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Using Mobile Technology to Improve Autonomy in Students with Intellectual Disabilities in Postsecondary Education Programs

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I am submitting herewith a dissertation written by Catherine Caudle Smith entitled "Using Mobile Technology to Improve Autonomy in Students with Intellectual Disabilities in Postsecondary Education Programs." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

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Using Mobile Technology to Improve Autonomy in Students with Intellectual Disabilities in Postsecondary Education Programs

A Dissertation Presented for the
Doctor of Philosophy Degree
The University of Tennessee, Knoxville

Catherine Caudle Smith
August 2013

Dedication

To my husband

Mark Smith

my sons

Seth and Drew

and my sister

Lori Caudle

Thank you for your love and support throughout my career.

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Abstract

Nationwide there are approximately 200 postsecondary education programs that provide inclusive college experiences for young adults with intellectual disabilities (ID) (Grigal & Hart, 2010). To navigate college campuses, the greater surrounding community, and ultimately competitive employment, young adults with ID need literacy, communication, and navigation skills. The purpose of these two studies was to investigate the effects of mobile technology to improve the autonomy of students with ID enrolled in a postsecondary education program. The purpose of experiment I was to examine the effectiveness of three different communication applications (i.e., text, audio, and video) to send and receive text messages (i.e., iMessage, Heytell, and Tango) for college-aged students with ID. Four students enrolled in a PSE program at a large university in the Southeastern United States participated in experiment I. An alternating treatments design was used to examine if there were differences in the acquisition and communicative understanding of each application. The results indicated that each participant learned how to send and receive text messages using multiple applications. Furthermore, all students improved the quality of communication including grammar and mechanics, relevance and comprehension, and professionalism.

Experiment II examined the effectiveness of a navigation application for three college-aged students with ID also enrolled in a PSE program. Using a withdrawal/reversal ABAB design, students used the Apple iPhone and the Heads Up Navigator application to navigate to novel locations independently. First, students were given a copy of the university map during the baseline phase to walk to an unfamiliar location on campus. During the mobile application phase, students were taught how to operate and use a mobile device and navigation application (i.e., Heads Up Navigator) to navigate to unfamiliar places. Results from Experiment II indicated all students improved navigation skills with 100% nonoverlapping data which indicated a highly effective intervention. Visual analysis procedures were used to evaluate the intervention effects of both studies. Findings from the studies include implications for PSE and adult participants, the viability of mobile technology as an effective tool, and using digital tools to teach leisure and work skills. Recommendations for future research and practice are discussed.

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Chapter 1

Significance of the Problem

The definition of success is different from person to person. Living independently, earning a paycheck, interacting with friends and loved ones, and enjoying an autonomous lifestyle are some indicators of "success". For individuals with intellectual disabilities (ID), success can be defined in a variety of ways. The term intellectual disability is "characterized by significant limitations both in intellectual functioning and in adaptive behavior" (AAIDD, 2011). In the past, many discounted the potential of people with disabilities. According to the National Longitudinal Transition Study 2 (NLTS-2, 2003), young adults with disabilities are perceived by family members as much less likely to pursue postsecondary education (NLTS-2). This is in direct contrast to the goals of many people with ID who desire to continue education past high school and ultimately obtain competitive employment and live as independently as possible (Grigal & Neubert, 2004).

Long-term outcomes are poor for people with ID following traditional secondary instruction (NLTS-2, 2003). Students with ID exiting public high schools in the United States have low employment rates, poor wages and benefits, limited community supports, and low rates of independent living (Grigal & Hart, 2010). In fact, people with disabilities are three times more likely to live in poverty than peers without disabilities (National Council on Disability [NCD], 2011). According to the 2011 National Report on Employment, only 20% of working-aged (i.e., 21 to 64) individuals with intellectual or developmental disabilities are working or looking for work (Butterworth, et al., 2011). Additionally, only 7.2 percent of people with a disability are employed full-time (NCD, 2011). For those people with ID working, the estimated weekly salary is approximately $200 (Butterworth, et al.). Regardless of ability level, employment and career outcomes are closely related to satisfaction and quality of life. For students with ID, work and career are crucially important to independence and self-sustainability (Collet-Klingenberg, 1998).

Independent living and employment are ultimate goals of education. Although the level of independence will vary among people with ID, making decisions and indicating preferences about one's own life are common goals for all people (Test, Richter & Walker, 2012). Despite the personal feelings of satisfaction that come from independence, it is beneficial for family members, and to society as a whole, for people with ID to be independent. For example, families do not have to provide as much support if the individual with a disability can live independently or with a non-family support persons. Dependency results in extra time and financial expenses for families and caregivers, and a lack of autonomy for people with disabilities (NCD, 2011).

It is beneficial to society for people with ID to contribute to the workforce as productive wage-earning, tax-paying citizens. By participating fully as economic consumers, people with ID would be viewed as a "viable market" which would encourage companies to focus on including universal-design principles (design for inclusion and access for all) when developing products and services (NCD, 2011). There are approximately 20.9 million families in the United States who have at least one family member with a disability (U.S. Census Bureau, 2002). Americans with disabilities are the largest minority group in the nation at 18.1% and growing. Rather than relying upon Social Security, Medicare, and disability-related resources of our country, many people with ID are capable of working and contributing to the Nation's economy. However educators and family members must have high expectations for students with ID in order for this to be a reality (Grigal & Hart, 2010). Instead of sheltering or enabling young adults with ID, families and teachers should encourage students to expand their interests and abilities to prepare for life after school. People with ID need to be encouraged to pursue independence as a personal goal and focus on being in control of the decisions that affect their lives.

Post-Secondary Education

Twenty years ago, many people with ID faced a future of dependence and limited potential rather than planning for postsecondary education (PSE) and independent living. Possible postsecondary outcomes have included working in a sheltered workshop and sharing a group home with other residents. Young adults with ID also are less likely than peers without disabilities to live independently, despite an interest and ability to do so. In 2006, there were almost 85,000 people with ID and other developmental disabilities (DD) on the waiting list for residential support and services (Grigal & Hart, 2010). However, education has evolved in the last 20 years to include higher expectations in occupational, independent living, academic, and social outcomes for adults with ID (Grigal & Hart, 2010). Recent changes in legislation such as the Higher Education Opportunity Act of 2008 (HEOA; PL 110-315) have afforded young adults with ID the right to attend PSE programs specifically designed to improve independent living and occupational outcomes. After the HEOA of 2008, adults with a variety of disabilities began to pursue PSE, choose occupations geared toward individual interests and talents, develop meaningful relationships with others, and cultivate independent lifestyles. As of 2010, there were more than 200 PSE programs in the United States for college-students with ID (Grigal & Hart, 2010).

There are several configurations for PSE programs in the United States. Each configuration provides students with a spectrum of supports ranging from intensive (substantially separate model) to minimal supports (inclusive individual model) (Grigal & Hart, 2010). The program configurations include four models: (a) substantially separate, (b) mixed/hybrid, (c) inclusive individual support, and (d) dual-enrollment models (Grigal & Hart, 2010). These model structures range from least (substantially separate) to most inclusive (inclusive model) in relation to interacting with the general university population (no interaction to full-day inclusion). Students in substantially separate programs access facilities on campus, but only participate in specialized classes for students with disabilities. Substantially separate programs offer students the most support, but provide the least inclusive experience. In mixed/hybrid models, students have access to general college courses as auditors, but also engage in PSE program-specific courses that focus on career development and life skills. In the mixed/hybrid model, students are included among the general population part-time and may access university facilities. The inclusive individual support model is the most inclusive program type. In this model, all supports and instruction are individualized. Instead of a program home (centralized location devoted to the program, staff, and students), students are supported by family or an outside agency on the university campus. Lastly, dual-enrollment programs are designed to provide college experiences to students who are still enrolled in high school but desire to pursue educational, social, and career exploration goals in a college environment. Students who are dually-enrolled attend high school part-time, and a PSE program part-time. Each unique configuration offers students individualized options for supports and inclusion within campus communities. Through this unprecedented access to college and university communities, students with ID are afforded opportunities to experience college for the first time.

Students with ID who attended any PSE were twice as likely to be employed as those with only a high school education (Gilmore, Bose, & Hart, 2001). Smith, Grigal, and Sulewskil (2012) found a positive correlation between enrollment in PSE in the United States and employment for youths with cognitive disabilities. In a study of eight students receiving individualized supports to access postsecondary education, Weir (2004) concluded that students who benefited from an inclusive, individualized support model could make the same types of gains as students without disabilities. Weinkauf (2002) interviewed staff at three inclusive individualized postsecondary education (IPSE) programs and identified a number of student outcomes including the development of self-esteem and confidence, improvement in academic skills, the development of job skills, and social status enhancement. In addition, Zafft, Hart, and Zimbrich (2004) examined postsecondary student activities and outcomes. Through a matched cohort study of 20 students with significant disabilities who participated in postsecondary education and 20 students who remained in high school, Zafft et al. found that participation in postsecondary education correlated positively with two employment variables: competitiveness and independence. Employment training appears to be a strength of this type of service delivery. Almost all students were involved in employment training in the community or on the college campus.

Postsecondary education supports students in the pursuit of academic gains, social interactions, and career development. By providing access to campus communities, facilities, and peers without disabilities, students with ID have new opportunities to pursue these goals. The outcomes of PSE include increased independence and career competitiveness. Both of these skills are important when pursuing competitive employment.

Employment

The ultimate goal for transitioning and postsecondary students with ID is to achieve gainful employment. In addition to earning a paycheck, employment has other benefits including: improved status, increased self-worth, and reduced stigma of disability (NCD, 2011). Traditionally, individuals with disabilities have low employment outcomes including reduced hours, wages, or benefits (Frank & Sitlington, 2000). Luftig and Muthert (2005) determined that 36 postsecondary students who previously attended a vocational program during high school with emphasis on technology skills demonstrated higher than average rates of employment and level of income than the national average for people with ID. Despite the occupational improvements, most students in this study were still living at home indicating that independent living skills were not emphasized as much as technical and employment skills during high school.

In transition-aged students, career exploration should start with a broad interest and narrow to a specific job at the end. Researchers have indicated that one of the best predictors of post-school employment is participation in work-based experiences during high school (Lindstrom, Doren, Flannery, & Benz, 2012). Landmark et al. (2010) concluded that employment preparation and a variety of work experiences were among the most substantiated practices in quality transition programs. Transition and PSE work experiences should include job shadowing, unpaid internships, and paid/competitive employment (Landmark et al.). It is also important that the employment staff in secondary and PSE settings are highly trained in job development and in supported employment (Grigal & Deschamps, 2012). This reduces the likelihood of poorly designed work experiences, inadequate transition plans and a lack of interagency collaboration.

Structured work experiences in secondary and PSE settings lay the foundation for a lifetime of paid employment. In high school, best practices for career and work exploration include job shadowing, service-learning, internships, work-based learning, and regular employment with necessary supports. These experiences provide students with a safe environment in which to try new tasks. In PSE, promising practices to help students develop work skills also include internships, apprenticeships, trade school, customized employment, supported employment, and job shadowing (Lindstrom et al., 2012).

One barrier to successful workplace inclusion for students with ID is limited communication and the development of "soft skills" or transferable work skills in the workplace. People with ID often lack communication workplace skills such as conflict management, active listening, and interpreting constructive criticism (Ganzel, 2001; Hendricks, 2010). These are critical skills to maintaining employment. For workers with ID, however, such apparently "easy" interactions may present a real challenge. Communication within the workplace is different for people with disabilities with less frequent opportunities to engage in social conversations and a higher perception of less valuable contributions by coworkers and supervisors (NCD, 2011). There is evidence that workers with intellectual disabilities typically interact less with co-workers at break-times (Parent, Kregel, Metzler, & Twardzik, 1992), engage with a smaller range of co-workers (Storey, Rhodes, Sandow, Loewinger, & Petheridge,1991), and are less involved in workplace joking and teasing (Hatton 1998). Reviewing this literature, Hatton concluded that while people with ID are generally accepted by co-workers they typically do not achieve “a high degree of social integration” (p. 91). People who demonstrate limited skills in communication, problem-solving, conflict management, and other “soft skills” or “people skills” are less likely to have long-term employment and success (Ganzel; Grigal & Hart, 2010).

Self-Determination

In order to succeed in a PSE program or a work environment, problem-solving, self-determination, literacy, communication, and technological skills are essential. Problem-solving skills encompass the ability to: identify the problem, develop a creative solution, and self-analyze the results (Cote et al., 2010; Palmer et al., 2004). Problem-solving is directly related to independence and successful post-school outcomes (Cote et al., 2010). Although problem-solving is highly correlated with visual-perceptual reasoning, which is often a limitation in people with ID, individuals with ID can learn memory, planning, and judgment skills to enhance problem-solving abilities (Masson, Dagnan, & Evans, 2010). In a PSE or a work environment, learners with ID must constantly process situations, make judgment calls, and problem-solve. In one study, students with mild and moderate ID used a real-world problem solving strategy to improve problem-solving abilities (Cote et al., 2010). The strategy focused on three steps: (a) identify the problem, (b) create a solution, and (c) determine if the solution was successful. In a similar study, O’Reilly et al. (2004) taught social skills to adults with ID using the problem-solving strategy. All participants generalized and maintained problem-solving skills over an extended period of time.

Problem-solving is part of the framework of “self-determination” (Field, Martin, Miller, Ward & Wehmeyer, 1998). Pioneered by Michael Wehmeyer (1998b), self-determination focuses on student-centered methods of instruction and learning that incorporates choices for all students. A central theme of self-determination is promoting autonomy for individuals with ID by increasing their self-awareness, self-understanding, and ability to make choices.

Self-determination refers to an individual's ability to set goals, take actions to achieve the goals, and evaluate the results (Field et al., 1998). Researchers have indicated that students with higher levels of self-determination have better outcomes as adults (Collet-Klingenberg, 1998; Lachapelle et al., 2005; Wehmeyer & Palmer, 2003; Wehmeyer et al., 2007). Wehmeyer and Palmer (2003) surveyed 94 students with ID and Learning Disabilities (LD) who were leaving secondary education. Results indicated that students who were more self-determined exhibited higher quality of life (QOL) factors including: employment, access to health and other benefits, independent living, and financial freedom. In a similar study, Lachapelle et al. (2005) investigated the relationship between self-determination and QOL. Participants included 182 adults with mild ID from 4 countries including the United States and Canada. The authors indicated that self-determination was correlated significantly with a higher QOL and that self-determination predicted membership in the high QOL group. Self-determination is an important key to independent transition outcomes (Thomas & Wehmeyer, 2005).

Technology

The development of technological skills also has been linked to positive post-secondary education outcomes for people with ID (Luftig & Muthert, 2005). Assistive technology (AT) can be defined as "the application of practical or industrial arts that help people with disabilities" (Bryant & Bryant, 2012, p. 6). The definition of AT encompasses strategies, practices, devices and services that are designed to assist individuals with disabilities (Cook & Hussey, 2007). The use of AT has been established to facilitate transition, independence and post-secondary educational outcomes (Mull & Sitlington, 2003). In the Assistive Technology Act an AT device is defined in the as: "…any item, piece of equipment or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (ATA P.L. 105-394). AT devices include both appliances that benefit the individual without any required skill (e.g. eyeglasses) and tools which require skill from the user (e.g. power wheelchair) (Cook & Hussey, 2007). AT services are defined as "…any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device" (ATA P.L 105-394). The goal of AT is to increase functionality to create an equal opportunity for people with disabilities (Patterson & Cavanaugh, 2012).

Assistive technology devices range from low-technology (e.g. pencil grips and adapted utensils) to high-technology (e.g. voice-recognition software and handheld devices including iPads and iPods) (Martinez-Marrero & Estrada-Hernandez, 2008; Mull & Sitlington, 2003). Assistive technologies provide support across a continuum that varies from minimal assistance (i.e., augment the user's abilities) to significant assistance (i.e., assist users completely in task functionality). AT also is classified into hard and soft technologies (Cook & Hussey, 2007). Hard technologies include tangible devices (e.g. computers, software, or switches). Soft technologies are intangible and include human knowledge (e.g. training, decision-making, and concept formation). The use of AT can maximize the skills and abilities of students with ID while helping to promote universal access. In addition to AT, secondary and PSE for young adults with ID should include a focus on other sources of technology and digital communication including the Internet, social media, and social networking. For young adults of all ability levels, technology is a primary source of education, communication, social interactions, and recreation (Cook & Hussey, 2007).

Over the last 30 years, changes in legislation have provided students and educators with AT needed for success and independence (Patterson & Cavanaugh, 2012). In 1973, section 504 of the Vocational Rehabilitation Act mandated that federally funded organizations can't discriminate against people with disabilities. Section 504 also requires agencies to provide auxiliary aids as necessary to ensure equal access and opportunity. Auxiliary aids include texts printed in Braille, interpreters, and closed captioned videos. In addition, many universities and employers have introduced structural improvements (e.g. elevators and curb cuts) to reduce barriers (NCD, 2011). Following this act, the Education for All Handicapped Children Act (EHA-now IDEA) of 1975 was passed. In 1986, the EHA was reauthorized and renamed as the Individuals with Disabilities Education Act (IDEA) and required AT considerations to be made for all school-aged children in order to ensure equal access. Later, the Technology Related Assistance for Individuals with Disabilities Act (Assistive Technology Act) of 1988 further defined AT services and devices. This act was followed by the Individuals with Disabilities Education Acts (IDEA) of 1990 and 1997, which specified how AT would be applied by students in educational and transitional settings. The 1997 IDEA reauthorization added a new stipulation that required each IEP team to consider the AT needs of the student. The Rehabilitation Act Amendments of 1998, which is contained within the Workforce Investment Act of 1998, P.L. 105-220, required states to have an AT provision in place and to include necessary AT in Individualized Written Rehabilitation Programs (IWPs). Section 508 is an important component of the Rehabilitation Act in that it ensured that federal employees with disabilities had access to accessible computers and other office equipment (Cook & Hussey, 2007). This act had a tremendous impact on the manufacturers of computers and the accessibility for users with disabilities.

In conjunction, these regulations provide AT services and devices to any qualified individual with a disability including students transitioning to PSE settings and to those entering the workforce. Additionally, the overarching protections of the Americans with Disabilities Act of 1990 (ADA) and the 2008 Amendments, guarantee the civil rights of people with disabilities and guard against discrimination in school, work, or community settings. For young adults with ID, technology and technological advances are vital to ensure access and promote independence. By allowing individuals with ID to access activities, environments, and communicative interactions that may be otherwise inaccessible, AT provides learners with a platform of equality and independence (Patterson & Cavanaugh, 2012).

Although most of the students enrolled in PSE programs have mild to moderate ID, little research exists that explores the benefits of technological interventions with this group of students. While most researchers have established that technology-based interventions led to positive outcomes, there are several external validity limitations associated with the research base. Most studies have been conducted with school-aged children. Due to this gap in the literature, most of the research that supports technological interventions focuses on participants with moderate to severe ID. Researchers indicated that students with ID benefit from specially designed AT interventions (Cihak, Fahrenkrog, Ayres, & Smith, 2010; Mechling, Gast, & Seid, 2009). Riffel et al. (2005) used a palmtop computer with a touchscreen to decrease prompt dependence and task completion time for students with ID. The authors found that students required fewer prompts and increased the level of independence as a result of the intervention. For example, Mechling et al. (2009) used a Personal Data Assistant (PDA) to increase independent task completion for students with developmental disabilities. All students demonstrated independent task completion as a result of using the PDA.

