Systematic review of assistive technology-based instruction for postsecondary students with developmental disabilities

Betul Cakir-Dilek

University of Iowa

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SYSTEMATIC REVIEW OF ASSISTIVE TECHNOLOGY-BASED INSTRUCTION FOR POSTSECONDARY STUDENTS WITH DEVELOPMENTAL DISABILITIES

by

Betul Cakir-Dilek

A thesis submitted in partial fulfillment of the requirements for the Master of Arts degree in Teaching and Learning (Special Education) in the Graduate College of The University of Iowa

May 2019

Thesis Supervisors: Associate Professor Suzanne Woods-Groves Associate Professor Allison Leigh Bruhn
To my son, Mustafa Kemal DILEK
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ABSTRACT

The purpose of this thesis is to identify empirical studies that investigated the efficacy of assistive technology-based instruction to teach independent living skills with postsecondary education students with autism spectrum disorder (ASD) and/or intellectual and developmental disabilities (IDD). An electronic search was conducted using the following databases: ERIC (Education Source version), ERIC (EBSCO host version), ERIC (ProQuest version), PsycINFO, and Google Scholar. Seven peer-reviewed journals were searched between 2008 and 2018. The references identified and relevant articles were scanned to find additional relevant literature. Dissertations referring to an assistive-technology based intervention that targets the area of independent living and that was taught within a postsecondary program were included. Participants were diagnosed with ASD and/or IDD and were enrolled in a postsecondary program designed for individuals with developmental disabilities. Only single-case studies or experimental/quasi-experimental designed studies were included. A total of 155 articles were found. The references and abstracts were saved in Endnote reference manager software for the selection process. First, 19 duplicates were found and excluded. A selection process was then carried out with the remaining 136 articles. The articles were screened by title and abstract, and 32 articles were excluded. Subsequently, full-text screening was conducted, and eight peer-reviewed articles and two dissertations were left. To conclude, the types of assistive technology used in teaching independent living skills to postsecondary students with disabilities were reported. The skills taught by using assistive technology were diverse. Results indicated the positive effectiveness of using assistive technology-based instructional practices in teaching independent living skills.
The primary objective of this study is to identify empirical studies that investigated the efficacy of assistive technology-based instruction to teach independent living skills with postsecondary education students with autism spectrum disorder (ASD) and/or intellectual and developmental disabilities (IDD). Studies were searched between 2008 and 2018. To obtain relevant literature, dissertations referring to an assistive-technology based intervention that targets the area of independent living and be taught within the postsecondary program were included. After collecting studies based on inclusion criteria, full-text screening was conducted, and eight peer-reviewed articles and two dissertations were left.

Overall, the types of assistive technology used to teach independent living skills to postsecondary students with disabilities were reported. The skills taught by using assistive technology were diverse. Using assistive technology-based instructional practices in teaching independent living skills were effective. Study limitations and future directions for research are discussed.
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CHAPTER 1

INTRODUCTION

Postsecondary education (PSE) offers better opportunities for individuals in adult life by providing an increased opportunity for employment, independent living experiences, and academic knowledge (Barrow, Brock, & Rouse, 2013; Grigal, & Hart, 2010; Hart, Grigal, & Weir, 2010; Migliore, Butterworth, & Hart, 2009). Postsecondary programs for students with autism spectrum disorder (ASD) and intellectual and developmental disabilities (IDD) provide not only academic and vocational training but also offer instruction in developing adult independence skills such as living on campus and meeting responsibilities in daily life (Think College, 2018).

Access to PSE programs is supported through legislative mandates such as the Higher Education Opportunity Act (HEOA) of 2008 and the Developmental Disabilities Assistance and Bill of Rights Act of 2000. These laws mandate accessibility to PSE for students with disabilities by providing (a) transition support, (b) access to apply for financial aid, (c) the use of universal design, and (d) individualized supports and services that support young adults in attending postsecondary education and in reaching post-school goals. As a result of federal mandates for transition and postsecondary education, the number of postsecondary programs at institutes of higher education (IHE)s within the United States that enroll students with ASD and IDD has increased (Wehmeyer et al., 2018).

**Evolution of PSE Programs for Students with IDD**

The number of IHEs with postsecondary education (PSE) programs for students with IDD has increased dramatically between 2004 and 2017, from 25 to 268 (Grigal, & Papay,
2018). This upward trend shows the increased attention in this area. Almost half of these programs emerged after 2009. One factor behind this rapid growth as noted previously could be the passage of HEOA (2008). The HEOA includes several provisions related to students with ID. According to Title VII of HEOA, the Office of Postsecondary Education (OPE) awarded a five-year grant to fund the model comprehensive Transition and Postsecondary Programs for Students with Intellectual Disabilities (TPSID) program via the U.S. Department of Education in 2010. Besides, according to Title IV, federal student aid is provided to students who are enrolled in an appropriate comprehensive transition postsecondary program. According to Title VII (Section 777), the duties of the National Technical Assistance Center; Coordinating Center include the provision of information and technical assistance to students, families, faculty, staff, and administrators of institutions of higher education who serve students with IDD. Besides, the center provides coordination and support for all TPSID funded programs, coordinates the collection and dissemination of information from TPSID programs (Grigal, & Papay 2018; Higher Education Opportunity Act, 2008).

In 2010, the U.S. Department of Education funded the model comprehensive Transition and Postsecondary Programs for Students with Intellectual Disabilities (TPSID) program to achieve growth in transitioning to PSE for individuals with ID (Folk, Yamamoto, & Stodden, 2012). If PSE programs for students with IDD are designated as a Comprehensive Transition and Postsecondary Program (CTP) then support is provided for additional options for financial support in lieu of the traditional necessities for retrieving Title IV financial aid for students with ID. When an eligible student with ID and financial needs attends a CTP approved program, the student would have access to Title IV financial aid funding (i.e., Federal Pell Grant, Federal Supplemental Education Opportunity Grant, Federal Work-Study; Grigal, & Papay, 2018).
Postsecondary Students with ASD and IDD

Students with IDD are often diagnosed shortly after birth or during the early childhood years and qualify for services under the Individuals with Disabilities Education Improvement Act (IDEA, 2004). IDEA (2004) has emphasized four core characteristics for classifying students with ASD: (1) a difficulty or an inability to communicate verbally or nonverbally, and to establish and maintain social interactions with others, (2) the clear undesirable evidences that impacts child's education before 3 years old, (3) the persistence of repetitive activities and stereotyped movements, and (4) struggling with changes in routines (IDEA, 2004).

According to IDEA (2004), three fundamental characteristics of students with ID include: (1) having an intellectual functioning which is below average, (2) deficits in adaptive behavior, and (3) characteristics that are obvious during the developmental period. Both autism spectrum disorder and intellectual disability are accepted as significant disabilities (IDEA, 2004).

In the definition of significant disability, it is emphasized that characteristics related to a disability influence an individual's life, and supports and services are often required over an extended period. Many students need to be extensively supported by special education services to continue their education until the age of 21 (26 years old in Michigan) after which they are longer be eligible or support under IDEA (Grigal, & Hart, 2010; Wagner, Newman, Cameto, Garza, & Levine, 2005). See Appendix B for glossary and further definitions of terms.

