioned limitations to be addressed and minimized in future research surrounding this research problem. Although this study provided a lot of insight into the effects of the theoretical framework and transportation app on adults with autism spectrum disorder, there is still much to be gleaned. Future development of the app should be done in order to work though many of the technical difficulties as there were still a number of bugs, and likely more to be discovered. Additional features may be beneficial, including features discussed by the participants. Albert suggested more information on the bus route, including images of bus stops and where they are located, as this will provide more contextualized information for the users. Aiden suggested information on how and when to take a transfer ticket, as this can be a stressful

event for individuals, as discussed in his interview. It would also be interesting to see if having the app beforehand would allow individuals to be more comfortable with its use.

Another variable that could be measured is the amount of time individuals spent using the app. Although the researcher was able to observe app use, there was not an accurate way to determine how often the participant was using the app. This could be implemented within the app by adding a usage tracker.

Additionally, using a specific design model would help increase the quality of the app and reduce stress for all of those involved in the development process. As the app was developed for this research project, it might be beneficial to develop future applications as a joint project between faculties.

Another consideration that could be made is the number of participants. By increasing the number of case studies conducted, this could provide more information on the needs of the diverse population of individuals with ASD, leading to a more inclusive app. The recruitment strategy of the researcher was limited to their network, perhaps partnering with an organization to expand on this research would be beneficial. Additionally, it may be beneficial for the researcher to be familiar with Autism organizations; this could lead to the researcher having greater connections with participants. Although this may lead to potential complications surrounding recruitment, the potential stress caused to the participant when working with a stranger may be reduced. Furthermore, the measurement tools used have not been tested for reliability and accuracy, as their design was to provide insight into the participants' experiences; future research could test the tools that

were created in this study. With greater supports implemented in this study, it could also be expanded to the population of individuals with autism who are also non-verbal or lower functioning.

The framework of this study was designed with inclusivity in mind and can be used to study other populations, including those with developmental disabilities, anxiety, or visual impairments due to the inclusive nature of the app. However, there are some areas of the framework that may need to be reworked. The hypothesis that the individuals would have greater interactions within their community was not supported by the participants' responses, although it was through the researcher's observations. The relationship between the participant and their community could use additional research as the literature supports the increase of community interaction, however this may not work with the intended population. The application of the theoretical framework to other populations is another avenue for research, as other studies can be conducted to look at populations with other developmental disorders, learning disabilities, or the general population. Additionally, this is not limited to the transportation app; other tools or apps could be built using this framework, providing a multitude of research opportunities.

Conclusions

The research question that drove this research project was: What are the effects of an augmented reality app on the development of intrinsic learning in individuals with ASD? To explore this relationship, a transportation app was developed for the Toronto Transit Commission (TTC). Three ethnographic case

studies were conducted to look at the effects of the transportation app on intrinsic learning. The findings of the study suggest that the transportation app influenced levels of self-reported autonomy in some participants, which is supported through researcher observations. Likewise, competence scores increased for Aiden, decreased for Albert, and did not change for Erik. However, researcher observations suggest that Erik displayed competency throughout the tasks, but was hindered by technical difficulties. Albert displayed issues with competency, often relying on the researcher when navigating in both tasks. However, this could be influenced with more time exploring the app and familiarity with the TTC. Relatedness scores increased for Albert, but did not change for Aiden or Erik. It must be noted that all individuals displayed increasing amounts of interaction with the researcher. Participants engaged in discussion with the researcher and were able to answer questions regarding the task at hand. Participants also discussed that they would share this information with a friend, engaging in knowledge sharing. The authentic and situated environment appeared to have been effective in increasing self-reported intrinsic learning. Future research could expand on these findings by improving the transportation app, reworking theories related to community involvement for adults with autism spectrum disorder, and applying the theoretical framework to other populations and tools. Although the transportation app did not prove to be as successful as initially thought, the environment that the individuals were learning in appeared to be beneficial. This is a positive take-away, as it supports a relationship between situated and authentic learning and autonomy and competence and provides areas for improvement and future research.

Reflection

While this concludes the final chapter of this research study, it is not the end of the journey. I look forward to continuing this research as I feel that there are still questions that I want to explore as well as limitations of this study that I would like to address. One avenue that is very interesting is to explore mobile app development and inclusive design in more depth. Throughout my research, I have had the pleasure to work with some fantastic individuals who have, or assist those with, autism. Working with these individuals has opened my eyes to how unbalanced society tends to be. This is something that I will continue to work through, increasing the amount of tools that are available that make use of inclusive design. While recruiting participants, I also noted the difficulty in reaching out to the adult population with ASD. The larger organizations that I contacted were focused on children with ASD; this, unfortunately, reinforced the argument that adults with ASD lack support. This can be changed; more research can provide greater insight to the needs of this diverse population. Furthermore, developing new digital technologies with the theoretical framework presented in this research project could offer greater benefits to the ASD community.

Before I started this research project, I was expecting a very linear path from start to finish. Since then, I have realized that life and learning is not very linear. The path that I took was very messy and full of obstacles that challenged my perspective. I think that this is where so much of my learning came from, the challenges and dissonance that I faced on a regular basis. I have learned a lot about the research

process and I know that I still have a long and messy journey ahead of me, full of valuable lessons.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Autism Speaks (2014). *Autism Speaks Canada facts and stats*. Retrieved from http://www.autismservicesinc.com/pdf/Autism%20Speaks%20Canada%20Updated%20Facts%20and%20Stats.pdf

Autism Speaks (2015). *Scientist to begin beta testing Google Glass autism apps next year*. Retrieved from https://www.autismspeaks.org/news/news-item/scientist-begin-beta-testing-google-glass-autism-apps-next-year

Azuma, R.T. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments, 6*(4), 355-385.

Billinghurst, M., & Dünser, A. (2012). Augmented reality in the classroom, *Computer, 45*(7), 56-63. DOI:10.1109/MC.2012.111

Brown, J.S., Collins, A., & Duguid, P. (1988). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

Burke, R.V., Allen, K.D., Howard, M.R., Downey, D., Matz, M.G., & Bowen, S.L. (2013). Tablet-based video modeling and prompting in the workplace for individuals with autism. *Journal of Vocational Rehabilitation, 38*, 1-14. DOI: 10.3233/JVR-120616

Campillo, C., et al. (2013). Using Tic-Tac software to reduce anxiety related behavior in adults with autism and learning difficulties during waiting periods: A pilot study. *Autism, 18*(3), 264-271. DOI:10.1177/1362361312472067

Cheng, Y., Moore, D., McGrath, P., & Fan, Y. (2005, July). Collaborative virtual environment technology for people with Autism. Paper presented at the 5th IEEE International Conference on Advanced Learning Technologies (ICALT'05), Kaohsiung, Taiwan.

Community Living. (2003). *It's a matter of rights.* Essex, Canada: Community Living Essex County.

Deci, E. L., & Ryan, R. M. (1990). A motivational approach to self: Integration in personality. In R. D. Dienstbier (Ed.), *Nebraska symposium on motivation: Vol. 38, Perspectives on motivation* (pp. 237-288). Lincoln: University of Nebraska Press.

Desbiens, B.L. (2011, April). Student testing: Why Ontario's on the right track. *In the Know with EQAO*, 1-2.

Desjardins, F., (2010). *Theoretical framework*. Retrieved from https://www.youtube.com/watch?v=EcnufgQzMjc

Desjardins, F. & vanOostveen, R. (2008, April). Collaborative Online Learning Environment: from PBL theory to working prototype. Paper presentation at the 1st annual conference for the Canadian Network for Innovation in Education (CNIE), Banff, AB.

Di Serio, A., Blanca Ibáñez, M., & Delgado Kloos, C. (2012). Impact of an augmented reality system on students' motivation for a visual art course. *Computers & Education*, 1-11. DOI:10.1016/j.compedu.2012.03.002

Escobedo, L., Nguyen, D.H., Boyd, L.A., Hirano, S.H., Rangel, A., Garcia-Rosas, D., … Hayes, G.R. (2012, May). MOSOCO: A mobile assistive tool to support children

with autism practicing social skills in real-life scenarios. Paper presented at the SIGCHI Conference on Human Factors in Computing Systems, Austin, Texas.

Feiner, S., MacIntyre, B., & Seligmann, D. (1993). Knowledge-based augmented reality. *Communications of the ACM, 36*(7), 53-62.