For transitional and postsecondary students with ID, researchers have suggested that AT can be beneficial in promoting independence and other post-school outcomes (Mull & Sitlington, 2003; Webb, Patterson, Syverud & Seabrooks-Blackmore, 2008; Zionch, 2011). In the past two decades, researchers have investigated a number of technological interventions. Two recent studies investigated the use of digital portfolios for high school and postsecondary students with ID to improve engagement in the educational process and self-determination skills (Black, 2010; Glor-Scheib & Telthorster, 2006). A digital portfolio is a collection of work (e.g. papers, projects, or videos) catalogued in a digital format (Wiedmer, 1998). Black (2010) found that using digital portfolios is an effective means of collecting data, documenting student progress, and allowing for student involvement in the transition process. Similarly, Glor-Sheib and Telthorster (2006) found that student involvement in the planning and data collection for a digital portfolio increased self-determination. In another study, Cihak et al. (2010) investigated the use of video modeling via a video iPod in conjunction with the system of least prompts to increase independent transitions from location-to-location for students with developmental disabilities. The results indicated that all students increased independence when using the mobile devices and video modeling prompts. Finally, Korbel, McGuire, Banerjee, and Saunders (2011) found that several technological interventions can be used to increase student engagement and empowerment among transition-aged students with disabilities.

In addition, computer-assisted instruction (CAI) has demonstrated sufficient evidence to be effective in promoting academics, pro-social behaviors, and independent skills in transition-aged students with ID. CAI is defined as instruction that is facilitated through the use of digital tools such as computers or tablet devices (Torgesen et al., 2010). CAI was used to teach academic skills including: reading comprehension (Elkind, Cohen, & Murray, 1993), fluency (Farmer, Klein, & Bryson, 1992), writing (Sturm & Rankin-Erickson, 2002), and mathematics computation skills (Okolo, 1992). CAI is an effective method to teach students with ID to navigate grocery aisles (Mechling, Gast, & Langone, 2002), to complete complex job tasks (Riffel et al., 2005), and to demonstrate self-advocacy skills (Lancaster, Schumaker, & Deshler, 2002). For example, Ayres and Cihak (2010) used CAI to teach cooking and food preparation skills. Hoppe (2003) examined the use of a computer-based multimedia program to improve social and behavior skills in 20 transition-aged students with disabilities including ID. The program consisted of software modules that focused on academic and personal issues (e.g. dropout prevention, self-esteem, and healthy lifestyles). Initially, all students demonstrated low scores in adaptive skills. Hoppe investigated areas of need including interpersonal, social and community interactions, and workplace relationship skills. The results of the study indicated that behavior and social skills can be improved through the use of computer-assisted interventions. Additionally, Hoppe suggested that it was beneficial for students to use the multimedia program based on the principles of Universal Design for Learning (UDL) as it enabled them to work and study at an individual pace.

UDL is based upon the tenets of Universal Design (design for inclusion and access for all) and is defined by the Higher Education Opportunity Act of 2008 (P.L. 110-315- HEOA) as a framework for educational practices that promote flexibility in presentation, engagement, and response while reducing barriers in instruction and holding students with disabilities to high expectations (McMahon & Smith, 2012). UDL principles are grounded in the theory of design for inclusion and access for all (NCD, 2011). In education, Universally Designed curriculum incorporates four concepts: (a) appropriately challenging goals, (b) materials presented in flexible formats via multiple means of representation, (c) flexible and diverse methods and (d) accurate, ongoing, and flexible assessment (Hitchcock, Meyer, Rose, & Jackson, 2002). Universal Design has evolved and now includes the components of the conceptual framework of "meta-design" (NCD, 2011). Meta-design includes communicating with people who have different perspectives, integrating diversity, and including the voices of all people. To maximize post-school success, educators must identify the potential barriers to using of AT. Wehmeyer, Smith, Palmer, and Davies (2004) identified six specific threats to successful use of AT to assist learners with disabilities. The barriers include: (a) locating equipment, (b) lack of training time, (c) time required to prepare equipment, (d) high cost of equipment,(e) lack of funds to purchase devices, and (f) limited teacher knowledge and training. Researchers have indicated that approximately 59% of people who could benefit from AT cannot afford to purchase it (NCD, 2011). Specific barriers for students after PSE include: financial constraints to buy and maintain AT, finding and communicating with other for help with AT issues, and misunderstanding by employers about the function of technology (Houchins, 2001; Wehmeyer, 1998a). While about half of adults with disabilities use AT, many lack the technology they need (NCD). Additionally, with limited follow-up and support, AT services and devices are often abandoned or underused (Wehmeyer et al., 2004).

To combat barriers with AT, it is necessary to facilitate structured supports for students in their new environment. In K-12 education, teachers and students should adopt AT early, maintain the same equipment throughout school and beyond, and participate in planning and evaluation of the AT (Mull & Sitlington, 2003). After high school and following PSE, people with ID should receive support from insurance providers to purchase and maintain AT devices, learn employability skills, connect with good support systems, and participate in job experiences to practice utilizing AT in workplace settings. In the workplace, AT must always be matched to the needs, capabilities, and comfort of the user (NCD, 2011). Educating employers and other community members about the benefits of the technology can reduce miscommunication and improve successful outcomes. In addition, researchers have indicated that satisfaction and long-term success with an AT device greatly increase with improved trial-ability (i.e. time to experiment or try out the device) prior to purchase (NCD).

Given the wide body of literature supporting the use of AT to improve independence and post-school outcomes for young adults with ID, relatively few students have the necessary skills to successfully operate the technology (Wehmeyer et al., 2004). Researchers indicated that 85% of people without disabilities use a computer or other device to access the Internet in comparison to only 54% of those with disabilities (NCD, 2011). The National Center on Educational Statistics (NCES) reported that children aged 5 to 17 years without a disability were significantly more likely to use computers and the Internet than their peers with disabilities (2001). Children and adolescences with ID were even less likely to use a computer or the Internet. Overall, Palmer et al. (2011) determined that those with access to technology and those who can use technology have a better quality of life and better long-term outcomes.

Digital Literacy

Traditionally, college students are adept at reading, writing, comprehending, and communicating in both written and verbal forms. This form of literacy is referred to as "academic literacy" (Alberto, Fredrick, Hughes, McIntosh, & Cihak, 2007). Academically literate individuals are able to comprehend and utilize content in academic settings. However, for transitioning and postsecondary students with ID, the likelihood of even minimal academic literacy is low (Ailor, Mathes, Jones, Champlin, & Cheatham, 2010). As a result of low literacy skills, young adults with ID are often marginalized and ignored when communicating with others (Morgan, Cuskelly & Moni, 2011).

Alberto, Fredrick, Hughes, McIntosh, and Cihak (2007) expanded the concept of literacy by including the concept of visual literacy. "Visual literacy" is defined as the ability to discern meaning through images (Alberto et al., 2007). Examples of visual literacy include logos, images, photographs, videos, icons, and simple graphs and signs. The authors suggested that literacy for students with ID should include more than the ability to decode words on a page. People with ID should be taught how to interpret visual information in which to make decisions and to alter their environment.

Researchers indicated that literacy greatly impacts the quality of life for students with ID (Forts & Luckasson, 2011; Moni, 2000). Literacy enables individuals with ID to sustain friendships, communicate with others, and benefit from enhanced work and leisure activities (Forts & Luckasson). Additionally, literacy improves self-confidence and has numerous implications for higher quality of life and relationships with others (Forts & Luckasson). For transitioning youth and college-aged students with ID, literacy skills are necessary to function in the college or workplace environment. Students enrolled in PSE need literacy skills to comprehend information, to make meaningful contributions to classes, complete career readiness training, and to engage in digital communication with others.

When seeking to determine recommended instructional practices for students with ID, the extant literature focuses on several evidence-based strategies. Spooner, Knight, Browder, and Smith (2012) conducted a review of the literature from 2003-2010 to determine which strategies were used to teach academic skills to students with developmental disabilities. Using the Horner et al. (2005) quality indicator criteria, the authors established that time delay, task analytic instruction, and systematic instruction were evidence-based practices (Spooner et al., 2012). Furthermore, the authors emphasized the importance of teaching generalization by using different settings.

With new advances in technology, "functional literacy" now includes the ability to derive meaning from digital and technological tools. This concept is referred to as "digital literacy" (Ng, 2012). According to Ng, digital literacy refers to a conceptual framework that encompasses the multiple literacies associated with digital technology. The digital age offers greater opportunities for inclusion than ever before (NCD, 2011). Digital media has changed the face of communication and collaboration and is now a source of knowledge and information. Additionally, it encourages users to think in alternative ways and demonstrate new ways of learning (NCD). As members of a technologically and digitally literate world, transitioning and PSE students with ID must embrace digital literacy as a necessary tenet of success and independence. Within higher education environments, digital communication is vital to engage in relationships, access resources, and participate in college courses. Many university and college instructors communicate with students primarily through email or web-based platforms such as BlackBoard to deliver instruction, post resources, and accept completed assignments (McMahon & Smith, 2012). In order to participate, benefit and contribute to academic courses, students with ID must be literate in the digital language of the classroom.

In some ways, the digital language of technology can be compared to a foreign language in that users must learn the new and uniquely associated vocabulary (Eshet-Alkalai, 2004). Digitally literate people are aware of advances, appropriately use new tools, create meaning and communicate with others through technology. Other encompassing digital literacy skills include: computer and Internet basics, email, general computer navigation, locating resources and tools, web searching, and content evaluation (National Telecommunications and Information Administration [NTIA], 2012). Specific digital tools include: laptops, tablets, smartphones, and game consoles. Mobile platforms such as mobile access to the Internet and wireless networks have reshaped the learning process and give users unprecedented access to information (NCD, 2011).

In addition to digital hardware, Web 2.0 technologies (e.g. Skype, Edmodo, and Dropbox) are digital tools that are widely available and utilized by college students (Ng, 2012). The concept "Web 2.0" includes the concept that the internet is an ever-evolving, dynamic tool that is influenced by the users, bloggers, and members of social networks (NCD, 2011). PSE students with and without disabilities are using Internet-based tools such as Dropbox and Google

Drive to create, share, store, and utilize a variety of documents at little or no cost. Students with ID must learn to access and utilize these applications.

Other components of digital literacy include adaptability to new technological advances and willingness to learn the new digitally-related language (Ng, 2012). Gilster (1997) posited that the ability to adapt to web-based and technology tools determines the ability to be successful in a technologically-geared society. Seale et al. (2010) referred to this concept as "digital agility" and noted it is one of the most important factors associated with including students with ID in PSE. Other components of digital literacy include information literacy, socio-emotional literacy, and photo-visual literacy. One notable aspect of these new forms of literacy is that they often rely upon graphic representations and images as the building blocks of the language (Eshet-Alkalai, 2004). This is beneficial for students with ID as visual prompts have been shown to be effective at improving comprehension and fluency in reading (Mechling, Gast & Thompson, 2009).

In addition to interventions and innovations, there is an overarching series of recommendations for transitioning and PSE students with ID regarding digital literacy. Burgstahler (2002) coined the phrase "second digital divide" in reference to a lack of appropriate online learning resources and activities for students with disabilities. Access to appropriate online content is referred to as "digital inclusion." Seale et al. (2010) investigated digital inclusion for students with disabilities in PSE. This research stemmed from the fact that students with ID have access to more technology tools than ever before, yet many do not use the tools consistently, or abandon them. Important recommendations that emerged from this research include maximizing e-learning by teaching digital agility, decision-making, and familiarity with digital tools. As prior research has indicated, decision-making is critical to foster independence in students with ID (Agran, Blanchard, Wehmeyer, & Hughes, 2002); however considerably more research is needed to close the digital divide for people with ID.

Communication

In the age of digital communication, instead of social networking, posting on blogs, or communicating with friends via text message, people with ID and low literacy skills are often isolated physically and emotionally (DeZonia, 2009). Digital social communities play a large role in creating relationships. The rates of social interaction for people with disabilities are lower than the rates for people without disabilities, despite the fact that networking is more important for those with disabilities (NCD, 2011). In 2010, while 70% of American households reported using the Internet, only 18% of family members with ID had an email address (U.S. Department of Commerce, 2010). With innovations in web-based applications such as Facebook, Dropbox, and Google Drive, an email address is required to even access the application. Additionally, employers and instructors in higher education settings require email addresses to correspond with students or employees.

The advances of technology afforded many individuals with ID the opportunity to gain access to information they otherwise may not have obtained. AT options have included positioning tools, Augmentative Alternative Communication (AAC) devices (e.g. Dynavox), tablets equipped with a communication application (e.g., the iPad with *Proloquo 2 Go*), adapted computers, and adapted environments (Martinez-Marrero & Estrada-Hernandez, 2008; Mirenda, 2009). For example, Myers (2007) used a four week AAC intervention to increase communication skills in students with ID.

Information and Communication Technology (ICT) is one of the most commonly used tools or media for entertainment, work productivity, and learning, and has rapidly become more advanced and affordable in recent years. Many studies demonstrate the advantages of using ICT for people with ID (Tanis et al., 2012; Van Laarhoven, Van Laarhoven-Myers, & Zurita, 2007; Wehmeyer, Smith, Palmer, & Davies, 2004). These benefits include the enhancement of communication systems, extension of social networks, and greater independence.

As a component of ICT, sending and receiving email is an important communication skill offering individuals with ID a means of communicating with others. According to Burgstahler (1997), sending and receiving email is an important communication skill that offers individuals with ID a means of advancing academic and career goals, as well as communicating with others to ease social isolation. Stanford and Siders (2001) developed an e-mail pen friend correspondence project. They were interested in improving written expression of students with specific learning difficulties. They found a significant effect in favor of e-mail pen friends compared with conventional pen friends and a control group who wrote to imaginary pen friends and received no replies to their letters. Stanford and Siders suggested that while any kind of pen friend offers students a genuine and authentic experience, email pen friends receive instant feedback. Networked communication is also being promoted as a means of facilitating participation in the mainstream digital world. For example, e-Buddies (www.ebuddies.org) is an e-mail "pen friend" program. This project is designed to support people with ID to find and make friends on the Internet. Here the "equalizing effect" has to do with targeting a particular group of people as a means of facilitating participation.

People with ID can use email to communicate and socialize with friends, family members, teachers, and employers. Email is the primary means of communication outside of school between employers and workers. Email has become an environment for conducting work, and for maintaining social life. Successful job seekers typically receive information about the opportunity through a short chain of one or two contacts (Calvó-Armengol & Jackson, 2004). If persons with ID are at a disadvantage with job networks, and if networks affect employment for persons with disabilities as they do the general population, then it is likely that a considerable portion of the unemployment experienced by persons with ID is due to this lack of social networking (Potts, 2005). Even with the rise of competing modes of communication including Twitter, Facebook, and text messaging, an email address continues to have an important function in the digital society. An email address functions much like a passport for many different login systems like Facebook, Twitter and other web applications. The suggestion here is that social networks are likely more important for people with intellectual disabilities than for the general population. "If disability narrows the set of jobs one is qualified to fill, then having the right channels of job contacts to get access to that smaller set of job opportunities may be even more crucial to employment success" (Potts, p. 22).

Navigation

Critical independent living skills include: navigation, community access, self-care, cooking, shopping, and home skills (Alwell & Cobb, 2009). One third of people with a disability indicated that accessible transportation is a major obstacle to independence (NCD, 2011). People with ID who are able to procure a job must be able to travel to the job on a daily basis. Independent travel skills are beneficial for people with disabilities to promote community engagement, engage in social networks, and to reduce isolation (McConkey, 2007; Wehmeyer & Bolding, 2001). When navigating, the problem-solving component is referred to as “wayfinding” (Mengue-Topio, Courbois, Farran, & Sockeel, 2011). IQ and other cognitive measures do not affect success as much as experience, confidence, and practice (Mengue-Topio et al., 2011).

Navigating safely across a college campus is a critical factor in the success of PSE students. Many young adults with ID have never had the opportunity to make a purchase independently, walk to a nearby building alone, or even cross the street without assistance and supervision. This lack of experience is due to many factors including perceived risks by parents, lower expectations, and limited instruction (Mengue-Topio et al., 2011). Denying individuals the right to navigate independently is in direct opposition to several of the general principles adopted by the 2006 United Nations Convention on the Rights and Dignity of Persons with Disabilities including: (a) independence of persons, (b) equality of opportunity, and (c) full and effective participation and inclusion in society.

An underlying factor related to equality for people with disabilities is the concept of “dignity of risk.” This term refers to the rights of an individual with a disability to move away from a safe place or person to make decisions, take steps toward independence, and feel the true autonomy of adulthood (McDonald & Kidney, 2012). By removing important experiences (e.g. independent travel), parents and other caregivers eliminate irreplaceable incidental learning opportunities from the fabric of youth and young adulthood. In addition to the right of dignity of risk, individuals with ID should be part of decisions that may have a large impact on their lives (Lotan & Ellis, 2010).

When students with ID enroll in a PSE program or transition from high school to an occupational setting, they will most likely have the opportunity to navigate and access community supports independently. Pedestrian travel is the most common form of transportation on college campuses and in metropolitan areas. Several interventions have improved street-level navigation and orientation skills for people with ID (Lancioni et al., 2010). A 2011 study investigated the use of digital games to teach adolescents and adults new pedestrian routes in an urban environment (Brown et al.). Participants used a game that simulated the travel route to improve navigation skills. All participants improved navigation skills. In a similar study, Mechling and Seid (2011) used a hand-held personal data assistant (PDA) to teach young adults with ID to travel independently between locations. The PDA was equipped with a three-level prompt system (auditory, picture, and video) that enabled participants to navigate between locations.

In addition to pedestrian travel, public transportation is an increasingly common mode of travel on college campuses and in communities. Davies, Stock, Holloway, and Wehmeyer (2010) evaluated a global positioning system (GPS) to support independent bus travel for adults with ID. The results indicated that the participants in the experimental group demonstrated better travel skills than the control group.

Independent navigation does not guarantee successful community inclusion. DeZonia (2009) investigated the phenomenon of isolation that negatively impacts many adults with ID. Even when equipped with navigational skills, technology, and natural supports to enable independent travel, many adults with disabilities find they are excluded when they reach a destination in the community or are met with pity, fear, and avoidance. DeZonia suggested that true mobility should include acceptance and that the general population should be educated about the prejudices associated with disabilities. In fact, 35% of people with disabilities say they are completely uninvolved in their communities compared to 21% of people with no disability (NCD, 2011).

In order to facilitate successful PSE, employment, community, and independence outcomes for people with ID, educators need to capitalize on the intrinsic benefits of technological interventions. Digital tools are abundant, inexpensive, and user-friendly. Many digital applications are available for free download and offer simulated experiences such as augmented reality to facilitate communication and learning. The two experiments in this investigation shared a common purpose: to improve the autonomy of students with ID within PSE environments through the use of digital tools. The first experiment examined the use of mobile technology to improve and facilitate digital communication. Similarly, the second experiment examined the use of mobile technology to facilitate independent navigation via an augmented reality application within inclusive college environments. While the experiments shared a common purpose, they incorporated the use of different digital tools and applications.

Research Questions

Two single-case design (SCD) studies were used to determine if there was a functional relation between the dependent and independent variables. Experiment I investigated the relationship between the dependent variable (the number of independent steps completed to engage in digital communication and the quality of the communication) and the independent variable (digital communication aid consisting of either (a) iMessage with voiceover, (b) HeyTell audio message or (c) Tango video message). Experiment II investigated the relation between the dependent variable (the number of correct “waypoint” decisions when traveling to target destinations) and the independent variable (the augmented reality iPhone application the Heads Up Navigator). Visual analysis and the percent of non-overlapping data (PND) were used to analyze the results.

Experiment I was designed to determine if changing technological interventions would improve communication and comprehension of digital communicative interactions. Additionally, the quality of the interactions was examined following each intervention.