College is the most desired outcome by parents of students with disabilities (Grigal, & Neubert, 2004). Grigal, Neubert, and Moon (2002) noted that students with disabilities and their parents were not satisfied with the outcomes of special education services at the high school level. When students with disabilities exit high school, the majority of them receive no vocational services and few independent living opportunities (Noyes & Sax, 2004). Thus, these students have only low-income job opportunities and a lower chance of gaining the ability to live
independently. Grigal and Hart (2010) reported that students with ID who were in inclusive secondary educational environments desired to be educated with their peers in college. The goals and desired outcomes for postsecondary education students with or without disabilities are the same: competitive employment, access for learning opportunities, self-determination or self-advocacy skills, and successful adult life (Grigal, & Hart, 2010). To achieve these goals, students need AT supports to support the acquisition of independent living skills.

**Independent Living Skills**

According to Cullen and Alber-Morgan (2015), the success of special education programs is related to maximizing the independent living skills of students with disabilities. One fundamental goal of postsecondary education for students with ASD and/or IDD is to empower students to live independently and to communicate effectively with others (Shogren & Plotner, 2012). Independent living skills include adaptive behavior skills such as personal care skills, shopping, cleaning, managing finances, preparing meals, using transportation, navigating specific places, using transportation, and completing household chores (American Occupational Therapy Association, 2008).

Independent living skill instruction has been supported through the specific curriculum. For instance, Clark, Field, Patton, Brolin, and Sitington (1994) introduced a life skills instruction approach that included goals, objectives, and instructional activities for teaching concepts and skills related to successful independent living. Objectives targeted through this curriculum include the following: (a) personal responsibility, social experience, and interpersonal relationships, (b) health (e.g., physical and mental), (c) home living, recreation and leisure skills, (d) employability, occupational awareness, and job skills, (e) consumer skills, and (f) community participation (Clark et al., 1994). Vatland et al. (2011) asserted that in addition to independent
living skills, *self-determination* could be considered as a life skill due to the positive outcomes it has on students’ quality of life. Self-determination is a psychological concept which indicates voluntary activities that facilitates: (1) one to act *autonomously*; (2) the person shows *self-regulated* behavior; (3) the person begin and continue to the act in a *psychologically empowered* approach and (4) one to performance *self-realizing* attitude (Wehmeyer, 2007, p. 6).

Commonly studied life skills were reviewed by Matson et al. (2012), and grouped into four broad clusters: work, self-help, leisure, and hygiene skills. Nietupski, Hamre-Nietupski, Curtin, and Shrikanth (1997) categorized life skills as self-care and domestic living, recreation and leisure, communication and social skills, vocational skills and other skills necessary for community participation (i.e., postsecondary education). As seen from the skills categorizations, living skills are crucial for all people including individuals with ASD and ID to accomplish varied roles of adult life because these skills fortify the quality of life, support being a part of the community, and sometimes play a critical role in health and personal safety (Test, 2012). The importance of independent living skills is also clearly stated in the Rehabilitation Act Amendments of 1992 (P.L. 102-569) with this statement:

> “Congress finds that...

Disability is a natural part of the human experience and in no way diminishes the right of an individual to-

A. Live independently;

B. Enjoy self-determination;

C. Make choices;

D. Contribute to society;

E. Pursue meaningful careers;
F. Enjoy full inclusion and integration in the economic, political, social, cultural, and educational mainstream of American society ...” (Section 2. Findings; Purpose; Policy). See Appendix B for a glossary for further definitions.

**Assistive Technology**

One method or medium for supporting independent living is the use of assistive technology. Assistive technology (AT) supports are crucial for students with disabilities because they encounter different challenges in reaching postsecondary education goals (Gobbo & Shmulsky, 2012). These challenges include the following: (1) transitions to new environments, groups, and activities; (2) handling environmental distractions; (3) following routines; (4) interpreting social interactions; and (5) navigating the classroom. However, students with ASD and ID can overcome these challenges by using AT devices and apps (Gobbo & Shmulsky, 2012).

Various types of AT options are emerging to increase, maintain, or support students with ASD and/or IDD. AT devices can be classified as (1) low-technology (e.g., laminated photos, modified eating utensils, clipboards, etc.), and (2) high-technology (e.g., computers, mobile phones, tablets, smart watches, software, and apps (Wendt & Lloyd, 2011). Recent high-tech devices such as mobile phones, tablets, and smartwatches enable students with disabilities to learn, improve or maintain independent living skills without being conspicuous (Kellems, et al., 2015).

Instruction in postsecondary programs for students with ASD and IDD can be supported through the use of technology. The use of AT can increase student access to content and improve students’ independence, efficiency, and participation in academic programs, employment, and recreation (Burgstahler, 2003). Within elementary and secondary programs, IDEA (2004)
mandates that the individualized education program (IEP) teams identify different types of AT that are individualized according to students' needs. Given the positive potential of AT for making the lives of individuals with disabilities more manageable, it is essential to examine how AT can meet the needs of students with ASD and IDD to initiate, improve, and to maintain independent living skills beyond the elementary and secondary level (Burgstahler, 2003). For this systematic review, the term assistive technology-based instruction will include only high-technology devices such as smartphones, tablets, smart watches, or computers.

The Significance of Systematic Literature Review

Although the number of postsecondary programs for students with ASD and/or IDD has increased along with AT options, there is insufficient literature regarding the use of AT in instruction to teach independent living skills within PSE programs. Students with ASD and/or IDD are increasingly attending postsecondary education (Think College, 2018). Currently, there is a lack of systematic reviews pertaining to the use of AT in promoting the development of independent living skills in postsecondary programs for individuals with ASD and IDD. Findings from this systematic literature review will provide a synopsis of empirical studies that have been conducted in this area and include the typography of these studies and findings.
CHAPTER 2

LITERATURE REVIEW

Postsecondary education is vital for all students including students with disabilities as it improves personal skills, academic skills, employment skills, self-advocacy, and self-confidence (Hart, Grigal, & Weir, 2010). According to Wehmeyer et al. (2018), over the past decade, there has been an increase in the number of postsecondary programs at IHEs within the United States that enroll students with ASD and IDD. There are currently 267 postsecondary programs designed to support individuals with ASD and IDD in the U.S. (Wehmeyer et al., 2018). The postsecondary programs are designed as mixed or hybrid, with separate, and inclusive individual supports (Grigal & Hart, 2010). The current PSE models and service delivery options will be explained further in this chapter. The Higher Education Opportunity Act of 2008 (HEOA) has supported this growth with provisions related to students with intellectual disabilities (ID). Specific HEOA provisions include federal student aid (i.e., Pell Grants), transition programs for students with ID, the development of model demonstration programs to support postsecondary programs for students with IDD, and the development of a national coordinating center (NCC).