Feldman, R., & Dinardo, A. (2012). *Essentials of understanding psychology* (4th Canadian ed.). USA: McGraw-Hill Ryerson.

Gal, E., Bauminger, N., Goren-Bar, D., Pianesi, F., Stock, O., Zancanaro, M., & Weiss, P.L. (2009). Enhancing social communication of children with high functioning autism through a co-located interface. *AI and Society, the Journal of Human-Centred Systems, 24*(1), 1-17.

Gentry, T., Lau, S., Molinelli, A., Fallan, A., & Kriner, R. (2012). The Apple iPod Touch as a vocational support aid for adults with autism: Three case studies. *Journal of Vocational Rehabilitation, 37,* 75-85. Doi: 10.3233/JVR-2012-0601

Gerhardt, P.F. (n.d.). *The current state of services for adults with autism.* Retrieved from http://www.afaa-us.org/about/history/think-tank.

Glass at Work (2015). *Glass at work*. Retrieved from https://developers.google.com/glass/distribute/glass-at-work

Golan, O., & Baron-Cohen, S. (2006). Systemizing empathy: Teaching adults with Asperger syndrome or high-functioning autism to recognize complex emotions using interactive multimedia. *Development and Psychopathology, 18*, 591-617. DOI: 10.10170S0954579406060305

Google Glass (2015). Retrieved March 2, 2015 from Wikipedia: http://en.wikipedia.org/wiki/Google_Glass

Griffin, M.M. (1995). You can't get there from here: Situated learning, transfer, and map skills. *Contemporary Educational Psychology, 20*, 65-87.

Grynszpan, O., Weiss, P.L., Perez-Diaz, F., & Gal, E. (2014). Innovative technology-based interventions for autism spectrum disorders: A meta-analysis. *Autism, 18*(4), 346-361. DOI: 10.1177/1362361313476767

Haddon, M. (2009). Asperger's and autism. Retrieved from: http://www.markhaddon.com/aspergers-and-autism

Haddon, M. (2004). *The curious incident of the dog in the night-time.* Toronto: Anchor Canada

Hammersley, M., & Atkinson, P. (2007). *Ethnography: Principals in practice* (3rd). New York: Routledge.

Hendricks, D. (2010). Employment and adults with autism spectrum disorders: Challenges and strategies for success. *Journal of Vocational Rehabilitation, 32*, 125-134. DOI: 10.3233/JVR-2010-0502

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development, 48*(3), 23-48.

Hourcade, J.P., Bullock-Rest, N.E., & Hansen, T.E. (2011). Multitouch tablet applications and activities to enhance the social skills of children with autism spectrum disorders. *Pers Ubiquit Comput, 16*, 157-168. DOI: 10.1007/s00779-011-0383-3

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

Hussein, A. (2009). The use of triangulation in social sciences research: Can qualitative and quantitative methods be combined? *Journal of Comparative Social Work, 1*, 1-12.

Inclusive Design Research Centre [IDRC] (2015). *Inclusive Design Research Centre*. Retrieved from http://idrc.ocad.ca/

Jonassen, D.H., Peck, K.L. & Wilson, B.G. (1999). *Learning with technology: A constructivist perspective*. New Jersey: Prentice Hall.

Kaufmann, H., & Schmalstieg, D. (2003). Mathematics and geometry education with collaborative augmented reality. *Computers & Graphics, 27*(3), 339-345.

Kearney, M., & Shuck, S. (2006). Spotlight on authentic learning: Student developed digital video projects. *Australasian Journal of Educational Technology, 22*(2), 189-208.

Korkmaz, B. (2011). Theory of Mind and neurodevelopmental disorders of childhood. *Pediatric Research, 69*, 101-108. DOI:10.1203

Lave, J. (1991). Situating learning in communities of practice. In L.B. Resnick, J.M. Levine, & S.D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 63-82). Washington: American Psychological Association.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.

MacKay, T., Knott, F., Dunlop, A. (2007). Developing social interaction and understanding in individuals with autism spectrum disorder: A groupwork intervention. *Journal of Intellectual & Developmental Disability, 32*(4), 279-290. Doi: 10.1080/13668250701689280.

McLester, S. (2011). An app for that…and that…and that. *T H E Journal, 38*(2), 19-20.

Morrison, A., Oulasvitra, A., Peltonen, P., Lemmela, S., Jacucci, G., Reitmayr, G… Juustila, A. (2009, April). Like bees around the hive: a comparative study of a mobile augmented reality map. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Oulu, Finland.

MTCU (2015). *Published College Program Standards*. Retrieved from http://www.tcu.gov.on.ca/pepg/audiences/colleges/progstan/

Nicaise, M., Gibney, T., & Crane, M. (2000). Toward an understanding of authentic learning: Student perceptions of an authentic classroom. *Journal of science education and technology, 9*(1), 79-94.

O'Donnell, V.L., Tobbell, J. (2007). The transition of adult students to higher education: Legitimate peripheral participation in a community of practice? *Adult Education Quarterly, 57*(4), 312-328. DOI: 10.1177/0741713607302686

Open Data (2015). *Accessing City Hall*. Retrieved from http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=9e56e03bb8d1e310VgnVCM10000071d60f89RCRD

Piaget, J. (1965). The stages of the intellectual development of a child. In B.A. Marlowe & A.S. Canestrari (Eds). *Educational psychology in context: Readings for future teachers* (pp. 98-106). California, USA: Sage Publications Inc.

Popper, K. (2002). *Conjectures and refutations: The growth of scientific knowledge.* New York, USA: Routledge.

Putman, C., & Chong, L. (2008). Software technologies designed for people with autism: What do users want? Paper presentation at ASSETS'08, Halifax, Canada.

Ryan, R.M. & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychological Association, 55*(1), 68-78. DOI: 10.1037110003-066X.55.1.68

Samsung (2015). *The Look At Me project*. Retrieved from http://pages.samsung.com/ca/lookatme/English/

Savin-Baden, M. (2007). *A practical guide to problem based learning online*. New York: Routledge.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 97-118). New York: Cambridge University Press.

Schalock, R. L. (2000). Three decades of quality of life. *Focus on Autism And Other Developmental Disabilities, 15,* 116-127.

Sibley, A., Kersten, P., Ward, C.D., White, B., Mehta, R., & George, S. (2006). Measuring autonomy in disabled people: Validation of a new scale in a UK population. *Clinical Rehabilitation, 20*, 793-803.

Sitdhisanguan, K., Chotikakamthorn, N., Dechaboon, A., & Out, P. (2011). Using tangible user interfaces in computer-based training systems for low-functioning autistic children. *Pers Ubiquit Comput, 16*, 143-155. DOI: 10.1007/s00779-011-0382-4

Toronto Transit Commission (2015). Retrieved May 28th 2015 from Wikipedia: http://en.wikipedia.org/wiki/Toronto_Transit_Commission

TTC (2015). *Riding the TTC*. Retrieved from https://www.ttc.ca/Riding_the_TTC/Frequently_Asked_Questions/Service_Information.jsp

Union Station (2015). Retrieved May 28th 2015 from Wikipedia: http://en.wikipedia.org/wiki/Union_Station_%28Toronto%29

Wehlage, G.G., Newmann, F.M., & Secada W.G. (1996). Standards for authentic achievement and pedagogy. In F.M. Newmann & Associates (Eds.), *Authentic achievement: Restructuring schools for intellectual quality*, (pp. 21-29). San Francisco: Jossey-Bass.

Wenger, E. (2009). A social theory of learning. In K. Illeris (Ed.), *Contemporary theories of learning: Learning theorists… in their own words* (pp. 209-218). New York, NY: Routledge.

Whitney, L. (2014). *Android loses some US market share but remains top dog.* Retrieved from http://www.cnet.com/news/android-loses-some-us-market-share-but-remains-top-dog/

Wood, D., Bruner, J., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Child Psychiatry, 17*, 89–100.

von Glasersfeld, E. (1989a). Constructivism in education. In T. Husen & T. N. Postlethwaite, (Eds.), *The international encyclopedia of education, supplement* (Vols. 1), (pp. 162–163). New York: Pergamon Press.

von Glasersfeld, E. (1989b). Cognition, construction of knowledge, and teaching. *Synthese, 80*(1), 121-140.

von Glasersfeld, E. (1987). Learning as a constructive activity. In C. Janvier (Ed.) *Problems of representation in the teaching and learning of mathematics*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Vygotsky, L. (1978). Interaction between learning and development. In M. Cole, V. John-Steiner, S. Scribner & E. Souberman, (Eds, Trans.) *Mind and society* (pp. 79-91). Cambridge, MA: Harvard University Press.