Specific research questions addressed in experiment I included:

1. Which of the three technological interventions (text message with voiceover, *HeyTell* audio message, or *Tango* video message) will be most effective at improving communication between a student and communicative partner?

2. Which of the interventions will improve the quantity and quality of responses from the students?

3. What is the social validity or acceptability of using each communicative intervention?

Experiment II was designed to determine if the addition of an augmented reality application would improve navigational skills in the participating students. Augmented reality involves the blending of the actual physical environment and digital markers or cues (Cobb & Sharkey, 2007).

Therefore, Experiment II addressed the following question:

1. Will the augmented reality application *Heads Up Navigator* improve navigation decision-making in community settings for the students?

2. What is the social validity or acceptability of using the navigation application intervention?

Chapter 2

Experiment I

Digital Citizens

The Higher Education Opportunity Act (HEOA) of 2008 (PL 110-315) expanded opportunities for thousands of young adults with disabilities. As a result of the HEOA students with intellectual disabilities (ID) are eligible to enroll in courses, receive financial aid, and enjoy the collective college experience alongside peers without disabilities (Grigal & Hart, 2010). As members of postsecondary education (PSE) communities, young adults with ID have been thrust into a digital, global society. Due in large part to recent technological advances, people around the world e-mail, text, and communicate through video and internet platforms regularly. The phenomenon of constant digital interaction is evident throughout college campuses in the United States where many students have access to a smartphone (e.g. Android® or iPhone®) or similar technology. In order to fully participate as digital citizens, students with ID need access and instruction in learning to use new technological tools.

"Digital inclusion" is defined as having access to the same experiences as others via technology (Seale et al., 2010). To ensure digital inclusion, learners with ID should be instructed on the usage and features of digital tools. Students also should receive instruction on the built-in accessibility features found on many devices. Additionally, students should have access to online resources that are designed to meet the unique needs of a person with ID. This access prevents what Burgstahler (2002) termed the "second digital divide" in which individuals with ID have access and knowledge to use tools, but are unable to access online learning forums in which to use the tools. To facilitate digital inclusion, portable technology tools (e.g. smartphones and tablets) can be used for mobile learning (mLearning) (Seale et al.). MLearning is part of the new generation of instruction for students with ID. In mLearning, instructors use any technology that can access web-based services and functions to instruct and engage students in the learning process using handheld or palmtop technologies (Seale et al.). Research indicates that utilizing mLearning and the associated tools promotes engagement and learning for students (Seale et al.). Additionally, the social validity of mLearning is high considering the popularity of mobile technologies.

Prior research has focused on the use of several interventions to develop digital literacy skills. Computer-assisted instruction has been used to successfully teach students digital literacy skills. Hutcherson, Langone, Ayres, & Clees (2004) used computer-assisted instruction (CAI) to teach community navigation and shopping skills to four students with moderate to severe disabilities. All students increased independence skills within community settings by using digital tools and digital literacy skills. In another study, Weeks (2001) investigated the use of *Life Online*, an online learning resource that included computer skills, technology confidence, and independent living skills (e.g. shopping, budgeting, and banking). All students demonstrated improvement in each of the areas.

Digital Communication

For people with ID, technology represents both a tremendous opportunity and a considerable challenge, if not specifically taught. Acquiring and generalizing digital communication skills creates positive benefits for people with ID. As a component of Information and Communication Technology (ICT), digital communication is an important skill offering individuals with ID a means of communicating with others for work and/or leisure purposes. It can ease social isolation and advance academic, career, and leisure goals by connecting people with ID to a community of peers and a network of supports (Burgstahler, 1997). People with ID can use email to communicate and socialize with friends, family members, teachers, and employers. Email is the primary means of communication outside of school between employers and workers. Email has become an environment for conducting work, and for maintaining social life. Successful job seekers typically receive information about the opportunity through a short chain of one or two contacts (Calvó-Armengol & Jackson, 2004). If persons with ID are at a disadvantage with job networks, and if networks affect employment for persons disabilities as they do the general population, then it is likely that a considerable portion of the unemployment experienced by persons with ID is due to this lack of social networking (Potts, 2005). Stock, Davies, Wehmeyer, and Palmer (2008) evaluated the use of a modified cell phone interface to increase accuracy and reduce dependency among participants with ID. Participants used cellphones equipped with the *Pocket ACE* system to make calls and use the multimedia features available on the phone. Using a within-subjects paired samples design, researchers found that equipping cell phones with a more accessible interface resulted in significant benefits for participants. Results indicated that all participants made significantly fewer errors ($p < 0.001$) and required significantly less help ($p=0.001$) when using the *Pocket ACE* interface. By creating a more accessible cell phone, the authors utilized the tenets of Universal Design, a theoretical framework in which all products and environments should be accessible and usable by all people, regardless of ability or circumstance (Story, 1998).

Limitations in communication and comprehension skills are detrimental in personal interactions and occupational settings. Many young adults with ID have limited skills in these critical areas. When young adults with ID open a text message or e-mail, deficits in comprehension and written communication often prevent the communicative exchange from progressing further. If one is unable to decode or comprehend a written text or e-mail message, an appropriate response is impossible. Text messaging is difficult for people with ID for several reasons. The act of texting requires motor dexterity which is a limitation for many people with ID (NCD, 2011). Text messaging also places cognitive demands on users who must use decoding, comprehension, and organization skills to text. Again, these are areas of weakness for many with ID.

Additional limitations may include speech or language disorders and limited fine or gross motor abilities. The actual ability to perform work tasks is just the tip of the iceberg in terms of success at work, with social and interpersonal skills underpinning the structure as much more significant predictors of workplace success (Black & Langone, 1997; Butterworth & Strauch, 1994; Hagnar, 1993; Huang & Cuvo, 1997). As Hatton (1998) pointed out, “Relatively subtle aspects of pragmatic language use can inhibit the development of meaningful relationships with others … the display of conversational competence can be considered as an essential prerequisite for the achievement of a valued quality of life” (p. 93). Moreover, only one out of five students with mild to moderate ID demonstrates basic literacy (Ailor et al., 2010).

In order to facilitate and maintain literacy and communication skills in transition from high school and beyond, researchers have discovered several effective instructional strategies. Douglas, Ayres, Langone, Bell, and Meade (2009) investigated the use of eText supports to improve reading and listening comprehension in transition-aged students with ID. Through a series of six single-subject studies, the authors examined the effects of supports including:

transitional, presentational, illustrative, instructional, and summarizing in order to assess comprehension skills. The six studies each employed a different eText support and focused on changes in reading and listening comprehension skills in the students. The studies included: (a) digitized speech and video supports, (b) text highlighting in conjunction with text-to-speech (TTS) software, (c) story retell with TTS and word-by-word highlighting, (d) video and audio supports, (e) computer-based graphic organizers, and (f) eText audio supports in conjunction with graphic organizers. Results of the six studies indicated that two eText supports (read aloud in recorded voice and TTS with graphic organizers) were effective in improving reading and listening comprehension in transition-aged students with ID. Other findings from the study suggested that explicit instruction should accompany the use of any eText support. With appropriate assistance, learners with ID can comprehend and ultimately respond effectively to a communicative partner using digital tools and technology. Izzo, Yurick, and McArrell (2009) examined the use of TTS software and digital textbooks to enhance the comprehension skills of transition-aged students with disabilities. Using a withdrawal/reversal design, results of the study indicated that the digital text interventions were significantly related to higher reading comprehension scores.

Purpose of Experiment I

Digital tools are available to improve the communication, comprehension, and general quality of life for people with disabilities (Cihak et al., 2010; Davies et al., 2010; Lancioni et al., 2010). With recent technological innovations, digital tools provide the assistance necessary to engage in meaningful digital communication. By teaching students to (a) access the necessary technology, (b) understand how to use the appropriate assistive tools, (c) comprehend the original message, and (d) compose and deliver a meaningful response, youth and young adults with ID can engage in thoughtful and complete communication with others. The purpose of experiment I was to evaluate the use of three technological interventions to improve digital communication between young adults with ID and a communicative partner. Specifically, which of the three digital interventions (text message with voiceover, HeyTell® audio message, or Tango® video message) would have the greatest impact on improving the comprehension and quality of communication for four young adults with ID enrolled in a PSE program? Social validity and acceptability also were examined.

Methods

Participants and Setting

Participants included four young adults (2 males and 2 female) enrolled in a PSE program at a large land grant university in the Southeastern United States. The PSE program incorporated a mixed/hybrid structure in which the students had access to general college courses as auditors, but also took program-specific courses that focused on career development and life skills. Students were included among the general student population part-time and had access to university facilities. The students were provided with a university netID upon admittance to the program. All students attended classes full-time, including university and program specific courses five days a week. Each of the students was familiar with basic technology skills including use of a cell phone, document creation with a word processor, and internet accessibility. Students demonstrated these skills in a digital literacy course in the prior semester. Students were selected to participate in the study based on the potential to improve upon current communication and technology skills. None of the students had been exposed to the digital tools used in the intervention previously (i.e. iMessage with voiceover, HeyTell audio message, and Tango video message). Additionally, all students qualified for special education services during K-12 years. (See table 1 for participant descriptions; all tables and figures are located in the appendix).

Ann. Ann was a 24-year-old student in her second year of the PSE program. Ann's IQ was determined to be 64 ($\bar{x}$ = 100; *SD* = 15) when evaluated with the Woodcock-Johnson III: Tests of Cognitive Abilities which placed her in the mild ID range (Woodcock, McGrew, & Mather, 2001). Ann received an adaptive behavior composite standard score of 71 on the Vineland Adaptive Behavior Scales, Second Edition (Sparrow, Balla, & Cicchetti, 1984). Academically, Ann's reading comprehension was equivalent to the fifth grade level on the Brigance Transition Skills Inventory (Curriculum Associates, 2010).

Lola. Lola was a 22-year-old student in her first year of the PSE program. Lola had an IQ score of 48 when assessed with the Woodcock-Johnson III: Tests of Cognitive Abilities which placed her in the moderate ID range. Lola's adaptive behavior composite standard score was 51 according to the Scales of Independent Behavior-Revised (SIB-R; Bruininks, Woodcock, Weatherman, & Hill, 1996). Lola scored at the first grade level equivalent on the Brigance Transition Skills Inventory.

Max. Max was a 25-year-old student in his second year of the PSE program. Max had an IQ of 65 according to the Stanford-Binet Intelligence Scales- Fifth Edition, which placed him in the mild ID range (SB5; Roid, 2003). Max's adaptive behavior composite standard score was 75 on the Vineland Adaptive Behavior Scales, Second Edition. Max's reading comprehension was equivalent to the second grade on the Brigance Transition Skills Inventory.

Will. Will was a 23-year-old student in his second year of the PSE program. Will had an IQ of 48 when assessed with the Reynolds Intellectual Assessment Scales, which placed him in the moderate ID range (RIAS; Reynolds & Kamphaus, 2003). Will's adaptive behavior composite standard score was 43 on the Scales of Independent Behavior-Revised. Will's reading comprehension was below first grade according to the Brigance Transition Skills Inventory. Will's lower reading comprehension level was a deciding factor in inviting him to participate in the study. Prior to the study, Will was unable to read or respond to any text messages. When he received a text, Will would take his phone to the nearest staff member of the postsecondary program and ask, "Who is this from?" and "What does it say?" These factors contributed to the need for the current study, the design of the study, and the inclusion of Will as a participant.

Setting

Experiment I was implemented on the campus of a large, public university in the Southeastern United States. More than 28,000 students, undergraduate through graduate level, were enrolled. The university housed nine undergraduate colleges and 11 graduate colleges. Within this larger university setting, all four students were enrolled in a PSE program designed to give young adults with ID a college experience. Students in the PSE program participated in university courses as auditors and attended program-specific courses to develop independent living and career skills. Within the PSE program, instructors included special education and counselor education faculty, a program coordinator, and graduate teaching assistants. Each of the four students participated in a peer-mentoring program in which university student mentors assisted PSE students with assignments, social, and university navigation-skills.

Data were collected within inclusive environments on the university campus including common areas and a computer lab. Data collection occurred during non-academic periods of social and casual interactions in both morning and afternoon time periods. The data collection environments were typically occupied by 3 to 10 other university students.

Materials

This experiment incorporated the use of multiple mobile devices and applications. As a stipulation of the PSE program, students were required to carry a cell phone. Each student was familiar with the format and features (i.e. how to place/receive calls, access text messages, and power the device off and on) of his or her personal cell phone. These cell phones were used as materials in this experiment. Each student had basic cell phone operation skills including making calls, opening text messages, and powering the device on and off. Students were observed using their personal cell phones prior to the experiment to assess these prerequisite skills. Additionally, two smartphones (Apple 4s iPhones) were used during the intervention phases as communication devices. The iPhones were equipped with communication applications including (a) the standard iPhone text messenger, iMessage, (b) the audio messaging application HeyTell, and (c) the video messaging application, Tango. As a requirement of the applications, permission was granted on each iPhone for communication between the student and communicative partner's application. For example, a HeyTell user must request permission to communicate with another HeyTell user. Tango users also must permit communication with another Tango user.

Variables and Data Collection

The dependent variables were (a) the number of steps completed independently to access and reply to a digital communication message and (b) the quality of the communication message.

Although students may be able to complete the steps independently to access and send a digital message, the quality of the message was assessed to ensure that the message was coherent, related to the original message, and understandable by the communicative partner (i.e. the researcher or research assistants). The research assistants were undergraduate special education majors who participated in the PSE program as peer mentors. The researcher individually trained the three research assistants to collect data and implement the interventions. The training sessions consisted of instruction on the data collection forms, use of the visual aids, implementing the system of least prompts, and utilizing the iMessage, Heytell, and Tango applications. The research assistants then practiced implementing the intervention procedures, using the communication application, collecting data and implementing the system of least prompts. Training continued until each student implemented all procedures with 100% accuracy for three consecutive trials. Additionally, the researcher observed the research assistants collect data during all baseline sessions and during the first two sessions of alternating treatments application conditions. The purpose of the observations was to simply answer questions and problem-solve.

Event recording procedures were used to record the number of task analyzed steps completed independently to access and reply to a digital message. Appendix A displays the task analysis steps to independently access and reply to a digital message using iMessage, HeyTell, and Tango. A 12-point rubric was developed and used to assess the quality of the digital message. The rubric included four indicators: (a) independence, (b) grammar, mechanics, and semantics, (c) relevance and comprehension, and (d) professionalism. (See Table 2 for the quality rubric). Each indicator was worth a total of 3 points for a maximum of 12 points. A student earned three points for completing the steps to access and reply to the digital message independently. Additional points were awarded based on the message's quality (i.e., grammar, mechanics, semantics, relevance, comprehension, and professionalism). For example, a student could earn 6 points for a response in which 80% of the steps were completed independently (1 point) on a response that contained 2-3 grammatical errors (2 points), was fully relevant but missing a component (2 points), and contained a partial thought (1 point). A student earned 9 points for a response in which 90% of the steps were completed independently (2 points), in a message that contained no more than one grammatical error (3 points), was fully relevant but missing a component (2 points), and expressed as a complete thought (2 points). A score of 12 was assigned to responses in which students completed 100% of steps independently to create a response that contained no more than one grammatical error (3 points), was fully relevant and contained all required components (3 points), contained a complete thought and used respectful tone (3 points). The number of points earned was divided by 12 to calculate a percentage of digital communication.

The independent variables included three different communication applications: (a) iMessage text with activated voiceover, (b) HeyTell audio message, or (c) Tango video message. iMessage (http://www.apple.com/ios/messages/) text with activated voiceover allows users to send texts, documents, photos, videos, contact information, and group messages. HeyTell (http://heytell.com/front.html) is a cross-platform voice messaging application that functions as a both a "walkie-talkie" for real-time communication or as an audio message retrieval application. When used as an audio message retriever, message recipients can access the audio message at any time. The iPhone alerts the message recipient of the waiting message via an on-screen notification. HeyTell is available to Android, iOS (Apple), and Windows Phone 7 users. HeyTell is a free application, but users can pay a fee to access more features. The third digital tool was Tango (http://www.tango.me/). Tango is a free VoIP (voice over Internet Protocol) application that is available to Android, iOS, and Windows Phone 7 system users. While Tango is available as a free application, users may upgrade to “premium services” for a fee. Tango functions as both a real-time video chat application, similar to Apple FaceTime and as a video message retrieval application. When used as a video message application, message recipients may access the message at any time. Similar to HeyTell, recipients are notified of a waiting message via an on-screen notification. Users of both applications need access to a wireless internet, but not necessarily a WiFi connection. HeyTell and Tango both operate with 3G, 4G, and WiFi network protocols which allows for greater network accessibility.

A session was defined as an uninterrupted period in which the student and communicative partner engaged in one digital dialogue communication. For example, the communicative partner would send a digital message to the student which required a response. The student would then reply to the communicative partner’s digital message. Students were instructed to compose a response that would be appropriate in a professional or work environment when responding to the initial message. If the student replied to the partner’s message coherently, and related to the message both professionally and independently, then it was considered an independent digital communication. Each initial message was created by the communicative partner using an Apple iPhone and sent to the student’s cell phone. Each student received only one message per session.

Experimental Design

An alternating treatments design (Kennedy, 2005) was used to determine the efficacy of the independent variables at improving the quality and level of independence on communicative interactions. The alternating treatments design was conducive for evaluating the relation between communicative interactions and the different applications (a) text message alone and text message with voiceover, (b) an audio message (HeyTell), and (c) video message (Tango). Intervention conditions were randomly presented to reduce carryover effects. Each intervention was assigned a number (i.e., 1= iMessage, 2= Heytell, and 3= Tango). An online random number generator application available at Random.org was used to create a list to implement the interventions randomly (see Table 3 for randomized list of applications). Data were collected during the alternating treatments application phase until one communicative application was determined to be more effective or preferred by the student. Communicative application preference was defined as demonstrating communicative interactions with 100% accuracy via the rubric, a bifurcation of data paths, or if the student reported a preference using one application over another via the social validity questionnaire. Afterwards, only the preferred communication application continued to be assessed.

Experimental Procedures

Baseline. Baseline data were collected for a minimum of four sessions and until a stable baseline with less than 20% variability was observed. During baseline, students received one text message per session. The communicative partner sent a text message from an iPhone to the student's personal cell phone. As the students all had experience using cell phones and knowledge of the features and interface of his or her own phone, this condition represented the present level of performance for each student. Prior to the session, students were reminded to respond to the text in a professional manner. The initial message from the communicative partner required students to respond in a multi-word answer (ie. more than “yes” or “no”). Each initial text was formatted as a question and focused on topics familiar to the student (e.g. daily routine, courses within the program, and activities with peer mentors). For example, communicative partners asked, “Can you tell me about your plans for after graduation?” or “Why did you choose your university audit course?” The student opened the text, crafted a response, and sent a message in response to the initial text. Voiceover was not enabled in baseline and no other assistance was provided. Each student-constructed text message was scored on a 12-point rubric.