Before the HEOA, students were withheld from accessing financial aid for higher education because of (1) the variation in the eligibility requirements of financial aid, (2) the lack of communication and coordination among disability agencies, (3) the concerns about taking out student loans, and (4) the intense focus on the disability-related accommodations and medical needs which was a limiting and discriminatory reality. By the enactment of the HEOA reauthorization, students with disabilities have more sources and information to continue their academic life with having the eligibility including Pell Grants, VR funding, Supplemental Educational Opportunity Grants, subsidized and unsubsidized loans, and the Federal Work-Study
Program (Grigal & Hart, 2010; National Council on Disability, 2013). Therefore, HEOA allows students with disabilities to access PSE and employment. Migliore and colleagues (2009) noted that the effect of postsecondary programs for students with ASD and IDD are similar to the impact of postsecondary for traditional college students (Migliore et al., 2009). Postsecondary education (PSE) influences the following (1) employment opportunities, (2) independent living, and (3) academic life (Hughson, Moodie, & Uditsky, 2006; Migliore et al., 2009). Individuals who attend PSE programs have better jobs than those who do not attend such programs (Migliore et al., 2009). Migliore et al. (2009) noted 48% of young adults with ID who received PSE services found jobs with $316 average weekly income, whereas 32% of youth with ID who did not attend PSE programs were employed with $195 average weekly earnings. According to interviews with students, parents, facilitators, faculty, and mentors, PSE services increased the quality of life including personal identity, independent living, communication, relationships, personal development, self-determination, community acceptance, and emotional well-being (Hughson et al., 2006). Furthermore, students with ID who participated in PSE were reported to have gained confidence in completing academic work, assignments, getting feedback from instructors because such experiences allow students to achieve their goals. Parents of students also stated that they learned transferrable academic and social skills and knowledge (Hughson et al., 2006).

**Current PSE Models and Service Delivery Options**

PSE programs are categorized based on the amount of time that students participate in typical inclusive college courses; thus, the three PSE models are *mixed/hybrid model*, *substantially separate model*, and *inclusive individual supports* (Grigal & Hart, 2010; Hart, Mele-McCarthy, Pasternack, Zimbrich, & Parker, 2004; Neubert & Moon 2006). The mixed/
hybrid model ensures students with ID participate in inclusive occasions and includes the following opportunities: (1) to be involved in academic courses and social activities with students without disabilities (Grigal, Hart, & Weir, 2012); (2) to participate in life skills or occupational instructions in distinct location or classroom on or off the college campus (Papay & Bambara, 2011); and (3) to participate in individualized instruction by Local Education Agency (LEA) personnel on life skills (e.g., independent living, self-determination, socialization), employment, and academic skills on a college campus (Grigal, Dwyre, & Dawis, 2006). Substantially separate PSE programs do not offer access to typical college classes or inclusive activities to students with disabilities (Grigal & Hart, 2010; Papay & Bambara, 2011).

Substantially separate programs concentrate on life-skills instruction, community-based instruction, and vocational training (Papay & Bambara, 2011). Within these programs, students receive instruction with a separate curriculum designed by program personnel or commercially available (Grigal & Hart, 2010). In these programs students with disabilities participate in social activities on campus. The inclusive individual support model which is the highest level of inclusion for students with ID offers individualized services for increasing the involvement of the students with disabilities in college courses with students without disabilities (Grigal & Hart, 2010). However, the fewest number of the PSE programs adopted the inclusive individual support model as it is more difficult to make students' schedule functional and consider the level of inclusion of the students in academics. In this model, students with disabilities access individual support directed through a person-centered planning procedure by a team of support persons to distinguish their goals that affect the course of study, employment experiences, and any other PSE opportunities (Grigal, Dwyre, & Dawis, 2006). Students would attend college
classes with peers without disabilities and attend campus or community activities (Grigal & Hart, 2010).

The three options for PSE for students with ASD and IDD are; dual enrollment, sponsored programs, and services for adults with ID, and student family-initiated experience. The dual enrollment (also called “concurrent enrollment”) is for students with ASD and ID who are 18 to 21 years old, who receive education and transition services under IDEA (2004) and who are permitted to enroll college courses (Grigal & Hart, 2010). It would end when students age out of public school at the age of 21 (26 years old in Michigan). The main difference between the dual enrollment option and the sponsored programs and services option is the involvement of the local school systems; therefore, local school systems are not involved in delivering support or services for sponsored programs and services option (Grigal & Hart, 2010). Adult PSE options are college based, and parents require to pay tuition and other costs. Students with ID and their families could also request access and support from IHE to create PSE options; however, this option is less known, and there are not enough studies to compare and contrast this option to others (Grigal & Hart, 2010).

**Independent Living Skills**

A repercussion of the tremendous PSE growth over the past decade is the revelation of the lack of empirical support for effective instructional practices for learners with ASD and IDD in postsecondary settings (Kirst & Venezia, 2004). As PSE programs continue to grow within the U.S., it is essential to identify effective instructional practices for developing not only students' academic literacy skills but their independent living skills as well. Independent living skills are categorized as self-care and domestic living, recreation and leisure, communication and social skills, vocational skills and other skills essential for community participation (i.e., postsecondary
education; Nietupski et al., 1997). The ultimate goal of postsecondary education for students with ASD and or IDD is to achieve independent living skills and improve social communications (Shogren & Plotner, 2012). The National Longitudinal Transition Study-2 (NLTS-2) found that the independent living rate for young adults with multiple disabilities (16%), for young adults with autism (17%), for young adults with intellectual disabilities (36%) living independently is substantially lower when compared to the general population (59%) (Newman et al., 2011).

Prior to entry into PSE programs students with ASD and or IDD should receive individualized instruction through transition planning under the Individuals with Disabilities Education Improvement Act (2004). Adreon and Durocher (2007) asserted that from high school to college, students with ASD and or IDD transition supports should include: (1) assessing and teaching independent living skills, and (2) identifying strategies and accommodations to a college setting. High school and postsecondary students with ASD must master similar daily living skills such as going to class on time (Adreon, 2004), shopping (Prince-Hughes, 2004), dressing appropriately (Moreno, 2005), and using transportation (Williams & Palmer, 2004).

Test (2012) noted that life skills could be divided into five groups that include the following: (1) self-care and domestic living; (2) recreation and leisure; (3) communication and social skills; (4) vocational skills; and (5) other skills fundamental for community involvement. This taxonomy can be expanded to include communication skills, organizational skills, navigation skills, technology skills, and independent self-care (McEathron, Beuhring, Maynard, & Mavis, 2013). The Life-Centered Career Education curriculum (Brolin & Loyd, 2004) indicates nine daily living-skill or proficiency areas that can be focused on diverse educational and community settings: (1) managing finances, (2) selecting, managing, and maintaining a home, (3) caring for personal needs, (4) raising children and living as a family, (5) buying and
preparing food, (6) buying and caring for clothes, (7) engaging in civic activities, (8) using recreation and leisure, and (9) getting around the community (mobility). Frequent embedded practice opportunities, role-play simulations, community-based instruction, and different forms of antecedent prompting can be used for teaching independent living skills (Snell & Brown, 2006, as cited in Cullen, & Alber-Morgan 2015). Using AT in instructions for teaching independent living skills can support students with disabilities to participate in the community (Soderstorm, 2011).