Appendix A

Participant Documents

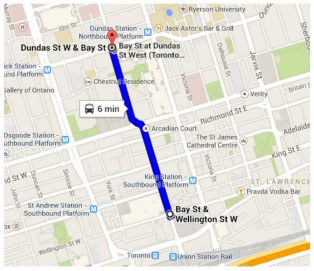
Bus routes.

Route Info – Without App

Easy

Start: Bay & Wellington
End: Dundas & Bay

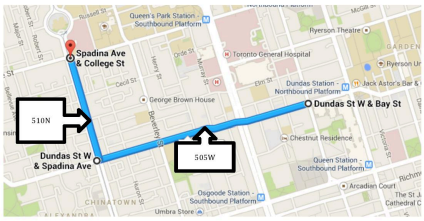
Directions:
1. Take 6B Bus North to Dundas



Medium

Start: Dundas & Bay
Stop 1: Spadina & Dundas
End: Spadina & College

Directions:
1. Take 505W Streetcar to Spadina
2. Take 510N Streetcar to College



Hard

Start: Spadina & College
Stop 1: College & Bathurst
Stop 2: Bathurst & King
End: Bay & King

Directions

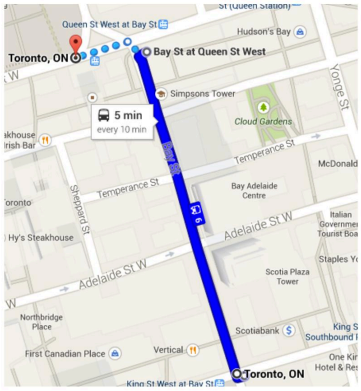
1. Take 506W Streetcar to Bathurst
2. Take 511S Streetcar to King
3. Take 504E Streetcar to Bay

Route Info – With App

With App

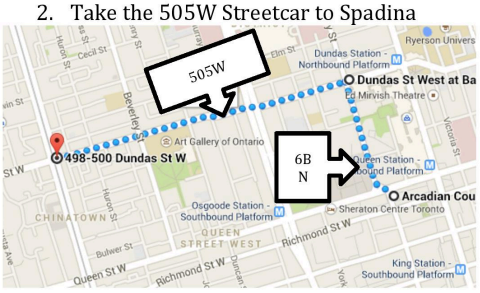
Easy
Start – Bay & King – 199 Bay St Toronto
End – Queen & Bay – 394 Bay St Toronto

Directions:
1. Take the 6B North Bus to Queen



Medium
Start – Queen & Bay – 394 Bay St Toronto
Stop 1 – Bay & Dundas – 570 Bay St Toronto
End – Dundas & Spadina – 283 Spadina Ave Toronto

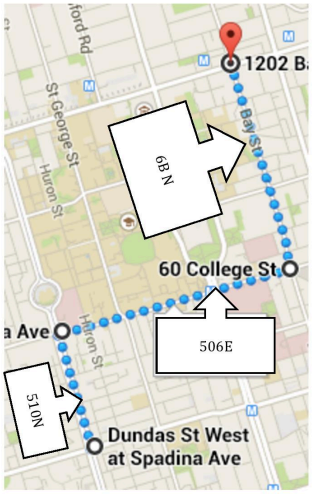
Directions:
1. Take the 6B N Bus to Dundas
2. Take the 505W Streetcar to Spadina



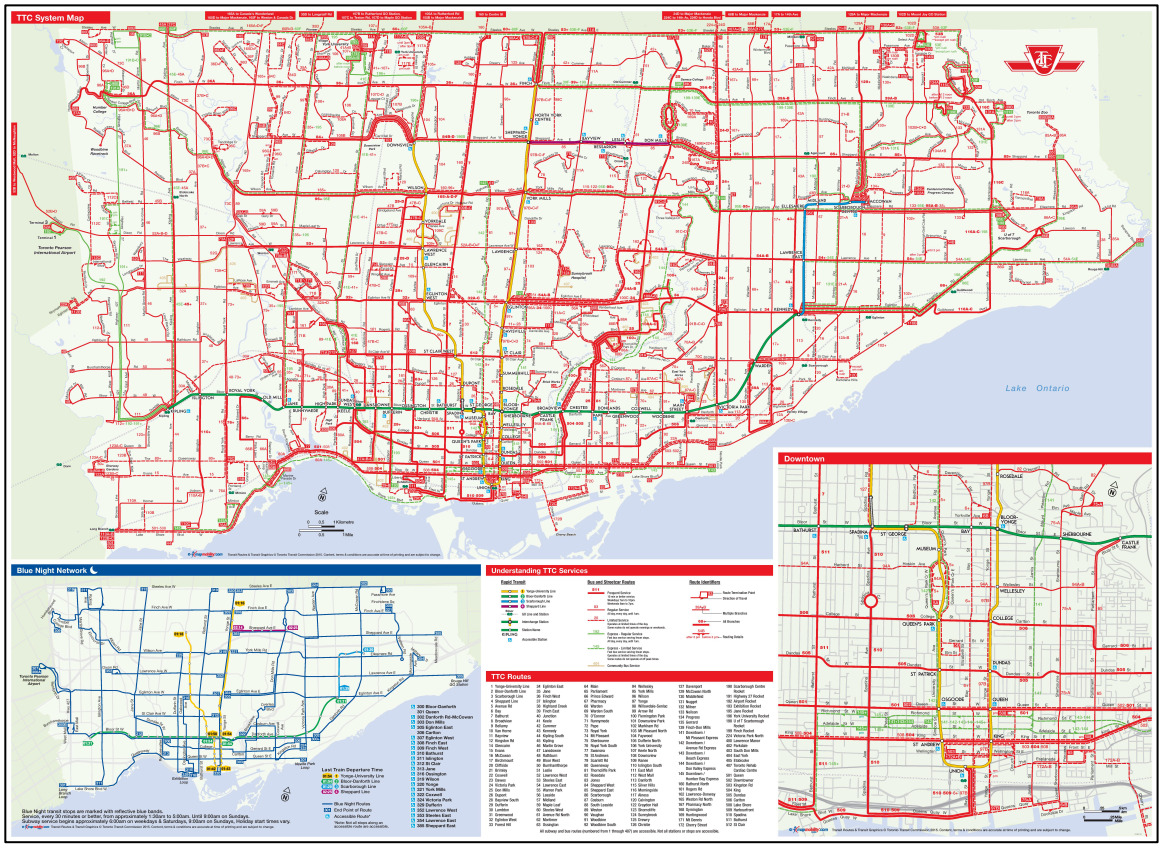
Hard
Start – Dundas & Spadina – 283 Spadina Ave Toronto
Stop 1 – College & Spadina – 455 Spadina Ave Toronto
Stop 2 – Bay & College – 790 Bay St Toronto
End –Bay & Bloor – 1170 Bay St Toronto

Directions:

1. Take the 510N Streetcar to College
2. Take the 506E Streetcar to Bay
3. Take the 6B N Bus to Bloor



TTC map.


TTC System Map
Lake Ontario
Downtown
Blue Night Network
Understanding TTC Services
TTC Routes

Participant instructions.

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY
BOX 385, 11 SIMCOE STREET NORTH
OSHAWA, ONTARIO, CANADA L1H 7L7
T 905.721.3181
F 905.721.1707
www.education.uoit.ca
www.uoit.ca

UOIT
CHALLENGE INNOVATE CONNECT

FACULTY OF EDUCATION

Exploring Situated Learning in Augmented Reality Apps for Adults with Autism Spectrum Disorder

REB File (14-038)

Participant instructions

- This research experiment will have you navigating the TTC to multiple locations.
- You will be asked to use the TTC to travel between locations with and without a navigation app. You will be provided with route information that includes bus route information, a map, and the stop you will be getting off at. You will also be provided with a TTC route map.
- The researcher will be with you at all times and can answer any questions that you might have.
- There are two routes that you will be navigating between, one with the app and one without. Each route will have three different levels – easy, medium, and hard.
- Before, in between the two routes, and after the navigation is complete you will be asked to fill out a questionnaire, and then participate in an interview.
- You may withdraw from this study at any point by letting the researcher know. You can also decide not to answer questions in the questionnaire or interview.
- If you need a break at any point, let the researcher know and the research will be paused until you are ready to continue.
- You will be using a android phone provided by the researcher, you will have to give this back to the researcher at the end of the navigation portion of the study.
- When using the phone, you must be sitting or standing. Do not use the phone while walking, as this can be distracting.