Teaching phase. After baseline and prior to the intervention, students received one instructional session on using basic features on the iPhone. The teaching session occurred in a classroom next to the common computer lab and lasted approximately 40 minutes. Students were taught how to access and use the different applications (iMesage, HeyTell and Tango). To assist students in acquisition, a visual aid (see appendix A) was created for each digital tool. On the visual aid, the steps regarding how to respond to a standard text, an audio message, or a video message, were task analyzed and included words and pictures of each step of the task. The cards were 8 x 11 inches, laminated, and attached to a ring for easy access. During the teaching phase, the researcher implemented the Model-Lead-Test procedures (Adams & Engelmann, 1996). First, the visual aid was provided and the researcher modeled each step of the task analysis regarding how to access and use the specific communication application. Second, the researcher led each student through each step of the task analysis. Contingent on student independent performance, the researcher provided verbal praise. The researcher did not provide any feedback regarding the quality of the message, only if the student independently used the application. Contingent on student errors or no response, the researcher implemented the system of least prompts with a 4s response time between prompt levels until the student correctly performed the step of the task analysis (Ault & Griffen, 2013). The system of least prompts included (a) gesturing to the visual aid card, (b) verbalizing what to do while gesturing to the visual aid, (c) verbalizing and gesturing on the device regarding the step to be performed, and (d) providing partial-physical assistance by guiding the student's hand to complete the step while verbalizing the step. Third, the researcher tested each student's ability to access, send and reply to a message by sending the student a message using each application. The teaching phase continued until each student could independently access and reply to a message for each application (iMessage, HeyTell, Tango).

Intervention. The intervention was implemented in inclusive settings within the university, including common areas and a computer lab. Each session was conducted within an inclusive environment, but individually with one student and one communicative partner. Sessions occurred outside of instructional time when students were engaged in social activities, or unstructured free time. Prior to each session, the random number list was used to determine which condition would be implemented. Students were presented with a different communicative interaction based on the random number list. One communicative interaction occurred during each session. An iPhone was used to send all initial and reply communicative messages across all application conditions.

Data were collected during the alternating treatments application phase until one communicative application was determined to be more effective or preferred by the student.

Communicative application preference was defined as demonstrating communicative interactions with 100% accuracy via the rubric, a bifurcation of data paths, or if the student reported a preference using one application over another via the social validity questionnaire.

During the iMessage condition, each student received a traditional text message via the iMessage application on the iPhone. However, the read-aloud voice-over option was enabled. The voice-over option is an accessible feature on the iPhone Settings menu. Once selected via *Settings*, voice-over is activated by highlighting the message and choosing “speak.” Similar to the teaching phase, the students were provided verbal praise for accessing and replying to the message independently. The researcher did not provide any feedback regarding the quality of the message, only if the student replied and used the application independently. Contingent on student errors or no response, the researcher implemented the system of least prompts following the same procedures as the teaching phase. During HeyTell, the initial communicative interaction was an audio message from the communicative partner. The HeyTell message was an audio-recording of the communicative partner’s actual voice. Students were alerted of the waiting audio message via an on-screen notification. By tapping the notification, the HeyTell application opens and the message is displayed in a list along with previous messages. After listening to the initial audio message, the student was expected to send an audio message reply. To create and send a response in HeyTell, users hold down a large orange button labeled “Hold and Speak.” When this button is released, the message is automatically sent to the initial communicative partner’s iPhone. Again, contingent on student errors or no response, the researcher implemented the system of least prompts following the same procedures as the teaching phase. Similar to iMessage, the students were provided verbal praise for accessing and replying to the message independently. The researcher did not provide any feedback regarding the quality of the message, only if the student replied and used the application independently. Contingent on student errors or no response, the researcher implemented the system of least prompts following the same procedures as the iMessage application condition.

During the Tango application condition, students received a video message from a communicative partner. After receiving an on-screen notification of a waiting Tango message, the students opened the application and watched the video message. In response to the initial video message, students accessed the Tango application and sent a video message response. To send the response, students were required to follow several on-screen prompts, access the iPhone's camera, record a video, and send the response via the Tango application. Similar to iMessage and HeyTell application conditions, the students were provided verbal praise for accessing and replying to the message independently. The researcher did not provide any feedback regarding the quality of the message, only if the student replied and used the application independently. Contingent on student errors or no response, the researcher implemented the system of least prompts following the same procedures as the iMessage application condition.

Preference Phase. Data were collected during the alternating treatments application phase until one communicative application was determined to be more effective or preferred by the student. Communicative application preference was defined as demonstrating communicative interactions with 100% accuracy via the rubric, a bifurcation of data paths, or if the student reported a preference using one application over another via the social validity questionnaire. The social validity questionnaire was administered after the intervention was complete prior to the preference phase. Afterwards, only the preferred communication application continued to be assessed. After the student reached criteria (100% independent communication for three sessions, with quality above acceptable, or a break in the data path) the preferred strategy was replicated (i.e.(a) iMessage text with voice-over, (b) Heytell audio message, or (c) Tango video message). The preferred strategy was defined as the most effective, efficient, or socially valid strategy. In instances when students demonstrated equal success or mastery and a break in the data path was not observed, students were asked to verbally identify their preferred strategy. After identifying their preferred strategy, the researchers implemented the preferred strategy only.

Social Validity Procedures

At the conclusion of the intervention phase, social validity of the experiment was assessed. It is of particular importance to assess social validity as it gives a voice to the students and takes into account each student's perspective on the intervention. Many people with ID may not have an opportunity to voice an opinion in everyday life, therefore it is important to include it in this study. The participating PSE students were asked to complete a social validity questionnaire. The questionnaire used a 5-point Likert-type scale with picture symbols of "thumbs-up" and "thumbs-down" to represent the top, middle, and bottom points on the scale. The questionnaire also included eight constructed response questions to allow students to describe their opinions about each individual tool in greater detail. (See Table 4 for the students' social validity questionnaire.) Additionally, the three research assistants who collected data throughout the experiment were asked to complete a social validity questionnaire. The questionnaire was composed of nine questions that used a 5-point Likert-type scale. (See Table 5 for the researchers' social validity questionnaire.) The researcher also debriefed the research assistants in a semi-formal interview to discuss the results and implications of the experiment.

Data Analysis Procedures

Visual analysis procedures were used to evaluate the results of the three communication application conditions. To assess intervention effects, six features were used to examine within- and between-phase data patterns: (a) level, (b) trend, (c) variability, (d) immediacy of the effect, (e) overlap, and (f) consistency of data patterns across similar phases (Kratochwill, 2010). Also, within-phase comparisons were evaluated to assess predictable patterns of data, data from adjacent phases were used to assess whether manipulation of the independent variable was associated with change in the dependent variable, and data across all phases were used to document a functional relation (Gast, 2012). Horner et al. (2005) suggested that a functional or causal relationship is established when at least three demonstrations of an effect at a minimum of three different points in time are observed. In addition, the percentage of non-overlapping data (PND) approach was used to calculate the percentage of non-overlapping data between baseline and following intervention phases (Scruggs, Mastropieri & Casto, 1987). Scruggs and Mastropieri (2001) suggested interpretational guidelines of PND, specifically PND greater than 70% was considered a highly effective intervention, PND greater than 50% and less than 70% was considered questionable effectiveness, and PND less that 50% was considered unreliable effectiveness for interventions.

Interobserver Agreement (IOA) and Treatment Integrity

The research assistants collected data during all of the sessions and the researcher collected data simultaneously but independently during 50% of the baseline sessions, at least

50% of the alternating treatments application phase, and during 50% of the preference phase for each student. The percentage of IOA was calculated for each student by adding the number of agreements and dividing by the total number of agreements and disagreements combined and multiplying by 100%. The percentage IOA ranged from 83% to 100% (*M* = 91%). Ann's IOA ranged from 83% to 93% (*M* = 88 %), Lola's ranged from 86% to 93% (*M* = 90%), Max's ranged from 88% to 93% (*M* = 90 %) and Will's ranged from 90% to 100% (*M* = 94%).

The research assistants also implemented all intervention procedures. Intervention procedures included: (a) sending the initial correspondence message to the student, (b) observing the students receiving the message, (c) observing wait time before offering assistance, (d) implementing the system of least prompts contingent on student errors or no response, (e) recording the independent steps completed by the student, and (f) receiving the response message. (See appendix B for treatment integrity document.) The researcher assessed treatment integrity throughout all phases by direct observation using the treatment integrity form that included a task analysis of the steps to implement the experiment. Treatment integrity data verified the research assistants' behaviors and was collected in a minimum of 40% of the sessions of each phase. Procedural integrity agreement was calculated by dividing the number of observed behaviors by the number of anticipated behaviors and multiplying by 100% (Billingsley, White, & Munson, 1980). The overall mean treatment integrity was 96 % (range = 92%-100%). Ann's treatment integrity ranged from 92% to 100% (*M* = 94 %), Lola's ranged from 92% to 100% (*M* = 96 %), Max's ranged from 93% to 100% (*M* = 98 %), and Will's ranged from 92% to 100% (*M* = 96%).

Results

None of the students engaged in digital communication with quality above acceptable (i.e. a score of 3 or above on the rubric quality indicators) during baseline. In baseline, the average independent digital communication for all students was 24% (range= 0-50%). Typical responses in baseline included those with grammatical errors or incomplete thoughts. For example, when asked, "Can you tell me about your favorite social time activity this year?" Ann replied, "rick climbing." Lola was asked "Can you tell me how you get ready to come to school?" to which she replied, "get for school." A descending trend was observed for all participants in baseline. During the iMessage with voiceover condition, all students improved communication to a mean of 70% (range = 25-100%). The second condition, HeyTell, resulted in improved communication for all students with a mean of 80% (range = 42-100%). Finally, during the third condition, Tango, all students improved communication to a mean of 85% (range = 50-100%). The overall mean student performance indicated that Tango was the most effective tool. On average, students required 13 sessions to meet criteria (i.e. a clear fractionization in the data path). (See Table 6 for percentages of independent communication in alternating phases.)

***Ann*.** During baseline, Ann's percentage of independent digital communication was 39% (range = 33-41%). Ann's percentage of independent digital communication increased during the iMessage condition to 86% (range = 67-100%), during the HeyTell to 91% (range= 67-100%), and during Tango to 87% (range = 75-100%). Across all conditions, Ann immediately improved her independent digital communication skills with 100% nonoverlapping data (Scruggs, Mastropieri, & Casto, 1987), which indicates highly effective interventions (Scruggs & Mastropieri, 2001). On average, Ann's percentage of independent digital communication was the highest during the HeyTell condition. HeyTell was replicated as the preferred condition and her mean digital communication performance was 96%. (See Figure 1 for Ann's percentage of independent digital communication.)

*Lola***.** In baseline, Lola's percentage of independent digital communication was 21% (range = 17-25%). Lola's percentage of independent digital communication increased during the iMessage condition to 81% (range = 25-100%), during the HeyTell to 65% (range= 42-92%), and during Tango to 73% (range = 50-83%). Across all conditions Lola immediately improved her independent digital communication skills with 94% nonoverlapping data (Scruggs, Mastropieri, & Casto, 1987), which indicates highly effective interventions (Scruggs & Mastropieri, 2001). On average, Lola's percentage of independent digital communication was the highest during the iMessage condition. IMessage was replicated as the preferred condition and her mean digital communication performance was 100%. (See Figure 2 for Lola's percentage of independent digital communication.)

Max. During baseline, Max's percentage of independent digital communication was 39% (range = 33-50%). Max's percentage of independent digital communication increased during the iMessage condition to 85% (range = 58-100%), during the HeyTell to 87% (range= 67-100%), and during Tango to 92% (range = 75-100%). Across all conditions, Max immediately improved his independent digital communication skills with 100% nonoverlapping data (Scruggs, Mastropieri, & Casto, 1987), which indicates highly effective interventions (Scruggs & Mastropieri, 2001). On average, Max's percentage of independent digital communication was the highest during the Tango condition. However, based on self-report it was determined that HeyTell was Max's preferred condition. For Max, there was no functional difference between

Tango and HeyTell. Therefore, social validity factors regarding which communication application the student preferred were considered. HeyTell was replicated as the preferred conditions and his mean digital communication performance was 100%. (See Figure 3 for Max's percentage of independent digital communication.)

Will. In baseline phase, Will's percentage of independent digital communication was 0%. Will's percentage of independent digital communication increased during the iMessage condition to 25% (range = 17-33%), during the HeyTell to 85% (range = 75-100%), and during Tango to 88% (range = 67-100%). Will's percentage of digital communication only increased to 25% during the iMessage condition due to low literacy levels including reading decoding and comprehension skills below first grade. Across all conditions, Will immediately improved his independent digital communication skills with 100% nonoverlapping data (Scruggs, Mastropieri, & Casto, 1987), which indicates highly effective interventions (Scruggs & Mastropieri, 2001). On average, Will's percentage of independent digital communication was highest during the Tango condition. Tango was replicated as the preferred conditions and his mean digital communication performance was 100%. (See Figure 4 for Will's percentage of independent digital communication.)

Social Validity Results. Results indicate that all students responded positively to the intervention as indicated on the social validity questionnaire. Students indicated they liked using the iMessage, HeyTell, and Tango applications to send messages and that learning to use these tools helped to improve their communication skills. When asked what he liked best about using the HeyTell application, Will responded, "I could tell my feelings." Ann noted that she liked Tango because "I can see myself and I can hear myself." When asked about HeyTell, Lola responded, “It’s easy.” Finally, Max reported that he enjoyed Tango because “It was fun.” (See Table 7 for results of social validity questionnaire.)

Results also indicate all three research assistants agreed or strongly agreed that (a) the target skills of digital communication were important, (b) the time spent assessing these skills was a good investment for students, (c) the assessment procedures were appropriate, (d) the visual aid was helpful, (e) the assessment was a valuable usage of their time, (f) the intervention helped them learn more about working with young adults with ID, and (g) they would consider using the intervention techniques again in the future.

Discussion

The purpose of experiment I was to evaluate the use of three technological interventions to improve digital communication between young adults with ID and a communicative partner. Specifically, which of the three digital interventions (text message with voiceover, HeyTell® audio message, or Tango® video message) would have the greatest impact on improving the comprehension and quality of communication for four young adults with ID enrolled in a PSE program? Prior to the study, all of the students demonstrated traditional cell phone usage, but none participated in digital communication (e.g. text message, audio message, or video message) independently with quality above acceptable.

As a result of using the three digital communication tools, all students increased independence and quality of communication. One student, Will, was unable to master the iMessage application due to limited literacy skills including reading comprehension and decoding skills below first grade level. Due to these barriers, HeyTell and Tango better met Will’s communicative needs and present levels of academic skills. The intervention was effective for all students, yet the preferred tool varied among students. Ultimately, all students achieved the goal of improving digital communication.

Limitations

To fully interpret and apply the results of this study, there are several limitations to consider. As in all single-case designs, a small sample was used ($n = 4$). Conclusions from the study should be interpreted and applied to a small number of participants. In the future, a larger sample size should be used to increase external validity and generalizability. Also, it is important to consider the similarities of the students in this experiment. All four students were diagnosed with ID and attended a PSE program for highly motivated adults with disabilities. The students were from similar cultural and socioeconomic backgrounds. Therefore, results cannot be generalized to all young adults with disabilities or to other age groups.

Time restraints may be considered a third limitation in this experiment. As this experiment was conducted in a university setting, the daily schedules and semester calendar limited the time students were available to participate in the experiment. Extending the time to implement and evaluate the effectiveness would allow future researchers to fully investigate this intervention.

Other limitations include the quality rubric and the pre-intervention skill levels of the students. The quality rubric was functional and useful for the present study. However, additional quality indicators may be required depending on the context of the message or the identity of the communicative partner. Finally, all students had previous experience using an iPhone and digital applications. Other students without a history of using this technology may require additional supports and demonstrate different outcomes.

Implications and Future Research

As the results of this experiment can be interpreted to suggest, each of the digital tools (i.e. iMessage with voiceover, HeyTell, and Tango) may be effective at improving digital communication skills for students with ID. It is necessary to evaluate this intervention with other groups and students in the future, including those of different cultural, age, or disability backgrounds. In addition, researchers should investigate the use of these tools within other locations such as community and employment settings using natural supports to improve a variety of communication.

These mobile applications should be used as a context to improve communication and social skills with a variety of communicative partners (e.g. friends, family, coworkers, or supervisors). The social acceptability of these tools offers the opportunity for a wide group of users to benefit from these advances. Pre-requisite skills should be assessed to determine elements required for student success.

Chapter 3

Experiment II

Navigation

In the teen and adolescent years, mobility gains new importance. Regardless of ability, many young people enjoy visiting friends, shopping, and pursuing hobbies outside the home. Relationships with peers reduce isolation and provide opportunities to practice social, communication, and cognitive skills. However, one third of people with a disability state that accessible transportation is a major obstacle to their success (NCD, 2011). Due to cognitive or other considerations, many young people with ID do not drive independently. Navigation skills are considered functional life skills and are required for independent travel and adult success post-high school. Even in pedestrian travel, young adults with ID may demonstrate limited or underdeveloped navigation or "wayfinding" skills. In navigation, the problem-solving component is referred to as "wayfinding" (Mengue-Topio, Courbois, Farran, & Sockeel, 2011).

Additionally, the ability to navigate independently from place to place affects the occupational and independent living outcomes for people with ID. Whether searching for jobs, or reporting to work on a daily basis, reliable transportation is required to gain and maintain employment. Once on the job, employees often are required to find locations within the building, or community for business purposes. Travel and navigation skills are also necessary to locate and secure housing. Young adults of all ability levels desire to live as independently as possible. In order to take advantage of independent living options, people with ID must be able to find the way home each day. By navigating public and pedestrian travel, young people with ID maximize job and community living opportunities.

With the new opportunities created by the Higher Education Opportunity Act (HEOA, 2008), young adults with ID have unprecedented access to college campuses. Most college campuses and metropolitan areas have public transportation systems. Postsecondary education programs (PSE) foster independence and occupational success for students with ID. As active members of a college community, young people with ID enrolled in PSE must travel safely across campus on a daily basis. Whether attending class, meeting friends for lunch, or visiting the student recreation center, independent travel is a critical skill for students in PSE.

Prior research has investigated the use of various technological interventions designed to develop navigation skills. Zionch's (2011) review of the literature investigated the technological options available to assist transitioning students with independent living and transportation skills. Zionch concluded that digital simulations (digitally-created and enhanced scenarios) and virtual reality demonstrations (delivered via a smart phone, digital video, or the internet) were effective at improving transition skills for students with disabilities including ID. Similarly, Stock, Davies, and Wehmeyer (2004) found that an internet-based system with embedded audio, video, and picture supports was effective at improving independence for 22 transition-aged students with ID. Results also indicate that the system reduced the number of additional prompts needed to demonstrate independence.

In another study, researchers investigated the use of digital games to teach adolescents and adults new pedestrian routes in an urban environment (Brown, McHugh, Standen, Evett, Shopland, & Battersby, 2011). The authors examined the impact of skill development through a game that simulated the route to be traveled. Results indicated that all participants improved navigational skills. However, Brown et al. recommended reducing cognitive demands (e.g.

comprehension and problem-solving) during independent travel to address safety concerns and reduce the likelihood of an accident. One limitation of this intervention is generalizability, as true navigation does not involve a simulated game. For many people with ID, generalization can be challenging and without the same tool in different settings, users may be unable to utilize skills developed.

Davies, Stock, Holloway, and Wehmeyer (2010) investigated the use of a global positioning system (GPS) to support independent bus travel for adults with ID. Using a between-subjects design, researchers assessed the number of successful bus trips in two groups of adults with ID. Participants in the treatment group used WayFinder, a GPS-based custom software system delivered via a PDA, to follow a novel bus route. Individuals in the control group navigated the bus route with a commonly available bus schedule and map. Results indicate that 73% of participants in the treatment group signaled the driver at the appropriate stop and exited the bus at the predetermined destination. Only 8% of the control group successfully traveled independently. However, this intervention utilized a custom device instead of a commercially available option. Using a custom device limits the availability and affordability of an intervention (Cihak, Kessler, & Alberto, 2007).