**Assistive Technology**

The term *assistive technology device* describes 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." (Sect 2, Assistive Technology Act of 2004). Therefore, common tools such as smartphones, tablets, and MP3 players can be considered as assistive technology devices, and the majority of postsecondary students have at least one of these tools (Kellems et al., 2015). Students with ASD and or IDD can take advantage of these tools in self-determination, daily living, academic, employment, and recreation and leisure activities. The benefits of these tools can include the following: (1) providing virtual practices for desired postsecondary skills, and (2) supporting students' vocational performance (Kellems et al., 2015). See Appendix B for a glossary with further definitions.

College students with ASD and IDD may struggle with independent living (Matson et al., 2011; Nietupski et al., 1997). Minimizing the effects of the difficulties can be possible with assistive technology (AT) support for completing such skills independently. AT has been used to teach independent living skills such as navigation and community participation (Johnson et al.,
To promote success, independence, productivity and participation in academic programs, employment, recreation, and other adult activities; technology may be one of the ways to alleviate barriers for students with disabilities (Burgstahler, 2003). Technology-based devices such as personal digital assistants (PDAs), smartphones, iPod touches, and tablets (including speech generating apps) are the most common tools used to deliver prompting strategies and enable independent participation of young adults with IDD in diverse activities (Odom et al., 2015).

To date, several systematic reviews and meta-analyses have been conducted concerning AT interventions in the development of independent living skills with individuals with ASD and or IDD. These studies are essential as they support the use of AT within daily living skills instruction.

Mechling (2007) reviewed the use of assistive technology as a self-management tool to begin and complete daily tasks for persons with intellectual disabilities, but this research was not specifically in postsecondary education settings. According to the results of Mechling (2007), the AT in the reviewed studies were picture prompts, audio cassette players, handheld computer-based systems, palmtop personal computers, and vibration systems. These technologies were used to support instruction in the following tasks (a) task completion, (b) task engagement, (c) on-task behavior, (d) accuracy of task performance, (e) initiation of tasks, (f) transitioning between tasks, and (g) fluency of work performance. Mechling (2007) focused on targeted task, self-management, rather than a general topic of living skills or PSE. However, self-management is an essential skill for independent living, and the results of this study showed that assistive
technology was useful as a self-management tool in teaching task initiations and completion to persons with disabilities.

Cullen and Alber-Morgan (2015) also conducted a review of the literature about technology-mediated self-prompting interventions of daily living skills for individuals with disabilities—not only ASD and or IDD— in diverse settings including community, school, and home. The technology-mediated self-prompting interventions included (1) audio prompts, (2) picture plus audio prompts, (3) video models and prompts, (4) mixed prompts, (5) computer-based self-instruction, and (6) combined self-prompting categories. A variety of technologies for self-prompting were used in the reviewed studies following: cassette players, DVD players, mp3 player, computers, PDAs or Palmtop PCs. These studies included the following daily living tasks: buying, preparing, and consuming food, choosing and accessing transportation, selecting and managing a household, buying and caring for clothing, and managing personal finances.

Some other systematic reviews focused on AT interventions for academic skills—not independent living skills—of students with learning disabilities (LD), but did not focus on students with ASD and or IDD (Perelmutter, McGregor, & Gordon 2017; Peterson-Karlan, 2011). Perelmutter et al. (2017) reviewed studies whether AT interventions were effective for students with learning disabilities. They found that overall AT interventions had benefits. Peterson-Karlan (2011) reviewed studies in terms of examining the effectiveness of technology for writing skill, specifically compositional writing, of students with learning disabilities. The researcher created four sub-skills of compositional writing while reviewing studies, and these sub-skills were plan-organize, transcribe, edit, and revise. According to the reviewed studies, technologies for plan-organize were a word processor, prompted outline, prompted graphic organizer, graphic organizer, and prompts. The technologies for transcribing were keyboarding,
word processor, word prediction, speech recognition. The technologies for editing were spellchecker, and grammar checker. The technologies for revising were a word processor, digital prompting, and text-to-speech technologies. According to the market survey in this study, the AT tools were Draft: Builder, Kurzweil 3000, Read and Write Gold. Peterson-Karlan (2011) did not find conclusive results to determine the effectiveness of interventions reviewed; however, trends in availability and use of computers and digital technologies were highlighted.

Walsh et al. (2017) investigated technology-aided interventions for employment skills – not independent living skills– for adults with ASD, not in PSE setting. Walsh et al. (2017) reviewed studies whether technology-aided interventions were effective or not. The reviewed studies used technologies including tablet, PDA, virtual reality, iPod, iPhone, Video, DVD, Radio and headset, laptop, and computer to increase vocational skills. The targeted skills for increasing employment outcomes were varied, and Walsh et al. (20017) grouped these skills into two categories: (1) on-the-job skills (i.e., sorting mail, entertaining customers, using a washing machine, cooking, shipping, clerical skills, cleaning, stocking and taking inventory, preparing silverware, folding, photocopying, sweeping) and (2) more generic skills (i.e. work performance, reducing personal support needs on the job, time-management, organization, job interview skills, social skills). Walsh et al. (20017) found that the use of AT interventions was effective in improving employment outcomes for adults with ASD.

Odom et al. (2014) also examined the use of technology in intervention and instruction for high-school students with ASD to create a theoretical and conceptual framework. The target skills in the systematic literature conducted by Odom et al. (2014) included adaptive behavior, challenging behavior, vocational, academic, and communication, and social competence skills. In the reviewed researches, researchers used various technologies (i.e., standard desktop
computers with specialized software, videotaping performances of participants using VCR technology, PowerPoint presentations, smartphones, personal digital assistants, electronic tablets, and virtual reality applications). These studies also had different types of interventions including video modeling, convert audio coaching (CAC), visual prompt, speech generating, self-management, specific training, performance feedback. Odom et al. (2014) found that choosing relevant skills of someone’s lives while using technology in intervention and instruction was a key factor of effectiveness. They emphasized the scope of concerned skills for high-school students with ASD including independence, vocational skills, academics, and social competence.

Among the reviewed studies, communication was the target skill in only one study (i.e., Kagohara et al., 2010, as cited in Odom et al., 2014); which indicated a need to identify additional interventions designed to target the communication needs of adolescents with ASD who were nonverbal (Achmadi et al., 2012, as cited in Odom et al., 2014). Odom et al. (2014) also found that the variety of technology itself and application in interventions and instructions were increasing.

**Quality Indicators for Evaluating Empirical Studies**

There has been a significant demand for special education to produce and share quality reviews of the research in the field (Talbot et al., 2018). It has been reported that only 0.1% of the budget that is spent on interventions and programs have empirical research background during the previous two governments in the U.S. (Bridgeland & Orszag, 2013). Thus, how well the resources are used in these programs, and their effects become significant in this sense.