Help guide.

[HELP GUIDE]
Help Guide

If the individual appears to be going in the wrong direction

1. Ask if they would like some help
2. Provide the next step of directions

If the individual says 'no':

1. Ask them to explain the route they are taking
2. If appropriate, allow them to take that route

If the route is off track:

1. Tell them that we should take the route according to the map
2. Show them what directions to take

If they are experiencing anxiety:

1. Ask if they would like to take a break (refer to "Time Out" strategy)
2. Diffuse anxiety according to CPI guidelines

Time Outs

- Time Outs will be provided to all participants when needed, this will be a period of time where the participant can rest, regroup, or even use a restroom. Participants will be reassured that this time will not be counted towards the research process. When the participant is ready, they will be asked if they would like to continue the research process or stop the study. If they would like to continue, ask for their (or guardian's) consent to continue the study.

Briefing/Debriefing script.

Briefing Script

This research project will be used for my Master's thesis titled Exploring Situated Learning in Augmented Reality Apps for Adults with Autism Spectrum Disorder. This research project aims to look at the effects of an iOS app that uses augmented reality, communities, and situated learning on intrinsic learning. You will be asked to navigate transit with and without the app to determine the app's effectiveness. You will be asked to complete surveys that will serve as data for the research project. Do you have any questions?

Debriefing Script

Thank you again for participating in this research study. Your participation helped tremendously in determining the effectiveness of our app on intrinsic learning. The following are goals we aim to meet with this research project:

- To determine if an environment that uses augmented reality, communities, and situated learning will create an authentic learning environment which will promote intrinsic learning in adults with autism spectrum disorder

The data that we collected through questionnaires and through observation will serve as our data to be analyzed.
Do you have any questions?

Appendix B

Recruitment Documents

Recruitment poster.

[RECRUITMENT POSTER]

DO YOU HAVE AUTISM SPECTRUM DISORDER?

WE ARE LOOKING FOR RESEARCH PARTICIPANTS

UOIT graduate student is looking for participants with Autism Spectrum Disorder to participate in a thesis study. Participants must be 18-30 and be familiar with riding the TTC.

This study will look at the effectiveness of a transportation app on intrinsic learning.

Participation in this study is completely voluntary; all information will be kept confidential.

If you would like to volunteer or if you have any further questions, please contact Jessica.clarkson@uoit.ca

Recruitment posting.

[RECRUITMENT POSTING]

Do you have autism spectrum disorder? We are looking for research participants!

UOIT Graduate student is looking for participants with Autism Spectrum Disorder to participate in a thesis study.

This study will look at the effectiveness of an iOS App on intrinsic learning.

Participation in this study is completely voluntary; all information will be kept confidential.

If you would like to volunteer or if you have any further questions, please contact Jessica.clarkson@uoit.ca

Communication script.

[RECRUITMENT SCRIPTS/EXCLUSION QUESTIONS]

E-mail

<Greeting>

My name is Jessica Clarkson. I will tell you a bit about myself and discuss the research project with you. I am a Master's student at UOIT where I am studying Education and Digital Technology. As part of my thesis requirements, I am completing a study that looks at technology and adults with Autism Spectrum Disorder.

If you are interested in participating in this study, you will be invited to participate in a training session on how to use the app. After the training session has been completed you will complete a brief online questionnaire. Following the questionnaire, you will be asked to navigate to different locations using TTC without the app. Afterwards you will complete a brief questionnaire and then be asked to navigate to different locations using the app. Lastly, you will complete a second brief questionnaire as well as participate in a short informal interview with the researcher. Participation is completely voluntary and does not affect your relationship with any Autism organizations.

Before we move on to the next step of the research process, I have a few questions for you.

- Do you have Autism Spectrum Disorder (or Asperger's)?
- How old are you?
- Are you able to use an iPod/iPhone? How often have you used one in the past? When was the last time you used an iPod or iPhone?
- How often do you use the TTC? How many times have you used the TTC in the past month? Do you normally ride by yourself or with a caregiver?
- Do you live independently or with a caregiver?
- Do you require any supports for reading or typing?
- How did you find out about this study?

Please respond to this e-mail with your answers and if you are interested in participating in this study, we will send you a letter of invitation and consent form, which need to be filled out. Do you have any questions?

If you prefer to talk on the phone, you can reach me at (416) 564-9335.

[RECRUITMENT SCRIPTS/EXCLUSION QUESTIONS]

E-mail

<Greeting>

My name is Jessica Clarkson. I will tell you a bit about myself and discuss the research project with you. I am a Master's student at UOIT where I am studying Education and Digital Technology. As part of my thesis requirements, I am completing a study that looks at technology and adults with Autism Spectrum Disorder.

If you are interested in participating in this study, you will be invited to participate in a training session on how to use the app. After the training session has been completed you will complete a brief online questionnaire. Following the questionnaire, you will be asked to navigate to different locations using TTC without the app. Afterwards you will complete a brief questionnaire and then be asked to navigate to different locations using the app. Lastly, you will complete a second brief questionnaire as well as participate in a short informal interview with the researcher. Participation is completely voluntary and does not affect your relationship with any Autism organizations.

Before we move on to the next step of the research process, I have a few questions for you.

- Do you have Autism Spectrum Disorder (or Asperger's)?
- How old are you?
- Are you able to use an iPod/iPhone? How often have you used one in the past? When was the last time you used an iPod or iPhone?
- How often do you use the TTC? How many times have you used the TTC in the past month? Do you normally ride by yourself or with a caregiver?
- Do you live independently or with a caregiver?
- Do you require any supports for reading or typing?
- How did you find out about this study?

Please respond to this e-mail with your answers and if you are interested in participating in this study, we will send you a letter of invitation and consent form, which need to be filled out. Do you have any questions?

If you prefer to talk on the phone, you can reach me at (416) 564-9335.

Letter of invitation.

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY
BOX 385, 11 SIMCOE STREET NORTH
OSHAWA, ONTARIO, CANADA L1H 7L7
T 905.721.3181
F 905.721.1707
www.education.uoit.ca
www.uoit.ca

UOIT
CHALLENGE INNOVATE CONNECT

FACULTY OF EDUCATION

[LETTER OF INVITATION]

Exploring Situated Learning in Augmented Reality Apps for Adults with Autism Spectrum Disorder

REB File (xx-xxx)

Dear [Participant Name],

You are invited to participate in a research study investigating learning and digital technology in adults with Autism Spectrum Disorder (ASD). Below, you will find the purpose of the study, a brief description of your involvement in the study, your rights and responsibilities as a participant, as well as a consent section to fill in if you wish to participate in the research study. Please note that participation is completely voluntary and you are able to withdraw from the study at any time. Participation in this study has no bearing on any services received from Autism organizations. Data retrieved will be kept confidential and anonymous.

Purpose of the Study

The use of digital technology as a tool for individuals with Autism Spectrum Disorder has been studied numerous times, however most studies focus on children with ASD. Unfortunately, the use of digital technology for adults with Autism Spectrum Disorder has not been studied as extensively. This study will attempt to bridge that gap by looking at the implications of learning and digital technology on adults with ASD. To do this, a navigation app has been developed for iPhones/iPods that provides users with transit information for TTC. This study will be the basis of my Master's of Education and Digital Technology thesis.

Methodology

If you are interested in participating in this study, you are welcome to bring along a guardian or caregiver. You will be invited to participate in a training session on how to use the app. After the training session has been completed you will complete a brief online questionnaire. Following the questionnaire, you will be asked to navigate to different locations using TTC without the app. Afterwards you will complete a brief questionnaire and then be asked to navigate to different locations using the app. Lastly, you will complete a second brief questionnaire as well as participate in a short informal interview with the researcher.

Publication of Results of Study

After the completion of the study, results can be made available by contacting the researcher at jessica.clarkson@uoit.ca. Results will be available in July 2015.