Mechling and Seid (2011) used a hand-held personal data assistant (PDA) to teach navigation skills to three young adults with ID. Participants used a PDA with auditory, picture, and video prompts as a self-prompting device. The PDA included a picture of a person standing at the landmark which when selected, provided an auditory prompt. A video link was available below the picture for further prompting, if needed. Using a multiple probe design across destinations, researchers recorded the number of landmarks and destinations reached independently. The participants had a maximum time limit of two minutes to reach each landmark. Results demonstrated a functional relation between the use of the PDA with various levels of prompt and the destinations reached by participants. In addition to navigating more independently with the PDA, participants were able to maintain gains over time and self-adjust the level of assistance as needed. There are several limitations to consider with this study. First, instead of choosing a location spontaneously, participants were required to travel to one predetermined location. Participants started from the same location each trip and used the PDA to navigate to the specified location. Instead of simply traveling to a desired location, participants (and researchers) were required to plan a trip several days in advance. This intervention also required preparation on the part of the researcher in that materials (e.g. auditory clips, pictures, and videos) had to be prepared well in advance of the travel.

Two recent studies investigated the use of the video iPod. Cihak, Fahrenkrog, Ayres, and Smith (2010) investigated the use of video modeling via a video iPod in conjunction with the system of least prompts to increase independent transitions in students with developmental disabilities. Video modeling is a tool in which learners observe the steps to complete a task by watching a video clip, and then replicate the skill. In video self-modeling, the student is the "actor" in the clip and portrays him or herself completing the target skill. For the intervention, students watched a video of themselves successfully transitioning on a video iPod. Results indicated that all students increased independence when using the video modeling prompts and that video iPods are effective monitoring and prompting tools. Limitations to this study include: (a) the lack of spontaneous travel (students were required to travel to a predetermined location) and (b) the researchers had to prepare the materials well in advance of the transition. In another study, Schmitz (2010) found that the video iPod was effective at facilitating freedom and independence in students with ID when video modeling was incorporated.

The extant literature provides evidence that technological interventions are effective at improving independence skills in users with disabilities. Stock et al. (2004) used an internet-based intervention to improve independence, but participants were limited by a lack of mobility. Brown et al. (2011) used a video game simulation to teach navigation skills. However, this intervention lacked generalizability. Davies et al. (2010) utilized a custom GPS system to improve bus travel skills which limited the cost-effectiveness and availability of the device. Three interventions (Mechling & Seid, 2011; Cihak et al., 2010; & Schmitz, 2010) incorporated the use of handheld devices (i.e. PDA or video iPod) to implement strategies to improve independence and travel skills. However, each of these interventions lacked spontaneity and required prior planning. Results of these studies indicate prior research is limited by lack of mobility and spontaneity, costly custom equipment, and extensive planning and preparation by the researcher.

Purpose of Experiment II

Digital navigation aids are available to maximize the independent travel skills of young adults with ID (Cihak et al., 2010; Davies et al., 2010; Mechling, Gast & Seid, 2009). Through direct instruction, systematic prompting, demonstration, and practice, learners with disabilities can master the use of technological tools to facilitate independent travel. Additionally, college students with ID are expected to navigate a large college campus when attending PSE programs. This study was designed to teach students to: (a) choose a novel location from a list of options and (b) follow the on-screen visual and auditory prompts to reach the destination independently.

Experiment II evaluated the use of a mobile device application to improve navigation skills in young adults with ID. Specifically, would the Heads Up Navigator mobile application improve wayfinding skills in three young adults with ID enrolled in a PSE program? Social validity and acceptability were also addressed.

Methods

Participants and Setting

Participating students included three young adults (2 males and 1 female) enrolled in a PSE program in the Southeastern United States. All students also participated in Experiment I. All students attended classes full-time including university and program specific courses five days a week. Each student had basic cell phone operation skills including making and receiving calls, accessing text messages, using the camera feature to take pictures, and powering the device on and off. The researcher assessed these prerequisite skills the prior semester in a digital literacy coursex. None of the students had been exposed to the digital navigation tool used in the intervention previously (i.e. the Heads Up Navigator application for the Apple iPhone). (See Table 8 for participant descriptions.)

Lola. Lola was a 22-year-old student in her first year of the PSE program. Lola had an IQ of 48 when evaluated with the Woodcock-Johnson III: Tests of Cognitive Abilities which placed her in the moderate intellectual disability range. Lola received an adaptive behavior composite standard score of 51 according to the Scales of Independent Behavior-Revised. Academically, Lola's reading comprehension was equivalent to the first grade level on the Brigance Transition Skills Inventory.

Max. Max was a 25-year-old student in his second year of the PSE program. Max had an IQ of 65 according to the Stanford-Binet Intelligence Scales- Fifth Edition which placed him in the mild intellectual disability range. Max's adaptive behavior composite standard score was 75 according to the Vineland Adaptive Behavior Scales, Second Edition. Max scored at the second grade level on reading comprehension when assessed with the Brigance Transition Skills Inventory.

Will. Will was a 23-year-old student in his second year of the PSE program. Will had an IQ of 48 according to the Reynolds Intellectual Assessment Scales. Will's adaptive behavior composite standard score was 43 on the Scales of Independent Behavior-Revised. Will's reading comprehension was below first grade level according to the Brigance Transition Skills Inventory.

Setting

This study was implemented on the campus of a large Southeastern public university in the United States. With 9 undergraduate and 11 graduate colleges, the university enrolled approximately 28,000 students at the time of the study. Within the larger campus environment, the three students were enrolled in a postsecondary education (PSE) program. Designed to give young adults with ID access to college experiences, the PSE program offered access to university students who served as peer mentors, university courses completed for audit credit and program-specific courses geared to improve independent living and occupational outcomes for students. Instructors at the PSE program included faculty members in counselor education, special education and educational psychology as well as graduate students in special education, recreational therapy, and counselor education.

Data were collected within inclusive campus environments including sidewalks, common areas, and pedestrian walkways. Data collection occurred during student pedestrian transitions between buildings and campus locations. Intervention sessions occurred during natural transitions according to the students' schedules. The inclusive environments were typically populated by other university students, staff, and faculty walking across campus.

Materials

An Apple iPhone equipped with the Heads Up Navigator mobile application was used. Students in the PSE program were required to carry a cell phone at all times and several owned an iPhone prior to the current intervention. However, none of the three students in this study owned an iPhone or had previously accessed the mobile navigation application. For the purpose of this experiment, an iPhone provided by the PSE program was used to deliver the intervention. Students received pretraining on the basic usage of the iPhone prior to the intervention and a specific application training session after the baseline phase.

The iPhone used in the current investigation was equipped with the *Heads Up Navigator: 3D Augmented Reality Navigation* (Niftybrick, 2010). Augmented Reality (AR) is based on the original concept of Virtual Environments (also known as Virtual Reality) (Azuma, 1997). In Virtual Reality, users are completely immersed inside an artificial environment and are unable to see the outside world. AR functions differently in that users see both the real world and virtual objects superimposed on their surrounding environment (Azuma). The Heads Up Navigator mobile application combines Google Maps with AR features to enable real-time navigation prompts to users. These embedded visual prompts appear as hovering arrows and named landmarks when viewed through the camera feature and directed toward a specific destination.

The prompts also include the distance to the location in miles. The Heads Up Navigator interface functions similarly to a compass in that the arrows are continually oriented toward the final destination. A small embedded map also appears at the bottom of the screen with a pinpoint showing the current location of the navigator. Figure 5 illustrates a screenshot of a user's view.

The Heads Up Navigator application was available for free download via Apple's App Store and requires an iOS (Apple's mobile operating system) of 3.1 or later. The App Store is available on all iPhones and is an online service in which consumers browse, download, and purchase software applications (e.g. games, AT, or educational tools) for smartphones, tablets, and desktop computers. The Heads Up Navigator mobile application must be downloaded via an internet connection, but once downloaded, functions independently. It relies upon Global Positioning System (GPS) data to deliver location information to users. The Heads Up Navigator must be free of interference (e.g. roof or bus stop alcove) in order for the GPS to operate.

Variables and Data Collection

The dependent variable was the number of independent way-points recorded when traveling to target destinations. An independent way-point decision was defined as indicating the correct turn-by-turn direction to get to the final destination (i.e. forward, left, or right). An assisted way-point decision was defined as needing a prompt delivered by the researcher or research assistant to get to the final destination. Event recording data collection procedures were used to record the number of independent and assisted way-point decisions. The total number of independent way-points was then divided by the total number of way-points possible to calculate the percentage of independent way-points. The mobile navigation application served as the independent variable. Each student traveled to one destination per session with one session recorded per day. Students participated in the intervention three days per week and began navigating from the same initial location every session.

The procedures were implemented by the researcher and a research assistant majoring in special education at the university. The research assistant was an undergraduate student who participated in the PSE program as a peer mentor. The researcher individually trained the research assistant to collect data and implement the intervention. The training sessions consisted of instruction on using the data collection forms, the system of least prompts, and using the mobile navigation application on the iPhone. The research assistant then practiced implementing the implementation procedures, using the navigation application, collecting data, and implementing the system of least prompts. The researcher observed the research assistant complete each step of the navigation application by using the treatment integrity task analysis. Training continued until each student implemented all procedures with 100% accuracy for three consecutive trials. Additionally, the researcher observed the research assistant collect data for the first two weeks of the intervention to answer questions and problem-solve.

Experimental Design

An ABAB design (Gast, 2010) was used to determine the efficacy of the mobile application and independent navigation between novel locations. The ABAB design allowed for replication within participants and comparison effectiveness across phases. The experiment included four phases: baseline, mobile application, no mobile application, and reinstated mobile application. The criterion for changing phases were based upon achieving stability in the data (Kennedy, 2005). For baseline (initial A), a stable baseline was achieved when data did not vary more than 20% from the mean for three consecutive days. In the first mobile application phase

(B), the criterion for changing phases was defined as 100% independent waypoint decisions for three consecutive days. In the withdrawal phase (no mobile application), criterion for changing phases was defined as three data points of a descending trend that approached baseline mean levels. Finally, criterion returned to 100% independent waypoint decisions for three consecutive days during the reintroduction of the mobile application (second B).

Experimental Procedures

The experimental procedures included pretraining, mobile navigation application training, campus map, and mobile application phases. First, students were assessed using a campus map to independently travel to an unfamiliar destination. Afterwards, the students were taught how to use the mobile application and assessed using the application to independently travel to an unfamiliar destination. The campus map and mobile application phases were reapplied to demonstrate a functional relation.

Baseline. Baseline data were collected for a minimum of three sessions or until stability was achieved. A session was defined as a one-on-one period of time in which the primary focus was navigating to a novel location independently. During the baseline phase, students traveled to one novel location per session and began navigating from the same initial location every session. Students were asked if they were familiar with a specific building on campus. If they reported to be unfamiliar with the location, they were asked to attempt to navigate to the location using a campus map. The map was the traditional campus map available at parking services given to all students at orientation. The campus map also was available at campus bus stops. The map featured campus streets and a key with building names. At a series of "waypoints," students were asked to make a decision as to which direction to travel from that location (e.g. forward, left, or right). At each waypoint, the researcher said “Which direction do we go from this point?” The student’s response was recorded, and assistance was provided if the student indicated an incorrect direction answer. The number of correct independent waypoint decisions was tallied at the end of the session. (See Appendix C for sample data collection form.)

Pre-training. Pre-training was provided to each participate to ensure that they could independently access and use the mobile application. Model-Lead-Test procedures (Adams & Engelmann, 1996) were used to instruct each student. First, the researcher modeled each step of the task analysis regarding how to access and use the mobile application. Second, the researcher led each student as they performed each step of the task analysis. Contingent on student independent performance, the researcher provided verbal praise. Contingent on student errors or no response, the researcher implemented the system of least prompts with a 4 s response time between prompt levels until the student correctly performed the step of the task analysis (Ault & Griffen, 2013). The system of least prompts included (a) verbalizing what to do, (b) verbalizing and gesturing on the device regarding the step to be performed, and (c) providing partial-physical assistance by guiding the student’s hand to complete the step while verbalizing the step. Third, the researcher tested each student to turn on the device, open the mobile application, use the mobile application, and then close the application. The pre-training phase continued until each student could independently perform each step of the task analysis for three consecutive trials.

Mobile Application Procedures. The intervention was implemented in inclusive settings within the university including pedestrian walkways, sidewalks, and cross-walks. Predetermined locations were programmed into the mobile navigation application prior to each session. At the beginning of each session, students were asked if they were familiar with a specific building on campus. If they reported that they were unfamiliar with the location, they were asked to attempt to navigate to the location using the iPhone and mobile application. The students accessed the mobile navigation application, chose the destination from the pop-up menu, and followed the on-screen visual prompts to travel to the location. At each waypoint the researcher or research assistant asked "Which direction do we go from this point?" The student's response was recorded as independent or with assistance from the researcher or research assistant. Contingent on a correct response, verbal praise (e.g. "That's correct") was provided and we continued to the next waypoint. Contingent on an incorrect response, the system of least prompts was implemented similar to the pre-training phase. The number of independent waypoint decisions was totaled at the end of the session. Students continued to use the mobile application until they reached criterion of navigating waypoint decisions independently for three consecutive sessions with 100%.

No Mobile Application Procedures. After reaching the destination independently for three consecutive sessions, the mobile application was withdrawn. Similar to baseline phase, students traveled to one novel location per session only using the campus map. At the beginning of each session, students were asked if they were familiar with a specific building on campus. If they indicated that they were unfamiliar with the location, they were asked to attempt to navigate to the location using the campus map. At a "waypoint," students were asked to decide which direction to travel from that location (e.g. forward, left, or right). At each waypoint, the researcher or research assistant asked "which direction do we go from this point?" the student's response was recorded, and assistance was provided if the student indicated an incorrect direction answer. The withdrawal phase continued for a minimum of three sessions, or until student performance approached baseline mean levels.

Mobile Application Reinstated Procedures. The criteria to reinstate the intervention phase occurred when the mean of the withdrawal phase approached the mean of the baseline phase or the student's performance trended in the opposite direction of the intervention. Similar to the previous mobile application procedures, students were asked if they were familiar with a specific building on campus at the beginning of each session. If they reported that they were unfamiliar with the location, they were asked to navigate to the location. Students then traveled to the destination with the mobile application enabled on the iPhone. Sessions continued until students reached criterion of 100% independence for three consecutive sessions.

Social Validity Procedures

At the conclusion of the study, social validity was assessed. It was important to assess social validity as it gave a voice to the students. The participating students were asked to complete a social validity questionnaire. The survey used a 5-point Likert-type scale with picture symbols of "thumbs-up" and "thumbs-down" to represent the top, middle, and bottom points on the scale. The questionnaire also included three constructed response questions to allow students to describe their opinions in greater detail. (See Table 9 for the participating students' social validity questionnaire.) Additionally, the research assistant who collected data throughout the experiment was asked to complete a short social validity questionnaire. The questionnaire was composed of eight questions that used a 5-point Likert-type scale. (See Table 10 for the researcher's social validity questionnaire.) The researcher also debriefed the research assistant in a semi-formal interview to discuss the results and implications of the experiment.

Data Analysis Procedures

Visual analysis procedures were used to evaluate the results of experiment II. To assess intervention effects, six features were used to examine within- and between-phase data patterns: (a) level, (b) trend, (c) variability, (d) immediacy of the effect, (e) overlap, and (f) consistency of data patterns across similar phases (Kratochwill, 2010). Also, within-phase comparisons were assessed to evaluate predictable patterns of data, data from adjacent phases were used to assess whether manipulation of the independent variable was associated with change in the dependent variable, and data across all phases were used to document a functional relation (Gast, 2012). Horner et al. (2005) suggested that a functional or causal relationship is established when at least three demonstrations of an intervention effect at a minimum of three different points in time are observed. In addition, the percentage of non-overlapping data (PND) approach was used to calculate the percentage of non-overlapping data between baseline and the intervention phases (Scruggs, Mastropieri & Casto, 1987). Scruggs and Mastropieri (2001) suggested interpretational guidelines of PND, specifically PND greater than 70% was considered a highly effective intervention, PND greater than 50% and less than 70% was considered questionable effectiveness, and PND less than 50% was considered unreliable effectiveness for interventions.

Interobserver Agreement (IOA) and Treatment Integrity

The research assistant collected data during all of the sessions and the researcher collected data simultaneously during 50% of the baseline sessions and at least 50% of the intervention and withdrawal sessions. In addition, IOA data were collected during 50% of the training trials for teaching students how to operate their iPhone and access the navigator application. The research assistant was trained in event recording data collection procedures, as well as operational definitions of correct and incorrect waypoint decisions. The percentage of IOA was calculated for each student by adding the number of agreements and dividing by the total number of agreements and disagreements and multiplying by 100%. The percentage IOA ranged from 80% to 100% (*M* = 97%). Lola's ranged from 84% to 100% (*M* = 97%), Max's ranged from 86% to 100% (*M* = 97%) and Will's ranged from 80% to 100% (*M* = 98%).

The research assistant also implemented all intervention procedures. Intervention procedures included: (a) checking the iPhone battery charge prior to the session, (b) assisting the student in reaching the front steps of the building prior to the session, (c) asking the student if they were familiar with the specific location, (d) allowing 10 seconds of wait time, (e) providing prompts when an incorrect direction was indicated by the student, or praise for correct responses, (f) observing safety precautions when traveling with the participating student, (g) recording responses throughout the session, and (h) tallying correct independent responses at the end of the session. (See Appendix D for treatment integrity document.) Treatment integrity was assessed during all training and intervention phases by direct observation by the researcher on a treatment integrity form that included a task analysis of the steps to implement the experiment. Treatment integrity verified the navigating student and data collector's behavior for a minimum of 40% of the sessions of each phase. Procedural integrity was calculated by dividing the number of observed behaviors by the number of anticipated behaviors and multiplying by 100% (Billingsley, White, & Munson, 1980). The overall mean treatment integrity was 95 % (range = 80%-100%). Lola's treatment integrity ranged from 87% to 100% (M = 95 %), Max's ranged from 87% to 100% (M = 97 %), and Will's ranged from 80% to 100% (M = 93%).

Results

None of the students engaged in independent navigation and wayfinding during baseline. During baseline, the average independent waypoint decisions for all students was 28% (range = 0-50%). During the mobile application phase, all students improved independent waypoint decisions to a mean of 94% (range = 71-100%). When the mobile application was withdrawn, independent waypoint decisions for all students decreased to an average of 24% (range = 0-42%). However, when the mobile application was reinstated, the mean independent waypoint decisions for all student increased to 99% (range = 86-100%). The overall mean student performance indicated that the mobile application was an effective tool to assist students in making waypoint decisions independently. In addition, students required an average of 5 sessions to reach criteria.

Lola. During baseline, Lola's percentage of independent waypoint decisions was 18% (range = 0-50%). During the mobile application phase, her number of independent waypoint decisions increased to 92% (range = 71-100%). When the mobile application was withdrawn and she relied upon the traditional map only, Lola's independent waypoint decisions decreased to a mean of 16% (range = 0-25%). However, Lola's percentage of independent waypoint decisions returned to a mean of 100% after the mobile application was reinstated. During both mobile application phases, Lola immediately improved her independent waypoint decisions with 100% nonoverlapping data (Scruggs, Mastropieri, & Casto, 1987), which indicates highly effective interventions (Scruggs & Mastropieri, 2001). (See Figure 6 for Lola's percentage of independent waypoint decisions.)