One of the most feasible methods to be used to investigate the effectiveness of interventions, programs and research in behavioral science area is the systematic review (Maggin, Talbott, Van Acker, & Kumm, 2017). A systematic review could be defined as the
technique to collect relevant evidence to answer a specific research question from different researches which meets some specific criteria (Lipsey and Wilson, 2001). By using systematic reviews, one can explicitly specify the criteria to collect appropriate evidence to reduce subjectivity and enlarge transparency to produce reliable results of findings (Maggin et al., 2017; Talbot et al., 2017). Consequently, it could legitimately be argued that systematic reviews are very beneficial to summarize the results from other research and produce reliable findings from all research going on in the area. The quality indicators of systematic reviews could be defined as the standards applied to systematic reviews to minimize the subjectivity and maximize the transparency and the reliability of evidence collected (Talbott et al., 2017).

**Purpose of the Study**

The purpose of this study is to conduct a systematic review of assistive technology-based instruction in the area of *Independent Living Skills* for college students with ASD and or IDD enrolled in PSE programs for students with IDD. The following research questions will be investigated:

1. What are the reported participants’ demographic characteristics?
2. What skills have been taught using AT and in what settings?
3. What types of technology have been used to teach independent living skills?
4. What types of intervention and systematic instructional practices were used?
5. With regard to study design and method, what types of studies (i.e., single-case, experimental, quasi-experimental) were conducted?
6. What types of dependent measures were used, what were the results and were aspects of the fidelity of implementation and social validity reported?
CHAPTER 3

METHOD

Within this chapter, the methodology used to conduct this systematic review includes the following: (a) a rationale for the selected methodology, (b) restatement of the purpose and the research questions, (c) empirical search and selection procedures, (d) inclusion and exclusion criteria, (e) search procedures, (f) retrieval procedures, and (g) coding scheme procedures. The design of this systematic review was based upon the Quality Indicators for Reviews of Research in Special Education (Talbott et al., 2017). A systematic search was conducted that incorporates systematic review quality indicators recommended by Maggin et al. (2017) and Talbott, et al. (2017) in order to identify studies that pertain to instruction in PSE programs for students with ASD and or IDD and the use of assistive technology devices to teach independent living skills.

Defining Systematic Reviews

To answer the research questions in this study, a systematic review was conducted. A systematic review is traditionally used to present all related evidence collected empirically which satisfies specific eligibility criteria for seeking an answer to a particular research question (Lipsey & Wilson 2001). It is important to emphasize that systematic reviews are different from other types of literature reviews; therefore, systematic reviews are not narrative reviews or meta-analysis (Maggin et al., 2017). As opposed to narrative reviews, systematic reviews explain details about inclusion and exclusion processes. However, systematic reviews do not use meta-analytic techniques to illustrate and organize the outcomes of independent research studies.
Restatement of Purpose and Research Questions

The purpose of this systematic review was to investigate studies that use assistive technology-based instruction to teach independent living skills for students with ASD and ID who are enrolled in PSE programs with students with IDD. The research questions include the following:

1. What are the reported participants’ demographic characteristics?
2. What skills have been taught using AT and in what settings?
3. What types of technology have been used to teach independent living skills?
4. What types of intervention and systematic instructional practices were used?
5. With regard to study design and method, what types of studies (i.e., single-case, experimental, quasi-experimental) were conducted?
6. What types of dependent measures were used, what were the results and were aspects of fidelity of implementation and social validity reported?

Empirical Search and Selection Process

I conducted a preliminary search for empirical studies. A multiple step process was used to find relevant research including electronic search, hand search, and an ancestral review. For finding relevant literature, I used a combination of electronic search, hand search, and ancestral review; provided the number of results yielded by each search method.

Electronic search. First, an electronic search was conducted using the following electronic databases: ERIC (Education Source version), ERIC (EBSCOhost version), ERIC (ProQuest version), PsycINFO and Google Scholar. This was done using a combination of the following free-text terms with truncation and Boolean search operators: autism, aspergers, pervasive development disorder, high functioning autism, intellectual disability, developmental
disabilities, PDD, HFASD, ASD, postsecondary education, assistive technology, computer, electronic ((autis* OR asperge* OR pervasive development disorder OR high functioning autism OR PDD OR HFASD OR ASD OR intellectual disabilit* OR developmental disabilit*) AND (postsecondary OR post-secondary education) AND (assistive technolog* OR computer OR electronic)). The abbreviation of PDD stands for “pervasive development disorder, the HFASD “high-functioning autism spectrum disorder, and ASD autism spectrum disorder. The results of this search yielded 116 articles that are provided in Table 1. The parameters of search comprised peer-reviewed articles and dissertations between 2008 and 2018 to ensure inclusion of recent technology.

**Hand search.** The researcher completed a hand search of 7 peer-reviewed journals between 2008 and 2018. The journals include *Education and Training in Autism and Developmental Disabilities, Journal of Special Education Technology, Education and Treatment of Children, Remedial and Special Education, Focus on Autism and Other Developmental Disabilities, Journal of Applied Behavior Analysis, Research in Autism Spectrum Disorders*. The Education and Training in Autism and Developmental Disabilities journal search yielded 29 articles, and the Journal of Special Education Technology yielded 10 articles. The other 5 journals did not have any relevant literature for this systematic review, the articles in these journals had assistive technology-based instruction taught in K-12 setting, not PSE setting. In total, the hand search of these journals revealed 39 additional articles, with the caveat that these numbers can overlap in some cases; some articles can be located in electronic search results.

**Ancestral review.** Another method of the literature search, ancestral review, is used by reviewing the reference sections of all articles and dissertations that met the criteria for inclusion
of this systematic review. However, the ancestral review did not yield any new articles which are not found by other research processes.

All of these search processes yielded 155 articles with the caveat that these numbers can overlap in some cases; some articles can be located in different results. After I removed duplicates by using “find and remove duplicates” of Endnote and scanned the last results, 136 articles remained.

**Inclusion and Exclusion Criteria for Determining Eligibility**

In the preliminary search, five rules were applied for determining article inclusion eligibility: (a) Peer-reviewed articles or dissertation/thesis must be published within 10 years (i.e., 2008 to 2018), (b) Only empirical work published in peer-reviewed journals or published dissertation/thesis will be included, (c) Participants must have been diagnosed with ASD and or IDD and be enrolled in a postsecondary program designed for individuals with developmental disabilities, (d) Only single-case or experimental/quasi-experimental designed studies will be included, and (e) The independent variable of the study must be an assistive-technology based instruction/intervention that targets the area of Independent Living and be taught within the postsecondary program. If an article adheres to the five rules, then the article will be included. I applied the inclusion and exclusion criteria. To focus on the purpose of this systematic review, studies of participants with high-incidence disability (e.g., learning disability, EBD, speech impairment) were excluded. A preliminary search for articles yielded 136 articles. I read the articles to determine their eligibility for inclusion. For this preliminary search and examination, 8 articles and two dissertations were found that met all five inclusion criteria.
Retrieval Procedures

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher, Liberati, Tetzlaff & Altman, 2009) statement protocol, including a checklist and four phase flow-diagram, were used to guide the methodology and reporting of this review. The PRISMA flow-diagram is provided in Figure 1.

A total of 155 articles were found. The references and abstracts were saved in Endnote reference manager software for the selection process. First, 19 duplicates were found and excluded. A selection process was then carried out with the other 136 articles left. The articles were screened by title and abstract, and 32 articles excluded. Subsequently, full-text screening was conducted, and 8 articles and two dissertations were left.