If you would like to participate in this study, please e-mail jessica.clarkson@uoit.ca. If you have any questions or comments about the study, please contact the principle investigator, Jessica Clarkson (jessica.clarkson@uoit.ca), or research supervisor, Dr. Roland van Oostveen. If you have any questions about your rights as a research participant, please contact the Compliance Office (compliance@uoit.ca or 905 721 8668 ext. 3693).

Sincerely,

Jessica Clarkson
jessica.clarkson@uoit.ca

Dr. R. van Oostveen
roland.vanoostveen@uoit.ca

Consent letter.

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY
BOX 385, 11 SIMCOE STREET NORTH
OSHAWA, ONTARIO, CANADA L1H 7L7
T 905.721.3181
F 905.721.1707
www.education.uoit.ca
www.uoit.ca

UOIT
CHALLENGE INNOVATE CONNECT

FACULTY OF EDUCATION

Exploring Situated Learning in Augmented Reality Apps for Adults with Autism Spectrum Disorder

REB File (14-038)

This research project is being conducted by Jessica Clarkson under the supervision of Roland van Oostveen, within the Faculty of Education at the University of Ontario Institute of Technology in Oshawa, Ontario.

The Study: You have been invited to participate in a research study investigating learning and digital technology in adults with Autism Spectrum Disorder (ASD). We are studying the effects of a mobile transportation app on intrinsic learning.

Procedure: During this study, you will be asked to navigate Toronto Transit Commission (TTC) streetcars and buses. You will be asked to navigate different TTC routes, first with route information and instructions on paper and second with a transportation app. These routes with have three levels of difficulty: easy, medium, and hard. You will have all of the tools needed to complete these routes including instructions and maps. The researcher will be present with you at all times and you may bring along a caregiver or guardian. The University will pay for all TTC tokens; there is no cost to you. Before, during, and after the study you will be asked to complete questionnaires about your feelings of the tasks. You will also be asked some questions in an interview, at the Toronto Reference Library, that will be recorded. Each route will take approximately 30 minutes (60 minutes total) with 35 minutes for questionnaires and interviews (5 minutes per questionnaire and a 20-minute interview), for a total of one hour and 35 minutes. The study will be conducted during non-rush hour times.

Risks: You will be asked to navigate TTC with and without a transportation app. Based on your previous experience, most risks that may occur are those that you have already experienced. These include stress associated with being in a bus or a streetcar, embarrassment or anxiety associated with participating in a research study, being identified with Autism Spectrum Disorder in public, or feeling coerced into participating in this study. This risks have been considered by the researcher by traveling during non-rush hour times to reduce the number of individuals on the bus or streetcar, as well as completing all questionnaires/notes on electronic devices which will not stand out. The app is designed to look like a regular transportation app so it will not stand out. Also, participation in this study is strictly voluntary and will not reflect on any services you receive from any Autism organizations.

Benefits: By participating in this study you will be making a helpful contribution to Autism research. Through this research we can help develop more tools to support individuals with ASD. Additionally, you will be able to gain new knowledge in working with digital tools and apps.

Study Participation: Your participation in this study is completely voluntary. Participation in this study will not affect any services received from any Autism organizations.

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY
BOX 385, 11 SIMCOE STREET NORTH
OSHAWA, ONTARIO, CANADA L1H 7L7
T 905.721.3181
F 905.721.1707
www.education.uoit.ca
www.uoit.ca

UOIT
CHALLENGE INNOVATE CONNECT

FACULTY OF EDUCATION

Right to Withdraw: You may withdraw from this study at any point, without any penalty. If you decide to withdraw, all data collected up to that point would be destroyed. There are no negative repercussions of withdrawing from this study and you may do so at any moment by telling the researcher that you do not wish to continue. You may also indicate that you do not wish to continue by not answering questions during the interview and questionnaires.

Confidentiality: Your confidentiality will be preserved at all times. All information collected will be held in the strictest of confidence. Any data collected will be coded and your name will not be used. Also, all data will be stored on a password-protected computer, in password-protected folders, that only the researchers will have access to.

Data Use: The data collected will be used for a Master's thesis and may be used for conference presentations, journal publications, and/or academic books. All information collected will be kept confidential and anonymous throughout these events.

Data Collection
If you agree to this research study, the following methods of data collection will be used:

- Video recording of interviews
- Audio recording of interviews
- Responses on questionnaires
- Observations made by researcher

Device Use: During the study, you will be using an Samsung Galaxy SIII that is the property of the EI Lab at the University of Ontario Institute of Technology. The phone must be returned to the researcher at the end of the study. It is expected that you will be careful with the phone, however if there is any damage done to the phone you will not be held responsible.

Questions
If you have any questions about this study please feel free to contact the researcher, Jessica Clarkson (jessica.clarkson@uoit.ca). If you have any questions about your rights as a research participant, please contact the Compliance Office (compliance@uoit.ca or 905 721 8668 ext. 3693).

If you agree to participate in the study, please complete and sign this form.
Thank you so much for supporting our research!

Sincerely,

Jessica Clarkson

Dr. R. van Oostveen

By e-mail:
Jessica.clarkson@uoit.ca

Roland.vanoostveen@uoit.ca

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY
BOX 385, 11 SIMCOE STREET NORTH
OSHAWA, ONTARIO, CANADA L1H 7L7
T 905.721.3181
F 905.721.1707
www.education.uoit.ca
www.uoit.ca

UOIT
CHALLENGE INNOVATE CONNECT

FACULTY OF EDUCATION

Research Consent

Name (please print clearly): _____

1. I have read the above information and have had any questions answered to my satisfaction.

2. I understand that I will be participating in the study called Exploring Situated Learning in Augmented Reality Apps for Adults with Autism Spectrum Disorder. I understand that this means that I will be asked to navigate TTC with and without an app and participate in an interview.

3. I understand that my participation in this study is voluntary and I may withdraw at any time.

4. I understand that every effort will be made to maintain the confidentiality of the data now and in the future. The data may also be published in professional journals or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality. Should you be interested, you are entitled to a copy of the findings.

5. I am aware that if I have any questions, concerns, or complaints, I may contact Jessica Clarkson (jessica.clarkson@uoit.ca), Roland van Oostveen (roland.vanoostveen@uoit.ca) or the Compliance Office at UOIT (compliance@uoit.ca).

6. By agreeing to participate in this research, I do not waive any legal rights.

7. I am entitled to bring a caregiver or guardian to accompany me during this study.

   I would like to bring my caregiver or guardian _____

   I do not wish to bring a caregiver or guardian _____

I have read the above statements and freely consent to participate in this research:

Signature: _____ Date: _____

Emergency Contact
Please list the name of whom you would like to be contacted in case of an emergency. This individual should be different than the caregiver accompanying you (if desired).

Primary	Secondary
Name: _____	Name: _____
Phone number: _____	Phone number: _____
Relationship: _____	Relationship: _____

Appendix C

Data Collection Materials

Questionnaires.

Note: Questionnaires #1-3 have the same questions and formatting.

Exploring
Situated Learning in Augmented Reality Apps for Adults with Autism Spectrum Disorder - Questionnaire #1

Thank you for participating in this questionnaire. Before you begin, please note the following:
•We will be asking you some questions, if you do not feel comfortable answering any of these questions, you can skip the question.
•Participation is completely voluntarily, so you are able to decline participating in this questionnaire without any consequence. In order to decline participation, do not complete any questions or exit the survey. All of your data will be deleted.
•Your responses will be collected as data for this research project, however your identity will remain confidential and you will remain anonymous, outside of the researcher (myself) and my supervisor (Dr. Roland van Oostveen).
•We are using SurveyMonkey, which uses American servers and therefore complies with the Patriot Act, we will not be collecting personal information on this survey nor will any data be stored on SurveyMonkey after the initial data collection.

This research project has been reviewed and approved by UOIT's Research Ethics Board. The assigned REB number is 14-038. If you have any questions, please contact Jessica Clarkson at jessica.clarkson@uoit.ca.