Max. In baseline, Max's percentage of independent waypoint decisions was 32% (range = 20-43%). His percentage increased to 96% (range = 89-100%) during the initial mobile application phase. During the withdrawal phase, Max's percentage of independent waypoint decisions fell to an average of 35% (range = 29-38%). Finally, during the reinstated mobile application phase, his percentage of independent waypoint decisions returned to an average of 100%. During both intervention phases, Max immediately improved his percentage of independent waypoint decisions with 100% nonoverlapping data (Scruggs, Mastropieri, & Casto, 1987), which indicates highly effective interventions (Scruggs & Mastropieri, 2001). Max's average percentage of independent waypoint decisions was highest during the reinstated mobile application phase. (See Figure 7 for Max's percentage of independent waypoint decisions.)

Will. During baseline, Will's percentage of independent waypoint decisions was 33% (range = 20-50%). This percentage increased to 94% (range = 75-100%) during the initial mobile application phase. When the navigation application was withdrawn, Will's independent waypoint decisions fell to an average of 23% (range = 11-42%). In the final phase, reinstatement of the mobile application, Will's percentage of independent waypoint decisions returned to an average of 97% (range = 86-100%). During intervention phases, Will immediately improved his percentage of independent waypoint decisions with 100% nonoverlapping data (Scruggs, Mastropieri, & Casto, 1987), which indicates highly effective interventions (Scruggs & Mastropieri, 2001). Will's average percentage of independent waypoint decisions was highest during the reinstated mobile application phase. (See Figure 8 for Will's percentage of independent waypoint decisions.)

Results indicated that all students responded positively to the intervention as indicated on the social validity questionnaire. Students indicated they liked using the mobile application to find locations and that using this tool helped them improve their navigation skills. When asked what he liked best about the mobile navigation application, Max responded, “It showed me where the places were. I don’t know where everything is.” Will thought the mobile application was “a lot of fun” and Lola described it as “kind of easy”. (See Table 11 for results from social validity questionnaire.)

Additionally, results indicated the research assistant agreed or strongly agreed that (a) the target skill of navigation was important, (b) the time spent assessing navigation skills was a good investment for students, (c) the assessment procedures were appropriate, (d) the data collection forms were easy to use, (e) assessing navigation skills is a valuable practice, (f) collecting data was a good use of time, (g) collecting data for this experiment was useful in learning more about working with young adults with ID, and (h) that the research assistant would consider using the intervention techniques again in the future if possible.

Discussion

The purpose of this study was to examine the effectiveness of a mobile application (i.e., Heads Up Navigator) to teach three students to travel independently. All students successfully selected a novel location from a list of options and followed the on-screen visual and auditory prompts to reach its destination independently. Prior to the study, all of the students demonstrated basic technological skills (e.g. cell phone usage, document creation), but none could navigate to a novel location independently. A functional relation was established since experimental control occurred by demonstrating data variation patterns in at least three different series at three different points in time between independent navigation and the introduction the mobile application (Horner et al., 2005).

These findings extend previous literature in several ways. Through the use of commercially available devices and applications, students were able to improve navigation and self-determination skills. Students were able to travel to novel locations independently without the use of video modeling, or time intensive visual aids. Finally, the mobile application offered a socially valid tool for students to improve skills.

Limitations

To fully interpret and apply the results of the study, there are several limitations to consider. As in all single-subject case designs, a small number of students participated in this study ($n = 3$). Conclusions from the study should be interpreted and applied to a small number of participants. Future research should consider the use of a larger sample size to increase external validity and generalizability. Additionally, the three participating students shared similar characteristics (e.g. disability diagnosis, cultural and socioeconomic backgrounds). All of the students attended a PSE program for highly motivated adults with disabilities. Therefore, results cannot be generalized to all young adults with disabilities or other age groups. Also, due to time constraints involving the university calendar, no maintenance probes were collected in this study. This limiting factor should be addressed in future research. Finally, the application was only available to iPhone users and required access to both a WiFi network and GPS for functionality.

Future Research

As the results of this experiment can be interpreted to suggest, the mobile navigation application may be effective at improving navigation and wayfinding skills for students with ID.

It is necessary to evaluate this tool with other groups and participants, particularly those of different cultural and socioeconomic backgrounds and age groups. The mobile navigation application should also be investigated in community settings with natural supports available to improve navigation in a variety of locations. The social acceptability of this tool offers users the opportunity to improve navigation skills in a socially valid and acceptably way.

Chapter 4

Discussion

The two experiments in this investigation shared a common purpose: to improve the autonomy of students with ID within PSE environments through the use of mobile devices. The first experiment investigated the use of mobile technology to facilitate and improve digital communication skills. Similarly, the second experiment focused on the use of mobile technology to facilitate independent navigation via an augmented reality application within inclusive college environments. Both experiments successfully incorporated the use of mobile technology supports to improve independence in postsecondary students with ID.

These findings support previous findings that suggest that mobile technology is an effective tool to teach independent skills to learners with disabilities (Cihak et al., 2010; Schmitz, 2010), to improve communication skills (Douglas et al., 2009), and to develop navigation skills in users with ID (e.g. Brown et al., 2011; Davies et al., 2010; Stock, Davies, Wehmeyer, 2004).

PSE and Adult Participants

This study extended the literature in several ways. First, these studies were conducted in a PSE setting and included adults with ID. Most previous studies that examined technological interventions for students with ID have incorporated the use of children in K-12 settings (Cihak et al., 2010; Mechling & Seid, 2011; Riffel et al., 2005). The current studies expanded the knowledge base by including adults with ID using mobile technology. The participating students were between the ages of 23-25. By including a different age group to complement the existing literature, the current study increases the external validity of previous research.

One of the major benefits of PSE is improved self-determination skills for students. These studies capitalized on this benefit by incorporating opportunities for self-awareness, choice-making, and autonomy. Students with ID who exhibit higher levels of self-determination have better outcomes throughout adulthood including employment and financial freedom (Wehmeyer & Palmer, 2003; Wehmeyer et al., 2007). Weinkauf (2002) found that PSE programs promoted outcomes for students including improved academic and job skills, and the development of self-esteem and confidence. These studies support these findings as participants demonstrated improved skills and confidence. Students acquired an effective manner to communicate and navigate to unfamiliar places. Lachapelle et al. (2005) established that self-determination was significantly correlated with higher quality of life. As students mastered communicating via the mobile applications, or navigated independently, they developed self-determination skills and increased autonomy.

Furthermore, these studies occurred in a university setting where participants were surrounded by natural supports and peers without disabilities. The majority of previous intervention based studies occurred in K-12 school settings. As members of a PSE program, students in these studies benefitted from: (a) positive same aged role models, (b) enhanced social status, and (c) identity development as college students. These findings support previous research on PSE for adults with ID (e.g. Weinkauf, 2002). In these studies, students participated in typical college activities such as buying lunch or talking with friends at a coffee shop. Through these peer interactions, students practiced socialization and communication skills. Furthermore, students developed an understanding of social norms and age-appropriate interests. The inclusive opportunities afforded to PSE participants during these studies enhanced opportunities for socialization and language development.

Mobile Technologies

Second, these studies incorporated the use of mobile technologies. The portability of the devices and applications (i.e. the Apple iPhone, iMessage, HeyTell, Tango, and Heads Up Navigator applications) provided students with continuous supports in any setting at any time. Students accessed mobile digital assistance as needed. Rather than requiring a family member or personal assistant to navigate to a location, or to send and reply to a text message, students in these students could function more autonomously. Walking through any college campus, one would observe many students with headphones, cellular telephones, or tablet devices in hand. Teaching students with ID to use these tools, with the addition of mobile digital assistance, promotes inclusion and a “tech-savvy” appearance.

Mobile technology can be categorized as commercially available or custom-designed (Cook & Hussey, 2002). Cook and Hussey defined commercially available as mass-produced devices that are offered to the general public. However, when a commercially available device does not meet the needs of the user, it must be customized. If customization is not available, a custom device must be created to meet the needs of the user for the current task which requires additional time and money. Custom devices are expensive in that they are “one of a kind” creations for a single user (Cihak et al., 2007).

Cihak et al. (2007) noted that many commercially available devices now incorporate the theory of Universal Design (design for inclusion and access for all) by utilizing a variety of display and accessibility features (e.g. read aloud function for text messages). Given this new design perspective, a wide range of standard accessibility options exist in mass-produced devices, which in turn provides more opportunities for success without customization. Now commercially produced devices are equipped with the necessary digital assistance for users with ID which greatly improves the likelihood of access for all. Other advantages of using commercially available devices include the availability of training manuals, customer support, and repair services (Cihak et al.). Instead of a costly custom device, the mobile applications used in these studies were free. Each of the mobile applications (i.e. HeyTell, Tango, and Heads Up Navigator) was accessible via the App Store for free download. The Apple iPhone messaging tool, iMessage, available on all iPhones (version iOS 4 and later), is equipped with standard accessibility features such as read aloud voice-over and speech-to-text operations. These devices offer user-friendly on-screen instructions to access these features. iMessage allows users of iPhones, iPads, and the iPod Touch to communicate digitally without cellular telephone service. In contrast to previous studies that incorporated stationary technology platforms (Brown et al., 2011; Stock, Davies, & Wehmeyer, 2010), or customized assistive technology (Davies et al., 2010; Mechling & Seid, 2011), these studies utilized commercially available mobile technology which was both free and portable. The combination of these two factors allowed users to access mobile supports in a cost-effective, socially valid way.

Both digital applications provided immediate positive and natural consequences for the students. Stokes and Baer (1977) posited that students need only minimal exposure to a salient natural reinforcer for lasting effects. This implies that rather than continuing to present contrived intervention sessions, the embedded natural reinforcer provides the motivation for continued use. Prior to being introduced to the applications, students could not send an effective message or travel independently. In baseline in experiment I, students sent low quality messages which resulted in a communication breakdown. A communication breakdown is an interrupted or failed communication attempt due to a misinterpretation or inability to understand a message (Halle, Brady, & Drasgow, 2004). It might happen when people communicate (or try to communicate) with a partner but do not receive a desired response from that partner. Breakdowns often have happened when the partner requests clarification (Halle et al., 2004). However, with the introduction of the mobile applications, students accurately could convey their communicative intentions resulting in complete communication and reinforcement. Students accessed naturally maintaining contingencies (Greenwood, Delquadri, & Hall, 1984) and were motivated to participate. The mobile applications were easy to use and enjoyable for students and researchers. As Lola noted when asked what she liked best about the mobile application HeyTell, "It's fun."

These findings have implications for practitioners. Most teacher preparation programs include courses on using technology for instruction and data collection. The mobile applications used in these studies are user-friendly, inexpensive, and low-maintenance. Teachers would not need to invest time and energy developing visual aids, flashcards, or video demonstrations. This increases the likelihood that teachers would use these applications in the classroom. Additionally, these devices and applications require minimal maintenance (e.g. occasional software updates) and are available at local retailers.

Leisure and Work Readiness

Third, the current studies provided supports to facilitate leisure and work readiness skills. Digital communication is key to networking socially and professionally (NCD, 2011). In experiment I, students were instructed to respond to the initial text message in a professional manner (i.e. with a response that would be acceptable at work). Students were instructed to respond in this manner for several reasons. First, the overarching goal of PSE is to prepare students with ID for competitive employment. As part of this preparation, students learn to interact appropriately with employers, supervisors and coworkers. To practice generalizing these skills, students were asked to respond professionally. This also reduced the cognitive burden on students. Instead of deciding if their response was appropriate for the receiver, students knew to respond professionally which reduced decisions and anxiety. Improved communication skills result in higher levels of self-determination, improved relationships, and success in the workplace.

When using the communication application in experiment I, students were not constrained by limited vocabulary in their communication efforts. Instead, they were able to expand on their ideas and communicate more fully with their partner. To assess the quality of the communicative interactions, a 12-point rubric was used that assessed (a) grammar/ mechanics/ semantics, (b) relevance of response (comprehension), (c) professionalism, and (d) independence (percentage of independent steps completely correctly.) The quality of communication improved for every student over the course of the study. For example, in baseline Max was asked the question via traditional text message, “Why did you choose your university audit course?” He replied, “Iam not taking english iam taking sport mangment.” This response includes grammar and mechanical errors, is irrelevant (not related to the question), and unprofessional. After mastering the HeyTell application, Max was asked via HeyTell, “Can you tell me about your dream job?” He replied “My dream is to get a part-time job as an assistant football coach.” This response is grammatically correct, relevant to the initial question, and professional. Simply by removing the text and replacing it with an audio voice message, Max was able to significantly improve the quality of his communication. In baseline, Ann was asked, “Can you tell me about your favorite social time activity this semester?” She responded, “rick climbing.” This response contains spelling errors, is missing components, and is an incomplete thought. At the end of the Tango intervention, Ann was asked through a Tango message, “Can you tell me your plans for after graduation?” She replied “When I graduate I want to find a job in an office and remodel my room.” This response is grammatically correct, relevant, and professional. Ann was able to answer the question coherently and completely. During baseline, Lola was asked, “Can you tell me how you get ready to come to school?” She replied “get for school.” This response contains grammatical errors, is incomplete, and irrelevant. After mastering the HeyTell application, Lola was asked via HeyTell, “Can you tell me about your favorite summer activity?” Her response was “I am going to play with my dog this summer.” This response is grammatically correct, relevant, and professional. In a final example, Will was asked, “Can you tell me what you are learning about in your independent living skills class?” Will was unable to respond at all to this message due to low literacy skills. At the end of the Tango intervention, Will was asked via Tango, “Can you tell me about your favorite social time activity this semester?” He replied “My favorite social time activity is hanging out with friends and having a good time.” This reply is grammatically correct, relevant, and professional. By using communication supports, people with ID are more socially included and are able to communicate with friends, family, and coworkers. Adequate communication skills limit isolation for people with ID (DeZonia, 2009). Rather than being limited by a communication or literacy difference which may result in communication breakdowns, people with ID can focus on the essence of the message.

Navigation is another contributing factor to leisure and work skills development. According to the National Council on Disability (2011), one third of people report that transportation is a major obstacle to employment and independent living. To improve transportation options, students with ID need to learn ground-level navigation skills. In the second experiment students learned to travel to familiar and unfamiliar locations. Independent travel with the necessary supports decreases safety concerns for students with ID. It can be difficult for users with ID to stay oriented if surroundings look similar (Chang et. al, 2010). The mobile navigation application removed this factor by producing an augmented reality visual prompt (e.g., arrow similar to a compass) that was visible against all backgrounds. Whether traveling to work or visiting a friend's apartment, mobile navigation tools provide students with an ever-present digital assistant. This provides added security for parents or caregivers of students with ID.

Another benefit of the mobile navigation intervention was that it provided students with an opportunity to travel spontaneously without laborious planning. After choosing their desired location from the menu, students were able to navigate independently via the mobile application. Rather than relying upon researcher preparation, the mobile navigation application utilized a GPS signal to create the embedded prompts. The GPS system was also more flexible than a preplanned route delivered via video modeling in that if a student veered from the original course, the mobile application simply recalculated the directions. This immediately provided a visual prompt to orient the student toward the destination. A prerecorded video or audio prompt would rely solely upon one predetermined route. Therefore, the user would be unable to reroute, if needed.

Communication

These studies suggest benefits specifically for students with low literacy skills. In experiment I, all three communication applications improved communication for three of the four students (i.e. Ann, Lola, and Max). Lola preferred iMessage for digital communication, Ann preferred HeyTell, and Max preferred Tango. Will, however, was unsuccessful in mastering the iMessage application. This was due in large part to Will's deficits in reading comprehension, decoding, and written expression skills (i.e. equivalent to below first grade). He was able to access the iMessage application, use the read aloud function, and listen to the initial message, however he was unable to write a response in return. Will was successful in mastering the other two mobile communication applications (i.e. HeyTell and Tango). In fact, Will was able to master and ultimately preferred the Tango application. This is notable due to the fact that Tango has considerably more steps to complete than HeyTell or iMessage (i.e. Tango = 11 steps, HeyTell = 4 steps, iMessage = 7 steps). Therefore, while Will's literacy skills were too low to create a text response via iMessage, he was able to master the more complex Tango application. As a socially active person, Will desired to interact and communicate with friends and family via the Tango communication application, which included audio and video components. This finding has implications for other students with both low literacy skills and speech/language disabilities. For users with speech/language disabilities, HeyTell and Tango record the actual voice (and actions in the case of Tango) to be relayed to the communicative partner. For those familiar with the speech patterns of the user, the video component of Tango adds to the understandability and intelligibility of the message. Additionally, for students with limited social skills or reduced understanding of emotions in others, the HeyTell and Tango applications allowed the student with ID to hear and see the emotions and inflections in the voice and facial expressions of the communicative partner. These added cues can help the student with ID to understand the emotional context of the message.

The mobile applications (particularly HeyTell and Tango) offered opportunities to communicate with family and coworkers in an effective and socially valid way. With the rise in availability of technology, students with ID can engage in relationships and important communicative dialogues. For all employees, contact with coworkers and supervisors is a daily factor of employment (e.g. calling in sick to work). Many companies employ the use of email and text message communication. Employees with ID may be unable to use traditional text message systems to receive or deliver important news. Further, social networking sites such as Facebook and Twitter are often used by companies to communicate with employees and develop rapport. With mobile digital assistance, people with ID can access and network with friends and coworkers.

Limitations

Although this study indicated positive outcomes, conclusions must be interpreted within the context of this study and several limitations need to be considered. For example, only a small number of students participated similar to other single-subject design studies ($n = 4$ in experiment I; $n = 3$ in experiment II). The small size makes it difficult to generalize the results to a broader population. This study requires replication across a larger number of participants. Participating students also were diagnosed with ID. People with ID are a heterogeneous population. Further investigations that include participants with a range of characteristics are warranted.

The quality rubric used in experiment I is a second limiting factor. As the rubric was developed solely for the purposes of this study, its reliability and validity were not established. Future researchers would benefit from determining if the rubric was valid (i.e. did it assess what it was supposed to) and reliable (i.e. would the rubric produce consistent results across time and trials). Other indicators may need to be added to the rubric depending on the context and audience. For example, when communicating with family or friends, many people use abbreviations, colloquialisms, and emoticons (visual representation of a facial expression). While valid and appropriate in these settings, this type of communication would be considered casual and unprofessional in a workplace setting. Future research should investigate communication with a variety of recipients in various settings.

A third limiting factor to consider is the possibility of carryover or practice effects. Despite the random presentation of communication applications in experiment I, it is possible that some of the skills carried over to a different application resulting in success. Also, three of the four students participated in both experiments. Though the experiments utilized different mobile applications, and occurred at different points in the semester, it is possible that this double exposure resulted in some carryover or practice effects.

Another limitation is the requirement of fine motor and visual skills to access all of the mobile applications. Each application used the Apple iPhone for delivery. The iPhone is small in size and features a sensitive touch-screen. For users with limited fine motor or vision skills, the iPhone would not be conducive to success. Future research should investigate other options and devices such as the iPad, which features a larger screen and may be accessed via a traditional mouse or keyboard. The iPad is also capable of connecting to other assistive devices, such as gaming controllers.

Finally, it is important to consider the limitations of the technology itself. Each of the applications was available for download via the internet, which required users to have access to the internet; preferably with a high-speed connection. All of the communication applications required access to a Wi-Fi network for functionality. While the navigation application, Heads Up Navigator, did not require constant access to the internet to function, it did require initial internet access for download and set up as well as access to Google Maps at the beginning of each session. Therefore, an internet connection was required at every session. Another limitation of the navigation application is the fact that it utilized GPS technology to function. Interference by tall buildings, roofs or trees overhead causes the application to function poorly or to become inoperable.