Coding Scheme Procedures

The coding components were created based on research questions to collect descriptive information from the studies. I coded each study on multiple components that included the following: intervention types, participant characteristics, dependent variables and measures, study design and method. Parameters for coding were similar to the process included in Bruhn and McDaniel (2016). Coding components and details are described in Table 2.

Reporting Findings

Findings from this systematic review are reported in Table 3, Table 4, and Table 5 and provide a synopsis of findings that address each of the research questions.
Table 1. Results of Electronic Search.

<table>
<thead>
<tr>
<th>Electronic Databases</th>
<th>Number of Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERIC (EBSCOhost version)</td>
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</tr>
<tr>
<td>ERIC (Education Source version)</td>
<td>6</td>
</tr>
<tr>
<td>ERIC (ProQuest version)</td>
<td>10</td>
</tr>
<tr>
<td>PsycInfo</td>
<td>0</td>
</tr>
<tr>
<td>Google Scholar</td>
<td>90</td>
</tr>
</tbody>
</table>

*Note. See Appendix A for the Reference Lists from each database.*
Figure 1. PRISMA 2009 Flow Diagram
Table 2. Coding Components and Coding Details.

<table>
<thead>
<tr>
<th>Coding Components</th>
<th>Coding Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>• Describe the number, gender, age, race, disability status, achievement/intellectual/adaptive performance</td>
</tr>
<tr>
<td>Skills Taught</td>
<td>• What skills have been taught using AT and in what settings?</td>
</tr>
<tr>
<td>AT Types &amp; Strategies</td>
<td>• What types of technology and systematic strategies have been used to teach independent living skills?</td>
</tr>
<tr>
<td>Study design</td>
<td>• What type of study design was used?</td>
</tr>
<tr>
<td>Dependent Variables &amp;</td>
<td>• What were the dependent variables and results of the studies?</td>
</tr>
<tr>
<td>Results</td>
<td>• Was fidelity data collected?</td>
</tr>
<tr>
<td></td>
<td>• Was social validity data collected?</td>
</tr>
</tbody>
</table>
The purpose of this systematic review was to identify studies conducted in PSE settings that taught independent living skills through assistive technology-based instruction with students with ASD and IDD. A search of electronic databases resulted in 116 studies. An additional 39 studies were identified by reviewing articles located in various professional journals. Duplicate records and articles that did not meet the inclusion criteria were excluded. A total of eight published peer-reviewed articles and two dissertations were included in this review. A complete list of the included studies is listed in Table 3.

Within this chapter, I have provided an overview of the findings from eight published peer-reviewed articles and two dissertations. For the dissertations, one included a single study while the other dissertation included two studies. A total of 11 studies were examined. The results were reported for the following research questions:

1. What are the reported participants’ demographic characteristics?
2. What skills have been taught using AT and in what settings?
3. What types of technology have been used to teach independent living skills?
4. What types of intervention and systematic instructional practices were used?
5. With regard to study design and method, what types of studies (i.e., single-case, experimental, quasi-experimental) were conducted?
6. What types of dependent measures were used, what were the results and were aspects of fidelity of implementation and social validity reported?
Participants

For the 11 studies reviewed (i.e., eight published peer-reviewed journal articles and two dissertations-- one dissertation contained two studies) there were 15 female and 27 male participants with 42 total participants. The average age was calculated without the study of McMahon et al. (2013) as they provided the participants' age range instead of each participant's age. The average age for participants was 23.8 years with a range of 18 to 57 with a median of 23 years. Most studies did not provide information concerning race; however, three studies reported that six participants were Caucasian (i.e., Cullen et al., 2017; Green et al., 2011; Jimenez et al., 2014). Disability diagnoses were reported for all studies and included seven individuals with ASD and 35 individuals with ID. See Table 3 for authors, journal title, journal, and participants' demographics.

Academic achievement was reported for 22 participants for 6 out of 11 studies (i.e., Jimenez 2014; McMahon et al., 2015a; McMahon et al., 2015b; Purrazzella & Mechling 2013; Smith 2013; Smith 2013). Multiple measures were used to evaluate participants’ academic skills (e.g., Brigance Transition Skills Inventory, Brigance; 2010; Woodcock-Johnson III Tests of Achievement, WJ III, Woodcock, McGrew, & Mather, 2001; 2007; CASA Reading-Beginning Literacy-Life Skills, n.a., n.d.). McMahon et al. (2015a) reported participants’ (n = 6) academic skills via the Brigance Transition Skills Inventory as ranging from pre-kindergarten (i.e., decoding skills) to seventh-grade level. Another study of McMahon et al. (2015b) reported WJ III Broad Reading scores for participants (n = 4) ranged from 55 to 77 (M =100; SD = 15).

Purrazzella and Mechling (2013) reported participants’ Comprehensive Adult Student Assessment Systems (CASA; 2002) performance for three participants which ranged from first- to second-grade for reading level.
Intellectual performance was reported for 39 participants for the following studies (i.e., Cullen et al., 2017; Green et al., 2011; McMahon et al., 2013; McMahon et al., 2015a; McMahon et al., 2015b; Smith et al., 2017; Uphold et al., 2016; Smith 2013; Smith 2013) and indicated participants’ average performance (reported as standard scores with a mean of 100 and a standard deviation of 15) was 56.2 with a range of 48 to 79. Adaptive behavior performance was reported for 26 participants for the following eight studies (i.e., Cullen et al., 2017; Jimenez, 2014; McMahon et al., 2013; McMahon et al., 2015a; McMahon et al., 2015b; Smith et al., 2017; Smith 2013; Smith 2013).

Adaptive behavior performance was reported for 26 participants for seven out of 11 studies (i.e., Cullen et al., 2017; Jimenez 2014; McMahon et al., 2013a; McMahon et al., 2015b; Smith et al., 2017; Smith 2013; Smith 2013). Multiple measures were used to evaluate participants’ adaptive behavior performance (e.g., Scales of Independent Behavior-Revised, Bruininks et al., 1996; Vineland Adaptive Scales, Second Edition, 2005) Cullen et al. (2017) reported participants (n = 3) adaptive behavior standardized scores as 68, 72, 90 based on Adaptive Behavior Assessment Scale. McMahon et al. (2013) reported participants’ (n = 7) adaptive behavior scores via different measures (i.e., Vineland Adaptive Scales; Adaptive Behavior Evaluation Scale, Revised; Adaptive Behavior Assessment System). Five participants' adaptive standardized behavior scores ranged from 71 to 75 with a median of 71 based on the Vineland Adaptive Behavior Scales. One participant's adaptive behavior standardized score was 82 based on the Adaptive Behavior Evaluation Scale, Revised. The other participant's adaptive behavior standardized score was 69 based on the Adaptive Behavior Assessment System. McMahon et al. (2015) reported adaptive behavior standardized scores for participants (n = 4) that ranged from 65 to 73 based on Vineland Adaptive Behavior Scales. Smith et al. (2017)
reported participants’ adaptive behavior standardized scores as ranging from 43 to 75 based on the Scales of Independent Behavior-Revised. Jimenez (2014) used the General Adaptive Composite score (GAC) and reported participants' adaptive behavior scores as 58 (i.e., extremely low range) and 87 (i.e., below average range). Smith (2013) reported two participants' adaptive behavior standardized scores like 71 and 74 based on the Vineland Adaptive Behavior Scales, the other two participants' adaptive behavior composite standardized scores as 51 and 43 according to the Scales of Independent Behavior-Revised. Smith (2013) reported two participants' adaptive behavior composite standardized score as 51 and 43 according to the Scales of Independent Behavior-Revised, and one participant's standardized score as 75 according to the Vineland Adaptive Behavior Scales, Second Edition.