Next

Exploring
Situated Learning in Augmented Reality Apps for Adults with Autism Spectrum
Disorder - Questionnaire #1

1. What is your identification code? (Enter number)

2. Please rate the following statements on a three-point Likert scale in regards to your current use of TTC

	1 - Disagree	2 - Neutral	3 - Agree
I feel confident in using TTC by myself	○	○	○
I feel confident in using TTC with another individual	○	○	○
I could give someone directions for TTC	○	○	○
I would use TTC by myself	○	○	○
In the past month, I have used TTC effectively	○	○	○
I have been able to navigate TTC without any help	○	○	○
When using TTC, I am able to reach my destination as planned	○	○	○
Sometimes I need to ask others for help riding TTC	○	○	○
I feel comfortable in asking for help when I am riding the TTC	○	○	○
I look up directions before I use the TTC	○	○	○

I feel comfortable making transfers from one bus to the next	○	○	○
I know what to do if a route gets changed or cancelled	○	○	○

3. Using the space below, explain how you would currently manage if a bus route was cancelled?

4. Using the space below, explain how you might currently ask for help on the TTC?

5. Using the space below, explain how you normally plan your bus route

Prev Done

Interview questions.

[INTERVIEW SCRIPT]

Interview:

Thank you for participating in this interview. We will be asking you some questions, if you do not feel comfortable answering any of these questions, you can tell us to skip the question. Participation is completely voluntarily, so you are able to decline participating in this interview without any consequence. All of the data will be deleted. Your responses will be collected as data for this research project, however your identity will remain confidential and you will remain anonymous, outside of the researcher (myself) and my supervisor (Roland van Oostveen). Your responses will be recorded via cameras and audio recordings; this data will be kept confidential, anonymous, and stored on a password-protected laptop kept in my possession.

Autonomy

1. Who do you think was responsible for navigating from point A to point B in the research activity?
   [prompts] The app? The researcher? Your caregiver? You?

2. Do you feel as though you would be able to use this app by yourself?

3. Have you taken transit in the past?
   [If yes] How did this experience compare to previous experiences?
   [If no] Do you think the app helped?

4. Did you feel more or less confident when we went on easy or hard routes? With the app or without the app?

5. Did you feel independent during this research activity? Is this different than how you normally feel when taking the bus?

6. Did you feel that the researcher or your caregiver were directing you or influencing your decisions?

Relatedness

1. Who did you communicate with during the bus rides?

2. Is this different than when you have previously taken the bus?

3. Do you feel more comfortable taking the bus while using this app?

4. Do you feel more comfortable sharing your experience with others?

5. Would you recommend this app to a friend? Why?

Observation list.

[FIELD NOTES]

Participant:

Without App

With App

Appendix D

Data Analysis

Note:

Participant 71 – Aiden

Participant 95 – Eric

Participant 58 - Albert

Quantitative questionnaire responses.

	Questionnaire #1	71	95	58
1	I feel confident in using TTC by myself	3	3	2
2	I feel confident in using TTC with another individual	3	3	3
3	I could give someone directions for TTC	2	2	2
4	I would use TTC by myself	3	3	2
5	In the past month, I have used TTC effectively	3	3	1
6	I have been able to navigate TTC without any help	3	2	1
7	When using TTC, I am able to reach my destination as planned	2	3	2
8	Sometimes I need to ask others for help riding TTC	2	2	2
9	I feel comfortable in asking for help when I am riding the TTC	1	2	1
10	I look up directions before I use the TTC	3	3	3
11	I feel comfortable making transfers from one bus to the next	1	3	1
12	I know what to do if a route gets changed or cancelled	1	3	1

	Questionnaire #2	71	95	58
1	I feel confident in using TTC by myself	3	3	2
2	I feel confident in using TTC with another individual	3	3	3
3	I could give someone directions for TTC	2	2	2
4	I would use TTC by myself	3	3	2
5	In the past month, I have used TTC effectively	3	3	2
6	I have been able to navigate TTC without any help	3	3	2
7	When using TTC, I am able to reach my destination as planned	2	3	2
8	Sometimes I need to ask others for help riding TTC	2	2	3
9	I feel comfortable in asking for help when I am riding the TTC	1	2	2
10	I look up directions before I use the TTC	3	3	3
11	I feel comfortable making transfers from one bus to the next	2	3	2
12	I know what to do if a route gets changed or cancelled	2	3	2

	Questionnaire #3	71	95	58
1	I feel confident in using TTC by myself	3	3	1
2	I feel confident in using TTC with another individual	3	3	2
3	I could give someone directions for TTC	2	2	2
4	I would use TTC by myself	3	3	1
5	In the past month, I have used TTC effectively	3	3	2
6	I have been able to navigate TTC without any help	3	2	2
7	When using TTC, I am able to reach my destination as planned	3	3	2
8	Sometimes I need to ask others for help riding TTC	2	2	2
9	I feel comfortable in asking for help when I am riding the TTC	1	2	2
10	I look up directions before I use the TTC	3	3	3
11	I feel comfortable making transfers from one bus to the next	3	3	2
12	I know what to do if a route gets changed or cancelled	3	3	1

Qualitative questionnaire responses.

Participant - Aiden				
		Questionnaire 1	Questionnaire 2	Questionnaire 3
13	Using the space below, explain how you would currently manage if a bus route was cancelled?	Look up alternative route on phone	Same	Same
14	Using the space below, explain how you might currently ask for help on the TTC?	look up information on ttc website	Same	Same
15	Using the space below, explain how you normally plan your bus route	look up directions on Google maps prior to travel	Same	Same

Participant - Eric				
		Questionnaire 1	Questionnaire 2	Questionnaire 3
13	Using the space below, explain how you would currently manage if a bus route was cancelled?	Look up online or via nearest information source for alternate routes to the same destination within the same approximate time frame	Look up online or with the nearest information source what the best alternate route would be in the same period of time.	Look up alternative routes and methods to reach the same desired destination within a similar time frame.
14	Using the space below, explain how you might currently ask for help on the TTC?	Approach a fellow passenger to seek any help, or try approaching conductors for any support or guidance needed.	ask someone I am currently with their thoughts or ideas on any issue I'm having, or nearest patron or ttc official.	ask someone I am traveling with their thoughts or opinions on the issue, or attempt to ask another pedestrian or ttc official.
15	Using the space below, explain how you normally plan your bus route	usually plan it a day in advance or earlier the same day I plan to use it by looking up the schedules and routes from their websites.	looking up the various routes and schedules that can lead to my desired destinations, either the day of or prior to my travels.	looking up the various routes and schedules to reach my desired destinations, either the dY before or the day of.

Participant - Albert				
		Questionnaire 1	Questionnaire 2	Questionnaire 3
13	Using the space below, explain how you would currently manage if a bus route was cancelled?	Either change travel plans or find an alternate route.	Same	Same
14	Using the space below, explain how you might currently ask for help on the TTC?	Identify the specific problem I have, then ask someone for assistance with that particular problem.	Same	Same
15	Using the space below, explain how you normally plan your bus route	Usually, I only use bus routes that I am somewhat experienced with, so planning a new bus route would involve finding a convenient route and then practising it several times before using it.	Same	Same

Researcher observations.

Participant - Aiden

- Participant has experience taking TTC
- Uses subway to navigate to and from school (Etobicoke to Scarborough)
- Has experience programming – is very familiar with technology
- Uses a Samsung Galaxy Note – familiar with android and Samsung devices

Without App

- Participant almost missed first stop, I quickly let him know which stop we were at and we exited the bus
    - This may have been nervousness due to the first task
    - Also, we were having a conversation so he could have been distracted
- Participant used the map provided to navigate all routes
- Participant was aware that there was an electronic copy of the map as well as other route information, however he used the paper copy instead
- Participant did not have any questions about the route, was able to navigate without any further issues
- Participant was actively engaging in conversation, made conversation about different locations (i.e. CAMH – where his girlfriend works)

With App

- Participant programed the app for the first route, looked at the directions and then put the phone in his pocket and set off
- However, there was some difficulty programming the address as it wasn't recognizing it
- Participant looked at the phone during the bus ride of the first route and then put the phone in his pocket.
- Participant was able to get off the bus at the appropriate stop
- The participant looked at the sheet that listed the routes and maps and realized that the bus was nearly at the stop. We quickly boarded the bus and sat down in empty seats. During that time, the participant plugged the next stop into the app and looked at the directions, then placed it in his pocket.
- The participant kept the paper map in front of him and looked at it before getting off at the right stop.
- For the final route, the participant did not look at the app, but kept the paper in front of him.
- The participant looked confident in his decisions and was able to answer any questions I asked (i.e. "We are going East, right?" "What stop are we getting off at?")
- During this time, the participant was engaging in conversation with me and discussed that him and his girlfriend work on his behaviours, she would politely tell him if his behaviours or conversations were not socially acceptable. He stated that he is able to hold conversations better than other individuals who have ASD.