Another consideration within the technology itself is access. The mobile applications used in these studies were available to iPhone users. Two of the applications (i.e. iMessage and Heads Up Navigator) are available only to iPhone users and incompatible with Android or other brand devices. Often, students with ID may not have access to iPhones because of the perceived complexities. Instead, students and families choose simpler models without many of the "bells and whistles" of the iPhone. Additionally, many employers are not familiar with the mobile applications utilized in this study. Employees may not have access to an iPhone (for iMessage or Heads Up Navigator access) or to the internet (for HeyTell and Tango). Additionally, employers may be hesitant to install these applications and/or add their employee with an ID to the trusted network of communication partners (as is required for both HeyTell and Tango).

Future Research

As the results of these studies can be interpreted to suggest, mobile applications may be effective tools to improve communication and navigation skills in students with ID within PSE settings. In order to generalize these results, it is necessary to evaluate these interventions with other groups of students. Diverse groups of various ages and ability levels should be utilized in future research. Future research should consider the development of social and language skills for students using these mobile applications. Additionally, other settings should be investigated with the techniques developed in the current study.

Future research also should consider the use of new procedures to implement the intervention. New procedures may include new protocols, other dependent variables, or different error correction procedures. It will be important for future researchers to evaluate the instructional components and tools necessary for success and productivity when designing interventions. Future researchers should consider pre-requisite skills necessary to successfully use the mobile applications featured in these studies. For example, users must be able to attend to the screen, operate the device controls, and interpret the auditory and visual input. As a final procedural limitation, this study lacked maintenance phases due to time constraints related to the university calendar. In order to verify that students maintained these skills over time, future research should incorporate maintenance probes.

In addition, researchers should investigate the usage of technology that is accessible to those with limited abilities. The mobile applications in this study operated on the iPhone platform, which is not accessible to users with limited fine motor skills. The screen is small in size (approximately 4 x 2 inches) and responds to even a minimal touch. The applications also presented a cognitive load that may be inaccessible to users with limited cognitive skills. Cognitive demands included completing multi-step processes and internalizing a variety of prompts, feedback, and sensory input. A cognitive overload may lead to safety issues as students attempt to navigate using digital technology, digest the information from the device, and look at a screen while walking. This input also may be difficult for users with sensitivity to sensory input. Individuals with complex communication needs would have difficulty accessing and using these applications as they require verbal input and emit auditory messages. Other applications should be explored to meet the needs of a diverse group of users including those with motor, cognitive, or communication needs.

Although the teaching and research of mobile devices to people with ID requires continued attention, these studies demonstrate positive outcomes for the participating students. Disability is not the defining characteristic of the participant, nor is it necessarily a barrier to participation. Information and communication technology skills can have a particularly equalizing effect. Mobile technologies can be a resource for people with ID. They can use it for school, communicate with others, search for job opportunities, and build a network of supports. Mobile technologies can act much like a portable personal assistant. The first step in using mobile technologies is ensuring that students with ID can access and use digital literacy skills. These studies demonstrated the feasibility of increasing communication and navigation skills by teaching students how to use these skills effectively and over time. The challenge to educators is to assist students with ID to develop the 21st century skills that enable people with disabilities to fully realize technology’s positive effects of this global network, multimodal, digital age of information and communication.

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Appendices

Table 1. Participant Descriptions

Name	Age	IQ	Adaptive Score	Reading Grade Level Equivalent
Will	23	48[a]	43[d]	>1st grade[f]
Max	25	65[b]	75[e]	2nd grade[f]
Lola	22	48[c]	51[d]	1st grade[f]
Ann	24	64[c]	71[e]	5th grade[f]

Note: a. Reynolds Intellectual Assessment Scales b. Stanford-Binet Intelligence Scales, 5th Ed. c. Woodcock-Johnson III: Tests of Cognitive Abilities d. Scales of Independent Behavior-Revised e. Vineland Adaptive Behavior Scales, 2nd Ed. f. Brigance Transition Skills Inventory

Table 2. Digital Communication Rubric

Participant: ____
Date: ____
Treatment: ____

AREA	0	1	2	3	SCORE
Grammar / Mechanics / Semantics	Message contains more than 4 errors in spoken grammar or written grammar/mechanics or word usage (e.g. homophone)	Message contains 3-4 errors in spoken grammar or written grammar / mechanics or word usage (e.g., homophone)	Message contains 2-3 errors in spoken grammar or written grammar/ mechanics or word usage (e.g., homophone)	Message consists of no more than 1 error in spoken grammar, written grammar / mechanics (including spelling) or word usage (e.g., homophone)	
Relevance of Response (Comprehension)	Response is not relevant or is missing most required components for the message to be understood	Response is mostly relevant to the question, but is missing components or does not provide a complete answer	Response is fully relevant to the question, but is missing a component or provides a partially incomplete answer	Response is fully relevant to the question and contains all components required	
Professionalism	Response is not expressed as a complete thought or lacks respectful tone or appropriateness of language for the recipient, context, and technology	Participant responds with a partially complete thought or demonstrates minor lack of respectful tone, appropriateness of language for the recipient, context, and technology	Participant responds with a complete thought that is expressed mostly using a respectful tone and appropriate language for the recipient, context, and technology	Participant responds with a full sentence / complete thought that is expressed using a respectful tone and appropriate language for the recipient, context, and technology	
Independence	<80% steps completed independently	80% steps completed independently	90% steps completed independently	100% steps completed independently	
				TOTAL SCORE	
				PERCENTAGE	/12 = ______

Table 3. Randomized List of Digital Tools by Participant

	Participant			
Session	Ann	Lola	Max	Will
1	HeyTell	Tango	Tango	iMessage
2	iMessage	iMessage	iMessage	Tango
3	Tango	HeyTell	HeyTell	HeyTell
4	Tango	Tango	Tango	HeyTell
5	iMessage	HeyTell	HeyTell	iMessage
6	HeyTell	iMessage	iMessage	Tango
7	Tango	HeyTell	iMessage	HeyTell
8	HeyTell	iMessage	HeyTell	iMessage
9	iMessage	Tango	Tango	Tango
10	Tango	Tango	Tango	Tango
11	iMessage	HeyTell	HeyTell	HeyTell
12	HeyTell	iMessage	iMessage	iMessage
13	HeyTell	iMessage	HeyTell	HeyTell
14	iMessage	Tango	iMessage	iMessage
15	Tango	HeyTell	Tango	Tango
16	Tango	Tango	Tango	HeyTell
17	HeyTell	HeyTell	HeyTell	iMessage
18	iMessage	iMessage	iMessage	Tango
19	iMessage	HeyTell	HeyTell	iMessage
20	HeyTell	Tango	iMessage	HeyTell
21	Tango	iMessage	Tango	Tango
22	HeyTell	Tango	Tango	HeyTell
23	iMessage	iMessage	HeyTell	Tango
24	iMessage	HeyTell	iMessage	iMessage
25	Tango	HeyTell	HeyTell	iMessage
26	HeyTell	iMessage	Tango	Tango
27	HeyTell	Tango	iMessage	HeyTell

Table 4. Social Validity Questionnaire (Student Form)

Study: DIGITAL COMMUNICATION

Student: _________________________ Date: ___________

"I have some questions to ask you about the text message study. I am interested in your opinion, so there are no right or wrong answers. Do you have any questions before we begin?"

Questions	Responses				
					
1. I like sending Text messages with the iMessage and read aloud function.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2. I like sending Voice messages with the Heytell application.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3. I like sending Video messages with the Tango application.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
4. Learning how to use these tools helped me to improve my communication skills.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5. The pictures on the card were helpful when I used iMessage, Heytell, and Tango to send messages.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6. I would use iMessage again to send messages.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
7. I would use Heytell again to send messages.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8. I would use Tango again to send messages.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
9. I like iMessage the best.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
10. I like HeyTell the best.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
11. I like Tango the best.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
12. I liked iMessage better than HeyTell.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
13. I liked iMessage better than Tango.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Table 4. Continued

Questions	Responses
14. What did you like best about iMessage?	
15. What did you not like about iMessage?	
16. What did you like best about HeyTell?	
17. What did you not like about HeyTell?	
19. What did you like best about Tango?	
20. What did you not like about Tango?	
21. Is there anything you would like to change about doing this study?	
22. Is there anything else you would like to add?	

Table 5. Social Validity Questionnaire (Researcher Form)

Study: DIGITAL COMMUNICATION

Researcher: _________________________ Date: ___________

This questionnaire consists of 9 items. For each item, indicate the extent to which you agree or disagree with each statement. Please indicate your response to each item by circling one of the five responses to the right.

	Questions	Responses				
1.	The target skills of communicating with digital tools selected for interventions for these students are important.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2.	The time spent assessing the target skills was a good investment for the students.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3.	The assessment procedures such as the data collection forms were appropriate.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
4.	The data collection forms were easy to use.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5.	The visual aid (task analysis of the steps for each intervention) was helpful when assessing the students' target skills.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6.	Assessing the students' digital communication skills is a valuable practice.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
7.	Being involved in the assessment of the students target skills was a good investment of my time.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8.	Being involved in the assessment of the students' target skills helped me learn more about working with young adults with intellectual disabilities.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
9.	I would consider using the techniques in the interventions to teach digital communication skills to other students in the future if the opportunity arises.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Table 6. Percentage of Independent Digital Communication During Alternating Application Phase

Participant	Baseline	iMessage	HeyTell	Tango
Ann	39	86	91*	88
Lola	21	81*	66	73
Max	39	85	87*	92
Will	0	25	85	88*

Note. * = preferences

Table 7. Participants' Rating of Social Acceptability of Intervention

Statement	Participants' Response			
	Ann	Lola	Max	Will
I like sending text messages with the iMessage and read aloud function.	Agree	Strongly Agree	Strongly Agree	Strongly Agree
I like sending voice messages with the HeyTell application.	Agree	Strongly Agree	Strongly Agree	Strongly Agree
I like sending video messages with the Tango application.	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
Learning how to use these tools helped me to improve my communication skills.	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree
The pictures on the card were helpful when I used iMessage, HeyTell, and Tango to send messages.	Agree	Strongly Agree	Strongly Agree	Strongly Agree
I would use iMessage again to send messages.	Neutral	Strongly Agree	Strongly Agree	Strongly Agree
I would use HeyTell again to send messages.	Disagree	Strongly Agree	Strongly Agree	Strongly Agree
I would use Tango again to send messages.	Strongly Agree	Strongly Agree	Strongly Agree	Strongly Agree

Table 8. Participant Descriptions

Name	Age	IQ Range	Adaptive Score	Reading Grade Level Equivalent
Lola	22	48[c]	51[d]	1st grade[f]
Max	25	65[b]	75[e]	2nd grade[f]
Will	23	48[a]	43[d]	>1st grade[f]

Note: a. Reynolds Intellectual Assessment Scales b. Stanford-Binet Intelligence Scales, 5th Ed. c. Woodcock-Johnson III: Tests of Cognitive Abilities d. Scales of Independent Behavior-Revised e. Vineland Adaptive Behavior Scales, 2nd Ed. f. Brigance Transition Skills Inventory

Table 9. Social Validity Questionnaire (Student Form)

Study: NAVIGATION

Student: __________________________ Date: ___________

"I have some questions to ask you about the navigation study. I am interested in your opinion, so there are no right or wrong answers. Do you have any questions before we begin?"

	Questions	Responses				
						
1.	I like using the Heads Up Navigator to find places on campus.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2.	Learning how to use the Heads Up Navigator helped me to improve my navigation skills.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3.	The white arrow on the screen helped me find the new places.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
4.	The screen showing the street in front of me helped me to find new places.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5.	I would use Heads Up Navigator again to help me find new places.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6.	I would recommend Heads Up Navigator to a friend.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
7.	I like using Heads Up Navigator better than the map.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8.	I always found the place I was looking for using Heads Up Navigator.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
9.	I always found the place I was looking for using the map.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
10.	What did you like best about the Heads Up Navigator?					
11.	What did you not like about the Heads Up Navigator?					
12.	Is there anything you would like to change about using the Heads Up Navigator?					

Table 10. Social Validity Questionnaire (Researcher Form)

Study: NAVIGATION

Researcher: ____________________________ Date: ____________

This questionnaire consists of 8 items. For each item, indicate the extent to which you agree or disagree with each statement. Please indicate your response to each item by circling one of the five responses to the right.

Questions	Responses				
1. The target skill of navigating campus with the Heads Up Navigator for these students is important.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2. The time spent assessing the target skills was a good investment for the students.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3. The assessment procedures such as the data collection forms were appropriate.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
4. The data collection forms were easy to use.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5. Assessing the students' navigation skills is a valuable practice.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6. Being involved in the assessment of the students target skills was a good investment of my time	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
7. Being involved in the assessment of the students' target skills helped me learn more about working with young adults with intellectual disabilities.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8. I would consider using the techniques in the interventions to teach navigation skills to other students in the future if the opportunity arises.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Table 11. Participants' Rating of Social Acceptability of Intervention

Statement	Participants' Response		
	Lola	Max	Will
I like using the Heads Up Navigator to find places on campus.	Strongly Agree	Strongly Agree	Strongly Agree
Learning how to use the Heads Up Navigator helped me to improve my navigation skills.	Strongly Agree	Strongly Agree	Strongly Agree
The white arrow on the screen helped me find the new places.	Strongly Agree	Strongly Agree	Strongly Agree
I would use the Heads Up Navigator again to help me find new places.	Strongly Agree	Strongly Agree	Strongly Agree
I would recommend Heads Up Navigator to a friend.	Strongly Agree	Strongly Agree	Strongly Agree
I like using Heads Up Navigator better than the map.	Strongly Agree	Strongly Agree	Strongly Agree
I always found the place I was looking for using the Heads Up Navigator.	Strongly Agree	Strongly Agree	Strongly Agree

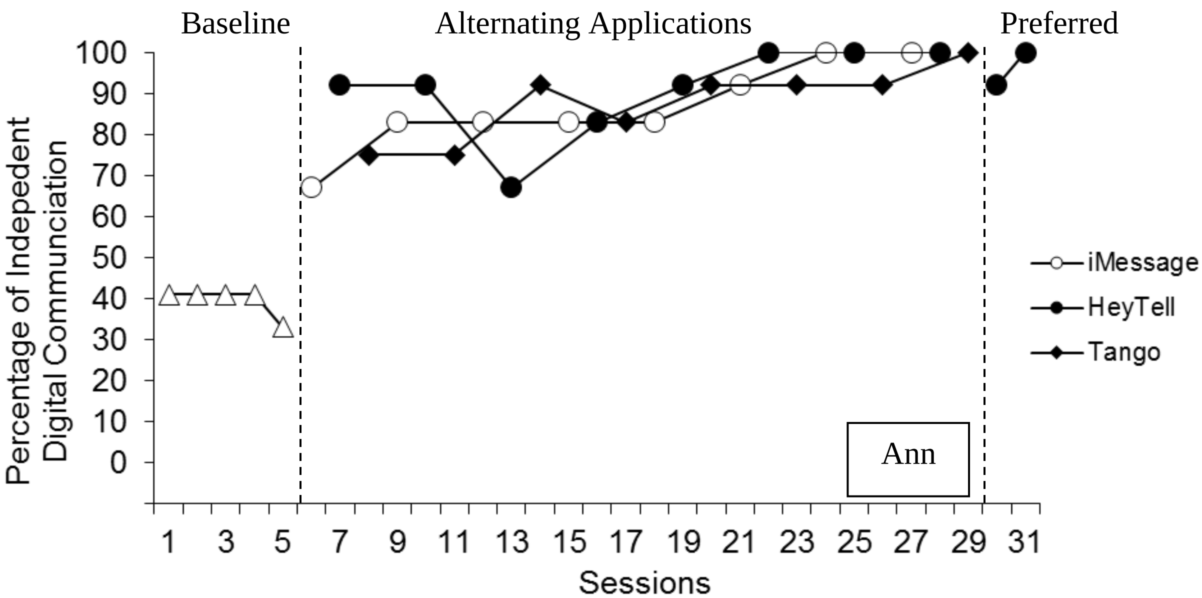


Figure 1. Ann's percentage of independent digital communication

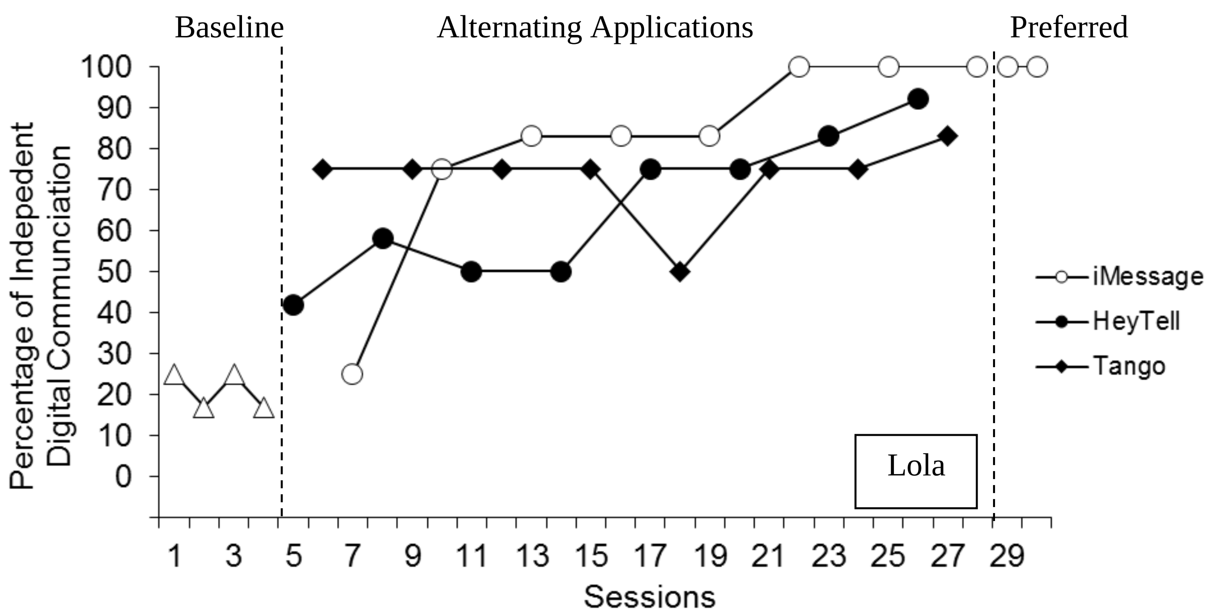


Figure 2. Lola's percentage of independent digital communication

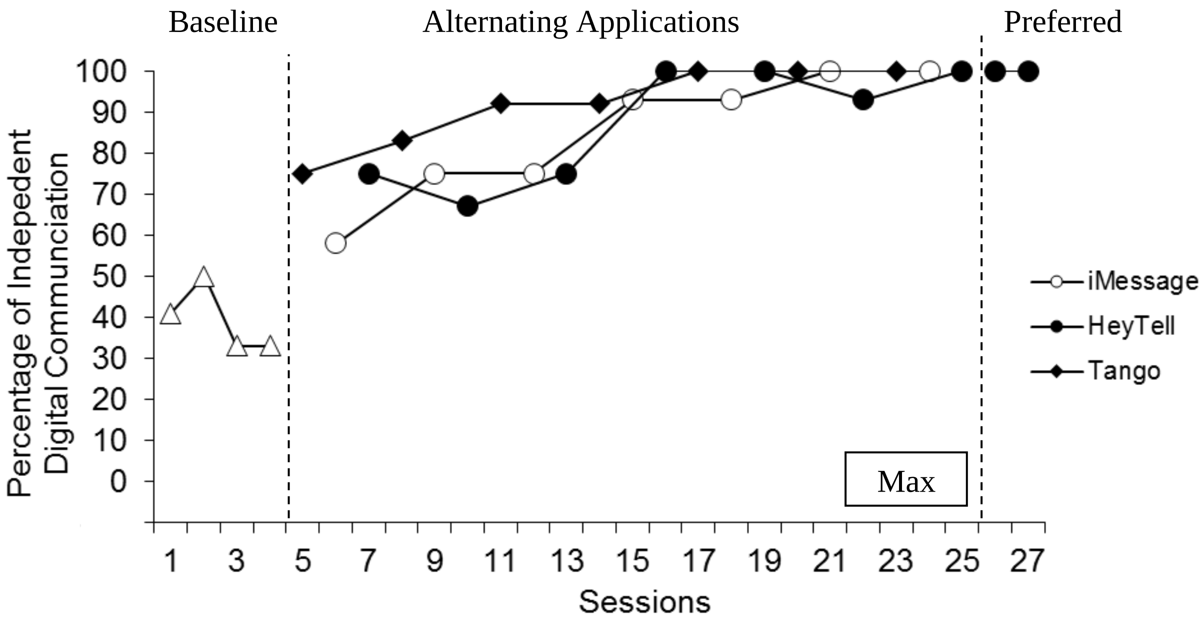


Figure 3. Max's percentage of independent digital communication.