**Skills Taught Using AT**

Assistive technology was used to teach a total of 11 different independent living skills. The following skills were taught: acquisition and generalization of cleaning counter, microwave, and a table (Cullen et al., 2017); time management of the student arriving to class following work shift (Green et al., 2011); identifying food allergens (McMahon et al., 2013), navigation (McMahon et al., 2015; McMahon et al., 2015; Purrazzella & Mechling, 2013; Smith et al., 2017; Smith, 2013); completing recreation tasks (Uphold et al., 2016); making a latte, weeding, watering plants, cleaning the sink area in the bathroom, doing laundry, and riding the bus (Jimenez, 2014), digital communication (i.e., how to place/receive calls, access text messages, and power the device off and on; Smith, 2013). See Table 4 for a description of AT, targeted skills, interventions, and the number of instructional sessions.
Settings Where Instruction Occurred

Across all studies, the participants were instructed in a total of nine settings. These settings included the following: a break room and medical building at a university in Midwest (Cullen et al., 2017); job internship in the university library (Green et al., 2011); school setting (i.e., the class of eating healthy foods; McMahon et al., 2013); public university campus (McMahon et al., 2015: Smith et al., 2017); downtown area (McMahon et al., 2015; Purrazzella & Mechling, 2013), recreational facility on the community college campus (Uphold et al., 2016), participants’ homes and community (Jimenez, 2014), inclusive settings in campus including common areas and computer lab (Smith, 2013); inclusive settings within the university including pedestrian walkways, sidewalks, and cross-walks (Smith, 2013).

Types of AT Devices

There were a total of 14 AT devices and apps used for the studies. In addition, nine instructional strategies were used in conjunction with AT devices and included the following: iPad 4 and MyPicsTalk App (Cullen et al., 2017); vibrating watch and the Watchminder2 model (Green et al., 2011); iPad or iPhone and Red Laser App (McMahon et al., 2013); augmented reality navigation app, Google maps, and paper map (McMahon et al., 2015), Layar mobile app (McMahon et al., 2015), iPhone 4 (Purrazzella & Mechling, 2013), iPhone 4 and Heads Up Navigator app (Smith et al., 2017), iPod touch and ePASS app (Uphold et al., 2016), iPod touch & inPromptu app (Jimenez, 2014), iPhone and iMessage text with activated voiceover, HeyTell audio message, or Tango video message (Smith, 2013), iPhone with the Heads Up Navigator mobile app (Smith 2013). See Table 4 for a description of AT, targeted skills, interventions, and the number of instructional sessions.
Intervention and Length Of Instructional Sessions

Interventions included the use of an AT device coupled with systematic instructional practices. The following instructional strategies were used: self-directed video prompting and a system of least to most prompting (Cullen et al., 2017); prompting with cues (i.e., vibration of wrist watch; Green, et al., 2011); role play (McMahon et al., 2013), explicit instruction (McMahon et al., 2015a; McMahon et al., 2015b), video modelling (Purrazzella & Mechling, 2013). Some interventions included the use of an AT device and also used the following instructional strategies: (a) explicit instruction and least to most prompting system (Smith et al., 2017), (b) explicit instruction and constant time delay (Uphold et al., 2016), (c) self-directed video prompting and a least-to-most prompting hierarchy (i.e., verbal, gestural, partial-physical, full-physical; Jimenez, 2014), and (d) role play and Model-Lead-Test procedures through the use of a visual aid (Smith, 2013). See Table 4 for a description of AT, targeted skills, interventions, and the number of instructional sessions.

Most studies did not mention the length of instructional sessions, and only several of them gave information about how many sessions were delivered. I have provided information if the study explains the length and number of sessions. In Cullen et al. (2017) video self-prompting was used with least to most prompting and the investigator delivered the intervention. Green et al. (2011) used a vibrating watch, the Watchminder2 model combined with prompting with cues to indicate when it was time to finish work and transition to the classroom. The job coach delivered nine instructional sessions. An iPad or iPhone and Red Laser App was used combining combination with a role play instructional strategy in McMahon et al. (2013). In this study, the researcher implemented 13- to-17 instructional sessions.

McMahon et al. (2015) used an augmented reality navigation app, google maps, paper map with explicit instruction. In this study, the researcher presented three instructional sessions.
Purrazzella and Mechling (2013) used video modeling. Explicit instruction was used while teaching how to use the Layar mobile app in McMahon et al. (2015). Explicit instruction was combined with least to most prompting with an iPhone 4 and Heads Up Navigator app (Smith et al., 2017), and was also used with constant time delay strategy with an iPod touch and ePASS app (Uphold, et al., 2016).

Jimenez (2014) used the iPod touch and inPromptu app with self-directed video prompting and a least-to-most prompting hierarchy (i.e., verbal, gestural, partial-physical, full-physical) to teach making a latte, weeding, watering plants, cleaning the sink area in the bathroom, doing laundry, and riding the bus. Smith (2013) used a combination of role play and Model-Lead-Test procedures to teach digital communication. An Apple iPhone equipped with the Heads Up Navigator mobile app was used with Model-Lead-Test procedures and a least-to-most prompting hierarchy in Smith (2013). Across all studies, instructional sessions averaged a total of 12 sessions with a range of 3 to 20 sessions and a median of 13. See Table 4 for study authors, skills taught, settings, type of AT device, intervention, length, and a number of instructional sessions.

Self-directed video prompting was used in the following studies: Cullen et al. (2017) and Jimenez (2014). Cullen et al. (2017) taught all participants to complete a primary task, cleaning a table with Mr. Clean and a sponge using self-directed video prompting. For generalization participants completed slightly different tasks out of three possible tasks in each session without self-directed video prompting. Jimenez (2014) supported self-directed video prompting with a least-to-most prompting hierarchy (i.e., verbal, gestural, partial-physical, full-physical) to teach making a latte, weeding, watering plants, cleaning the sink area in the bathroom, doing laundry, and riding the bus.
Prompting with cues was used in Green et al. (2011) to teach time management. In this study, a visual prompt of the word CLASS was used with a vibrating watch to remind student when it is time to finish work and to transition to class.

Role play was used in the following studies: McMahon et al. (2013) and Smith (2013). In McMahon et al. (2013), the target skill was identifying food allergens. Participants were presented with the following: (1) scenario-based problems that included common food allergens and specific food items; (2) real food items to search for ingredients and possible allergens with using industry terms; and (3) the augmented reality app (i.e., Red Laser) to find out all possible food allergens of specific food item. In Smith (2013), role play was combined with Model-Lead-Test procedures and visual aid for teaching digital communication. A visual aid was created for each digital tool to support students to respond with a standard text, an audio message or a video message.