Participant - Eric

- Participant has experience with TTC
- More experience with Durham Region Transit and Go Transit (to get to Toronto)
- Has experience with technology (smart phones, tablets, etc)

Without App

- Uses paper map to navigate transit
- Participant was reminded a few times that the stop was coming up as participant was talking to researcher about interests (TV shows, etc)
- Participant consistently checked paper map when using transit, when approaching stops, after exiting transit, and when bus/streetcar was approaching
- Participant was very talkative during transit navigation, conversation focused on common interests (TV shows, video games, etc).
- Participant seemed very comfortable during transit

With App

- Transit app had issues with server crashing, used a functionally identical app
- Participant used app often, was checking for updates regularly throughout trip
- Participant programmed first route and watched the app until the bus approached
- Participant let researcher know that they could stay on the bus between Route 1 and Route 2 as it was the same bus that they would be waiting for
- Participant was on a time limit and needed to return to Union Station before 3:00pm. Unfortunately there was construction on Bay St (used repeatedly during transit navigation). At approximately 2:30, participant and researcher discussed what should be done to keep to the time limit. Participant and researcher decided that the navigation with the app would be cut short after completing Routes 1&2 as there was no feasible way to complete route 3 and return to union by 3pm.
- Participant used the app often
- There was a bit of a learning curve with the app
- Participant seemed very comfortable throughout the ride
- Participant voiced some concerns about the app throughout the trip (further discussed in interview)
- Participant also used the paper map instead of just the app during trip
- Participant was able to answer questions of whether we were getting off at this stop

Participant - Albert

- Had experience with TTC, although majority of his experience was based on Durham Region Transit (getting to and from school for the most part, however did use transit to get to other places as well). Also has experience using Go Transit to get to Toronto.
- Does not have a smartphone with data, however has a lot of experience with technology
- Entering Computer Programming program at college, has experience and interest in computers

Without App

- Participant was confident in their ability to navigate transit
- Started towards first bus stop effectively
- Participant was very talkative throughout bus route
- Participant did not use map for the first two routes, relied on researcher to direct him (using help prompts)
- After encouragement from researcher, participant used map for the final route

With App

- Participant asked numerous questions about the app, outside of the needs for research project. Researcher answered all questions
- Participant had difficulty programming first address, researcher provided instruction
- Participant had many complaints about the app in terms of UI and functionality
- App provided a route that was not as practical (backtracked participant)
- Participant spent a lot of time asking questions about the app, really took a lot of time from study
- Participant and researcher completed the first route with difficulty, ran out of time and returned to union as participant's mother was waiting
- Participant tried to navigate to union from last bus stop using the paper map provided to show that it is more effective than the app
- Participant provided a large amount of feedback to researcher about the limitations of app

Interview transcripts

Aiden.

Participant - Aiden
A = Aiden
R = Researcher
Scripted questions are in red
Follow-up questions are in blue

Interview starts at 00:08

R – So the questions themselves, it's a semi-structured interview so basically… we will start with questions and see where it takes us.
A – Alright
R – [silence while researcher is bringing up questions]
R – [mumbling while brining up questions]
R – So the first question… let me just go over this first. We will be asking you some questions, if you do not feel comfortable answering these questions you can just skip them, and we will skip that. Participation is completely voluntary and you can withdraw at any time. Your information will remain confidential. Everything will be destroyed.
R – So, who do you think was responsible for navigating from point A to point B in the research activity?
A – I think I was
R – You were? You've got it? Awesome
A – [nods]
R – Do you feel that you would be able to use the app by yourself?
A – I do believe I would, yea.
R – You have taken transit in the past,
A – yes
R – And how do this compare to previous experiences? Like what you did today, is it similar to what you usually do?
A – Yea, it is fairly similar to my usual experience with transit. For the particular purpose, the app was a bit quirky. It didn't work well with addresses, but if you were going to a particular neighborhood or area it would work pretty well
R – A lot better?
R – Do you usually, do you bring maps or do you use Google maps?
A – I usually use Google Maps on my phone
R – Do you find that helps you with…
A – Yea
R – Your ability to navigate?
A – Oh for sure.
R – What about, does it make you feel… more confident or…
A – Um, there's a certain certainty that I like, knowing exactly what route is going to be serviced when.
R – Yea, I like having my app with me, Google maps or something to know what is going to happen.
A – Yea
R – I wasn't sure if you would like that too

A – mmhmm
R – Did you feel more or less confidence when we went on the easy routes, like just one stop, or the multiple stops?
A – um I think the multi-stop route; I think I had quite a bit of confidence in that one. Because it did have very good directions on the app, once you put the right location in for the destination
R – Yup, definitely. Awesome
R – Question, sorry I am trying to find my question.
A – [laughs]
R – We communicated during the bus ride, do you think that you would communicate with anyone else during the bus ride?
A – Um, I really only communicate during the bus ride if I know them and travelling with them. Like, even if I meet someone I know by coincidence on transit, only sometimes I will interact with them.
R – Yea, if you see someone and you are not quite sure if it is them…
R – Do you talk to people more when you know where you are going or when you don't know where you are going?
A – um, I would say when I know where I am going
R – You feel more confident so you are able to talk?
A – Yep
R – Yep
R – Is this different than when you have previously – we have touched on that. Do you feel more comfortable when using the app, or even having the app with you?
A – Uh, yea I do. It feels like sort of a safety net.
R – Yea. Because I know you didn't use it very much, you seemed to be- you were confidence enough to get around without it, but do you like having something there--
A – Yea
R – --you said as your safety net.
R – Do you feel more comfortable sharing your experiences with others, or helping someone out with directions when you have an app with you?
A – Um, it doesn't really help in that regard. I find if I have to look up something it doesn't seem like I know much about what I am talking about, so I don't want someone to take directions that they might not think that they can be confident in.
R – Ok, that makes sense
R – Would you recommend the app to a friend?
A – I think I would
R – Maybe when it's a little prettier too?
A – Yea, when it is a bit more polished and works a bit better [laughs]
R – Yea [laughing] that is probably a safe answer, absolutely.
R – Any questions or comments that you would like to make?
A – I found that even the difficult routes were a bit easy, like it was mostly the downtown area; there wasn't really a lot of long routes.
R – So do you think that it would make it more interesting?
A – It definitely would make it more interesting if it were a more complicated route to different areas of the city.

R – Yea
R – And what about transfers? You have a Metropass so you don't need transfers
A – Transfers, I am very uncomfortable with obtaining and using transfers. Because I am not sure if I might get a transfer from the wrong time or area.
R – Yea, I get freaked out with transfers too. It stresses me out with knowing – like do you ask for it? Do they give it to you? Can you use it at this place, how do you use it?
A – Yep
R – So that would be interesting, like we kept it easy with that, we didn't have to use transfers…. But adding that complexity.
A – Because that is the main reason I use a Metropass, I don't want to deal with transfers. I just show my card and then I am done.
R – Do you think that if the app had a transfer thing in it, would that help? Like a notification "get a transfer, use it for this"
A – Yea, that would definitely help.
R – Yea? Is there anything else you would want to see the app do?
A – Um, well besides properly accept addresses [laughs]. I think that app was pretty well designed.
R – Ok, so just cleaned a polished and ready to go?
A – Yea
R – Awesome.
R – You are good? Nothing else?
A – I think we are good
R – Awesome! Thank you

<<Transcript ends 08:15>>

Eric.