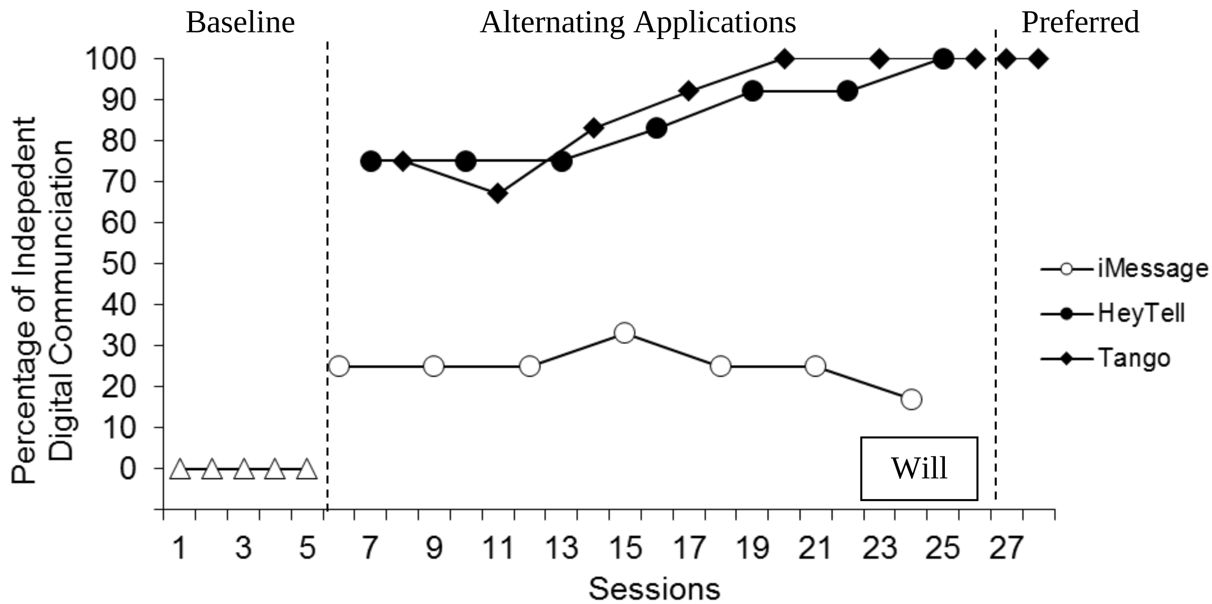


Figure 4. Will's percentage of independent digital communication.

Figure 5. Screenshot of Heads Up Navigator live view

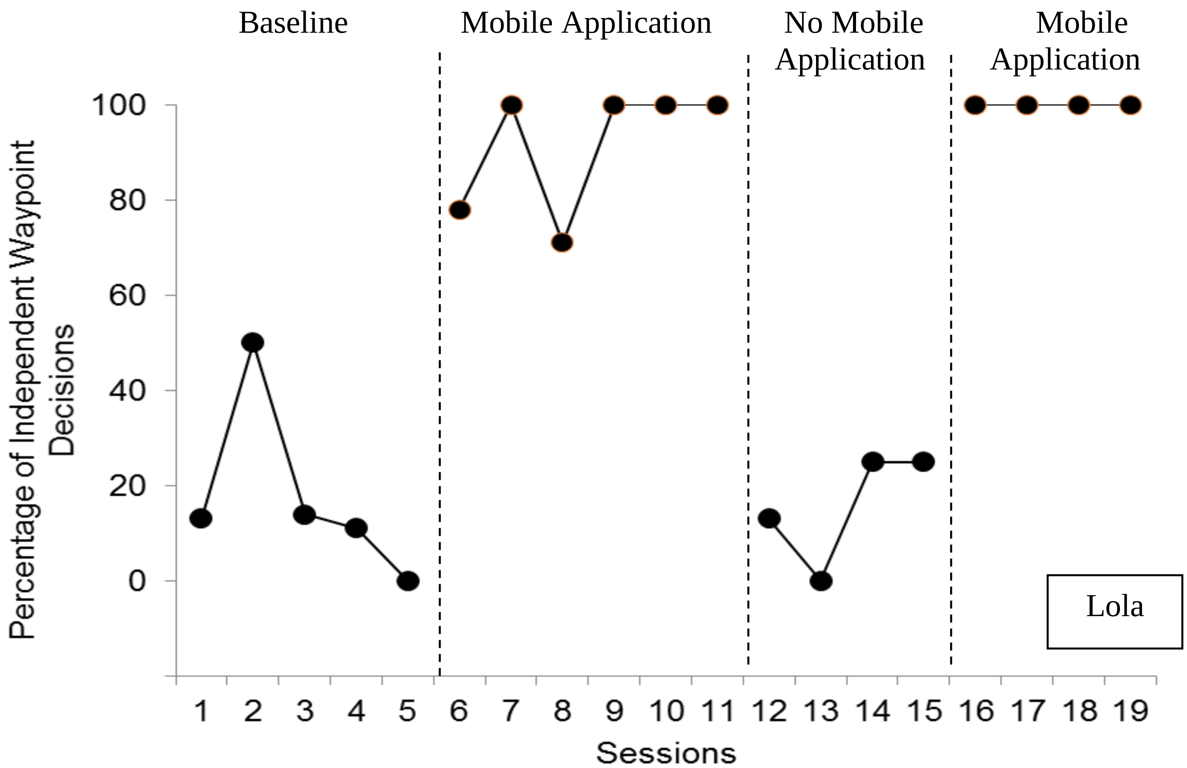


Figure 6. Lola's percentage of independent waypoint decisions across phases.

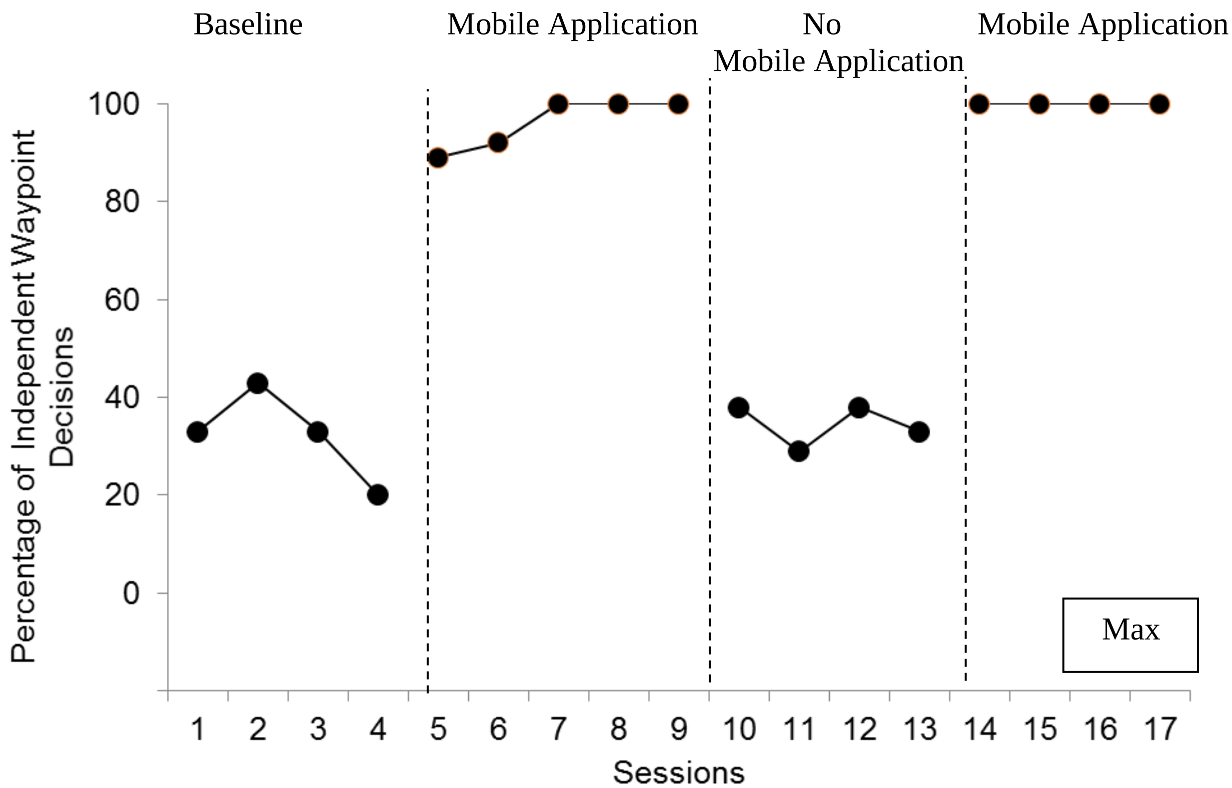


Figure 7. Max's percentage of independent waypoint decisions across phases.

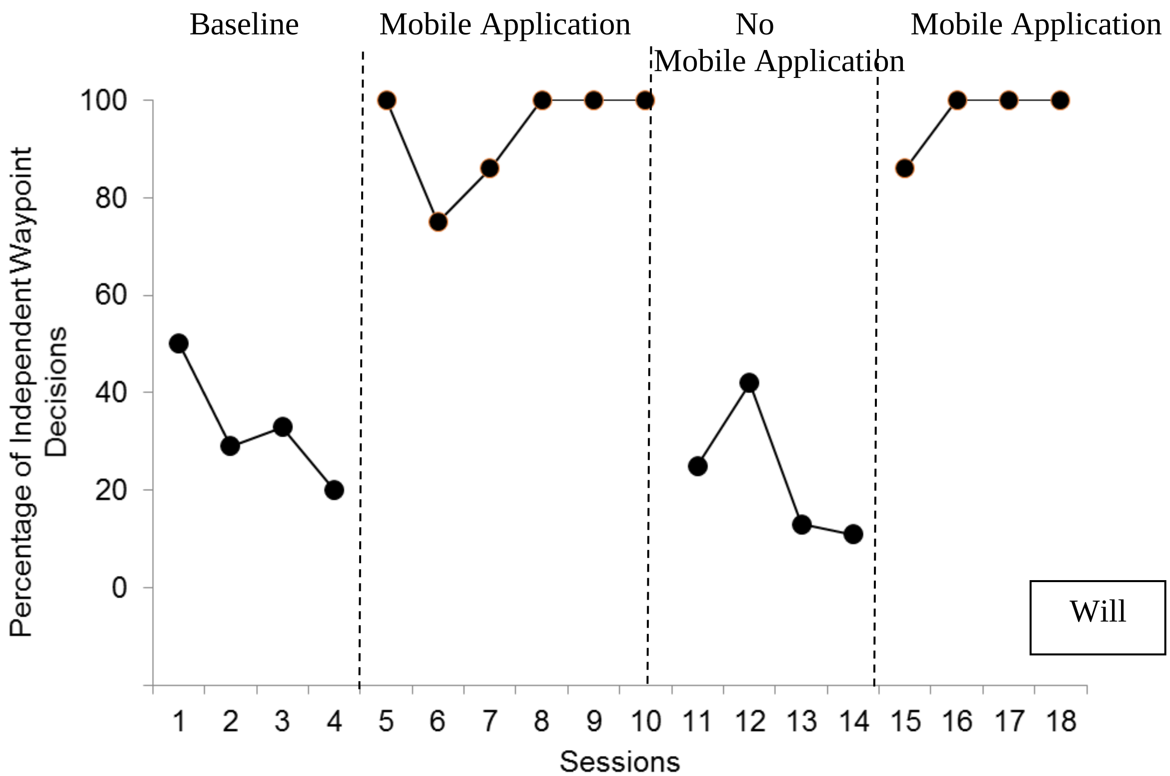
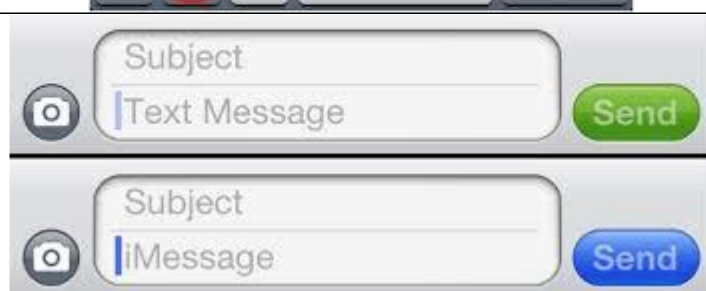


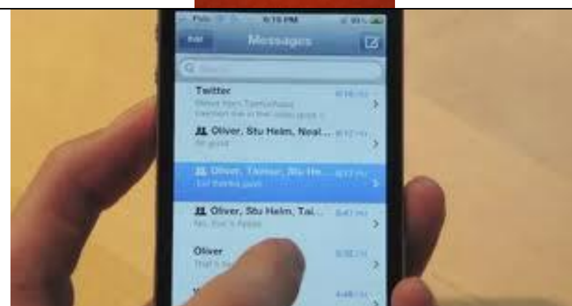
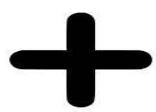
Figure 8. Will's percentage of independent waypoint decisions across phases.

Appendix A: Visual Aid Training Material

<table>
<tr><td colspan="3" align="right">iMessage</td></tr>
<tr><th>Step</th><th>Directions</th><th>Picture</th></tr>
<tr><td>1</td><td>Click green message bubble</td><td>
</td></tr>
<tr><td>2</td><td>Hold message to highlight</td><td>
</td></tr>
<tr><td>3</td><td>Click speak</td><td>
</td></tr>
<tr><td colspan="3" align="right">Page 1 of 2</td></tr>
</table>

		iMessage
Step	Directions	Picture
4	Click response bubble	
5	Type the response	
6	Push send	
7	Exit by pushing home button	
		Page 2 of 2

<table>
<tr><th colspan="3">HeyTell</th></tr>
<tr><td>Step</td><td>Directions</td><td>Picture</td></tr>
<tr><td>1</td><td>Click Launch</td><td>
</td></tr>
<tr><td>2</td><td>Listen to the message</td><td></td></tr>
<tr><td>3</td><td>Hold and Speak to Reply</td><td>
</td></tr>
<tr><td>4</td><td>Exit by pushing home button</td><td></td></tr>
<tr><td colspan="3">Page 1 of 1</td></tr>
</table>

		Tango
Step	Directions	Picture
1	Click view	
2	Click the message	
3	Push back arrow	
4	Push plus sign	
5	Click camera	
		Page 1 of 2

		Tango
6	Click video message	
7	Click red record button	
8	Speak message	
9	Push red record button to stop	
10	Push send	
11	Exit by pushing home button	
		Page 2 of 2

Appendix B. **Treatment Integrity Checklist**

Study: DIGITAL COMMUNICATION
Data Collector: ______________________ Date: ______________________________
Coder Name: ________________________

	Observed
1. Provided iPhone to student?	YES NO
2. Reminded students to respond professionally to digital message?	YES NO
3. Created message out of view/earshot of student?	YES NO
4. Kept visual aid out of student's line of vision until needed as prompt #1?	YES NO
5. Sent initial message to student?	YES NO
6. Observed the participant receive the message?	YES NO
7. Observed 10 second wait time before providing first prompt?	YES NO or N/A
8. Provided visual aid as first prompt if needed?	YES NO or N/A
9. Observed 10 second wait time before providing second prompt?	YES NO or N/A
10. Provided verbal prompt as second prompt if needed?	YES NO or N/A
11. Observed 10 second wait time before providing third prompt?	YES NO or N/A
12. Provided physical prompt as third prompt if needed?	YES NO or N/A
13. Recorded steps completed by student on data collection sheet?	YES NO
14. Received the student response on the iPhone?	YES NO
15. Collected iPhone, data sheet, and visual aid card at end of session?	YES NO

TOTAL: _________/__________ = _________

Appendix C. **Sample data collection form navigation**

Student _____________________ Date _____________________
Researcher _____________________

Navigator Intervention
Students will find their way to a new location using the Heads Up Navigator Application on the iPhone. The researcher should offer no assistance at each *Waypoint.* Use the System of Least Prompts if the student indicates he/she does not know the way. At each *Waypoint*, record a Yes if the student made the correct choice, or No if he/she did not.

Location 7: **Ayres Hall**
Tell the student: "We are going to take a walk over to Ayers Hall. Have you been there before? Do you know how to get there?"
Exit through the front of the Claxton Building.

(If student knows how to get there, tell Cate before you leave and get a new location).

Step	Waypoint	Student Response*
1	turn right at bottom of steps in front of College of Education	YES NO
2	continue down sidewalk on Volunteer Blvd	YES NO
3	at the red light/intersection turn right down pedestrian walkway	YES NO
4	continue down the walkway until you reach Phillip Fulmer Way	YES NO
5	at the other side of the street, turn right and head up the hill	YES NO
6	at Alumni Memorial Building, stop and look left before crossing	YES NO
7	cross street and continue straight until you reach the steps	YES NO
8	turn right to head up steps	YES NO
9	at top of steps, check for traffic	YES NO
10	cross street toward Ayres Hall	YES NO
11	turn left to enter Ayres Hall	YES NO

*Circle YES for correct response, NO for incorrect

Appendix D. **Treatment Integrity Checklist**

Study: NAVIGATION
Data Collector: ______________________ Date: ______________________________
Coder Name: ________________________

	Observed
1. Checked iPhone battery charge prior to session?	YES NO
2. Assisted student in locating front of building prior to session?	YES NO
3. Provided iPhone to student?	YES NO
4. Asked them if they know how to get to the specified location?	YES NO
5. Asked them to use Heads Up Navigator to find location?	YES NO
6. Observed the student open the application?	YES NO
7. Observed the student select the location from menu?	YES NO
8. Allowed 10 seconds of wait time throughout session?	YES NO or N/A
9. Provided prompt using system of least prompts if student indicated an incorrect response	YES NO or N/A
10. Provided praise for correct response?	YES NO
11. Observed safety precautions when traveling on foot with student?	YES NO
12. Recorded student responses throughout session on data collection sheet?	YES NO
13. Collected iPhone at the end of the session?	YES NO
14. Tallied the correct responses at the end of the session?	YES NO
15. Escorted student back to building at end of session?	YES NO

TOTAL: _________/__________ = __________

Vita

Catherine Caudle Smith was born in Charlottesville, VA, and grew up in East Tennessee. She attended Maryville High School, in Maryville Tennessee. After high school, Cate earned a Bachelor of Arts degree in Psychology in 2001 from The University of Tennessee, Knoxville. She returned to the University of Tennessee and earned a Master of Science degree in Education with a concentration in special education. Cate then taught in the public schools for five years before returning to the University of Tennessee for a third degree. She earned her Ph.D. in education in August of 2013.