Participant - Eric: Transcript

E = Eric
R = Researcher
Scripted questions are in red
Follow-up questions are in blue

Interview starts at 00:01

R - Thank you for participating in this interview, I will be asking you some questions. If you do not feel comfortable answering any of the questions, you can skip the question. Participation is completely voluntary; you can decline participating in this interview without any consequence. Data will be deleted. Responses will be collected as data for this research project, however your identity will remain confidential. You will remain anonymous outside of me and my supervisor Roland and the responses will be recorded on video camera just so I can transcribe it later, so I don't have to write stuff down <laughs>. So the first question is looking at autonomy.
Who do you think was responsible for navigating from point A to point B in the research, the app? You?
E – So I am going to have to say between myself and the app? I would say definitely me mostly because the app would tell me but I would ultimately need to know what to do in order to have the app do it.
R – Yea, definitely.
So do you feel as if you would be able to navigate the transit by yourself?
E – Absolutely.
R – Yea. Do you like having the app with you? Did it give you anything? Or even having Google Maps?
E – Um, the app did come in handy in regards to, this was my understanding of how it was working. If would give you the rough estimated time when the next bus or street car would get there, how long it would take. That is not necessarily information that I would have from looking up the different routes and that. So it kept me more up to date in regards to traffic and what the average is.
R – Yea, and how do you usually use transit? Like you said you were looking up schedules and stuff.
E – Yea, for transit usually, whenever I have it I look at where I want to go and look it up the day before, and what the different schedules are and the time frames are and, or if it is a spur of the moment type thing I will either look it up on my phone and at the same time look at the schedules or just determine what route that would get me in terms of destinations and what time frame I need to be there.
R – And you, do you usually use Google maps or a different type of app?
E – Um, Apps and that, this is probably my first time using an app for transit
R – Oh ok
E – I usually just use websites and go based on any news or what their last updates schedules are.
R – Do you print them off or?

E – No I usually either keep the webpage that is it on bookmarked or take a screenshot of it so I can have it on record, or I will have just a photo of it or have it written down from the previous time.
R – Would you use a transportation app in the future?
E – Given how this one was, probably. Like the time frame and that so I will better be able to manage how long it will take me to get to various routes and just to keep track of what my usual routes would be to cross reference to compare to future dates.
R – Yea. Um do you feel more or less confident when you were doing the um without the app. Sorry that was awkwardly worded. Did you feel confident with the first run-through without the app or with the app?
E – Um, I don't think my confidence really changed between the two personally. The app was good to have but it didn't change my knowledge of what the routes were and where they were going.
R – Yea, ok. For sure. Did you feel independent when doing this activity?
E – For the most part, yea.
R – Is that usually how you feel on the bus or transit or anything?
E – Yea
R – Yea. Um <pause> I wrote down a lot of questions and we have covered a lot of them, so. Um, do you, would you… if someone asked you questions would you give them directions? Like if you had the app vs. if you didn't have the app?
E – Um, if I had the app, I would probably use it to get as close, as best directions that I could for them. But also, at the same time for how much I was able to, I found I need to have an understanding of the area that I am in so I would know what streets are what. For the most part. So I would still use the app to try to give them the best directions, well better than what I know from the top of my head.
R – And do you usually talk to people when you are on the bus?
E – Uh, honestly, not usually. If I am with other people, yea I will talk to them but I am not really one to strike up a conversation with a random person.
R – Yea, no for sure. Um, <pause> I think that it is it. Um, yea did you feel more comfortable when you had the app, I guess?
E – Again, for me personally my comfort level didn't change much with not having the app or having the app
R – You were pretty good all around?
E – Yea
R – Ok, and would you? Like would you share your experience with the group that you have, like if you had a really great experience with Google Maps or any sort of transportation thing, do you think you would share that with your friends?
E – Oh yea
R – yea, for sure?
E – Oh definitely, if it would be beneficial to them in any way.
R – Cool, awesome. That's it! Pretty painless.

Interview ends – 06:04

Albert.

Participant - Albert: Transcript

A = Albert
R = Researcher
Scripted questions are in red
Follow-up questions are in blue

Interview starts at 00:03

R – Thanks for participating in this interview. I will be asking you some questions, if you don't feel comfortable answering the questions you can skip the question. Um participation is completely voluntarily… voluntarily <laughs> voluntary. Um, everything, data will be deleted, everything will be confidential. Um, so we can get started.
A – Ok
R – So who do you think was responsible for navigating from point A to point B in the research activity?
A – Um, for which section?
R – For one and then two?
A – For one, yea it was pretty much you.
R - <laughs> ok
A – For section 2, I don't think anyone was responsible <laughs>
R - <laughs> yea.
R – Do you feel as though you would be able to use a working version of that app yourself?
A – Yea I believe I could use that yea,
R – Blue skies?
A – Yea
R – As it stands right now? Probably not?
A – Yea.
R – Did you, you were saying that Durham Region Transit was a little bit trickier than Toronto Transit?
A – It is trickier in that there is less buses that come less often so you have to be a lot more exact in when you get there otherwise you are waiting a half an hour for another bus. Whereas with here, if you get it wrong you have more of an opportunity to fix it by getting on a different bus and heading back. So there are a lot more ways that it could go wrong, but it is much easier to correct your mistakes and head back to where you would be going.
R – Would there be a way that an app could make Durham region, Durham region transit easier?
A – It's not as much that, as it is about…
R – The timing?
A – Yea, it's just that even with the, even with the TTC they generally covers. It almost covers a smaller area than Whitby transit. It covers like only downtown Toronto and that is basically it.

R – Yea, it does go further, pretty far north too but, for what we were focusing on, very small.
A – Yea, yea. It is all very focused, yea it is very focused on you know, College, Wellesley, Dundas, Queen. You know, Spadina, Bay, University…
R – For sure
A – So you know, it is a lot more in the form of a grid for the TTC, whereas in, like the Durham Region Transit the case of like, it's just got like lines going everywhere and you have to think, you have to think ok when is this bus going to get here, when does this bus arrive, like you really have to plan things out because there are a lot of like, the bus that goes there only connects to another route on the other side of town so you have to go there to go the other way. Where here is pretty much a grid so no matter where you are there is probably a bus that goes near you that will lead you to a bus that leads you to your destination or something along those lines.
R – So what do you use when you go on Durham Region Transit? Maps and stuff?
A – Even with Durham Region, I don't use it too, too often. Well I use it often, but whenever I use it, it's generally like a pre-determined route that I already researched. Because it will generally be the one route from home to college or something like that. So I know that route, and there aren't really any surprises there. But in terms of like transferring, I generally don't do that because that adds a whole other layer of complexity, but it seems like the TTC would be a lot easier if I had enough time to prepare, or even just a map that let me know where all the bus routes are.
R – Um, have you ever thought of using like a Google Map or anything on transit?
A – See, I don't really have data, so it would be difficult for me to do that.
R – and so we talked about the static map, would a static map be useful for that? That's not data?
A – I suppose. Yea. Because then, it's basically the equivalent of carrying a ride guide or whatever, but it's in the form of, it's in your phone. So I guess in that case it's convenient but you wouldn't really be able to do anything more than a normal street map would do with the bus routes. With the bus routes marked out, <pause> unless you had it pre marked with all the destinations and paths but that would be unreasonable.
R – And I think that some of them do locations, where you can turn it on and it can show you -ish where to go.
A – But even then it requires some sort of data.
R – huh, well that's a good thing to look into
A – Yea because without data, the map is kind of worthless.
R – Definitely
A – Because I guess you could find like Wi-Fi hotspots, that could be… so you could be out somewhere and be like "oh, free Wi-Fi, I'm going to look up where to go next". Like, bus route that I need to get there, that would be useful. But as like a constant, without data it's not very useful.
R – That's a good point. Do you usually talk to people on the bus? I know we were chatting about video games often-
A – I will talk to people I know, but not really. There are either listening to their music or they are reading something. Like you know, if you are on the bus you do

not want some random person to be like hey-hey- what are you <muttering>. If you are on the bus you are trying to get somewhere.
R – what about directions? Do you give people directions?
A – People generally don't ask? Honestly I am not the best person to ask for directions so generally… If someone is like "hey how do I get to here" I go "hey I am not the person to ask, I wouldn't really know".
R – Do you think if you had an app that would change it?
A – I guess…
R – If you had data?
A – I guess it would change it to a certain degree, I don't know.
R – You still like to-
A – Yea, if they are going to try to get directions from someone, it should be from someone who definitely knows
R – The bus driver?
A – Yea, or someone who definitely knows, who is really experienced with bus routes or something.
R – Yea, that is a good point, um. Did you feel comfortable using the app? Obviously not though.
A – It seemed easy to use, if it worked. It was relatively intuitive, well to a certain degree. Like it was trying, but it didn't know the specifics.
R – It was really trying <laughs> The Thomas the Tank Engine of Apps
A <laughs> it is trying! It's trying but it's not necessarily doing the right thing.
R – Sounds good. Um I think that is it.
A – Alright.

Interview ends – 07:20