Explicit instruction was used in the following studies: McMahon et al. (2015)a, McMahon et al. (2015)b, Smith et al. (2017), Uphold et al. (2016). McMahon et al., (2015)a used explicit instruction to teach navigation skills. During each navigation session, a student was asked to navigate to a location. The researcher asked “what direction” and either said confirm it and continued to navigate to the target location or provided verbal and gestural assistance contingently. McMahon et al. (2015) taught students how to navigate an unknown business location using explicit instruction and verbal and gestural assistance. Smith et al. (2017) also used explicit instruction with least to the most prompting system to navigate an unknown location with on-screen visual prompts. At each step, the researcher asked the direction and used the system of least prompts (e.g., pointing, verbal cue, etc.) based on a student's answer. The combination of explicit instruction and constant time delay was used in Uphold et al. (2016) to
teach completing recreation tasks. During the intervention sessions, they used a one 0 s delay session and then they continued with 3 s delay sessions. The researchers used a gesture prompt as the controlling prompt for all intervention sessions.

Video modeling was used in Purrazzella and Mechling (2013) to teach navigation skills. Participants watched the video scenarios one time which included an adult model "lost," and then they continue five trials in which they use iPhone 4 to take videos.

Model-lead-test procedures were used with the system of least prompts in Smith (2013) to teach navigation skills. Participants had a mobile navigation application and followed the on-screen visual prompts to go to the targeted location with a researcher or research assistant. At each point of direction, the researcher asked the participant's how to proceed to the next step. Based on the participant's response, the system of least prompts was implemented. See Table 4 for a description of AT, target skills, intervention, and the number of instructional sessions.
Table 3. Studies and participants’ demographics.

<table>
<thead>
<tr>
<th>Author</th>
<th>Article Title</th>
<th>Journal</th>
<th>Par.</th>
<th>Age</th>
<th>Gen.</th>
<th>Race/Disability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cullen, Simmons-Reed, Weaver (2017)</td>
<td>Using 21st century video prompting technology to facilitate the independence of individuals with intellectual and developmental disabilities</td>
<td>ETADD</td>
<td>3</td>
<td>20, 22, 24</td>
<td>M</td>
<td>Caucasian ASD, ID &amp; Visual Impairment, ID &amp; TBI</td>
</tr>
<tr>
<td>Green, Hughes, Ryan (2011)</td>
<td>The Use of Assistive Technology To Improve Time Management Skills of a Young Adult With an Intellectual Disability</td>
<td>JSET</td>
<td>1</td>
<td>22</td>
<td>F</td>
<td>Caucasian ID &amp; Microcephaly</td>
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<tr>
<td>McMahon, Cihak, Gibbons, Fussel &amp; Mathison 2013)</td>
<td>Using a Mobile App to Teach Individuals with Intellectual Disabilities to Identify Potential Food Allergens</td>
<td>JSET</td>
<td>7</td>
<td>19-23</td>
<td>3 F &amp; not reported</td>
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Table 3. (continued).

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<th>Age</th>
<th>Gen.</th>
<th>Race/ Disability</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMahon, Cihak &amp; Wright (2015)b.</td>
<td>Augmented Reality as a Navigation Tool to Employment Opportunities for Postsecondary Education Students With Intellectual Disabilities and Autism</td>
<td>JRTE</td>
<td>4</td>
<td>21,23,2</td>
<td>2 M 2</td>
<td>not ID and ASD</td>
</tr>
<tr>
<td>Purrazzella &amp; Mechling (2013)</td>
<td>Use of an iPhone 4 with Video Features to Assist Location of Students with Moderate Intellectual Disability When Lost in Community Settings</td>
<td>ETADD</td>
<td>3</td>
<td>24, 28,</td>
<td>2 M 2</td>
<td>not ID</td>
</tr>
</tbody>
</table>

Table 3. (continued).

<table>
<thead>
<tr>
<th>Author</th>
<th>Article Title</th>
<th>Journal</th>
<th>Par.</th>
<th>Age</th>
<th>Gen.</th>
<th>Race</th>
<th>Disability</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMahon, Cihak &amp; Wright (2015)</td>
<td>Augmented Reality as a Navigation Tool to Employment Opportunities for Postsecondary Education Students With Intellectual Disabilities and Autism</td>
<td>JRTE</td>
<td>4</td>
<td>21,23,2</td>
<td>2 M 2</td>
<td>not</td>
<td>ID and ASD</td>
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<td>Purrazzella &amp; Mechling (2013)</td>
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</tr>
</thead>
<tbody>
<tr>
<td>Smith, Cihak, Kim, McMahon, &amp; Wright (2017)</td>
<td>Examining Augmented Reality to Improve Navigation Skills in Postsecondary Students With Intellectual Disability</td>
<td>JSET</td>
<td>3</td>
<td>22,23</td>
<td>2 M</td>
<td>not</td>
<td>ID</td>
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<tr>
<td>Uphold, Douglas, &amp; Loseke (2016)</td>
<td>Effects of Using an iPod App to Manage Recreation Tasks</td>
<td>CDTEI</td>
<td>6</td>
<td>57</td>
<td>2 F</td>
<td>not</td>
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Table 3. (continued).

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<thead>
<tr>
<th>Author</th>
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<th>Race</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Smith (2013)</td>
<td>Using Mobile Technology to Improve Autonomy in Students with Intellectual Disabilities in Postsecondary Education</td>
<td>Diss.</td>
<td>4</td>
<td>22,23,2</td>
<td>2 M</td>
<td>2</td>
<td>ID</td>
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<tr>
<td></td>
<td>Exp. 1, Digital Citizenship</td>
<td>Exp. 2, Navigating on</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>1 F</td>
<td></td>
<td></td>
<td>reported</td>
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<tr>
<td>Smith (2013)</td>
<td>Using Mobile Technology to Improve Autonomy in Students with Intellectual Disabilities in Postsecondary Education</td>
<td>Diss.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>1 F</td>
<td></td>
<td></td>
<td>reported</td>
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</table>

<table>
<thead>
<tr>
<th>Author</th>
<th>Skills Taught</th>
<th>AT Types</th>
<th>Intervention</th>
<th>Inter. Agent</th>
<th>Setting</th>
<th>Lesson #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cullen et al. (2017)</td>
<td>Acquisition and Generalization of Cleaning counter, microwave &amp; table</td>
<td>iPad 4 &amp; MyPicsTalk App with video model</td>
<td>Self-directed video model used with least to most prompting to teach task: cleaning a table. Generalization measured in each session. A component was changed in original task.</td>
<td>Experimenter</td>
<td>Breakroom at medical building at Midwestern University</td>
<td>Not Reported</td>
</tr>
<tr>
<td>Green et al. (2011)</td>
<td>Arrival to work on time</td>
<td>vibrating watch, the Watchminder2 model</td>
<td>prompting and visual cues with vibrating watch</td>
<td>Job Coach</td>
<td>job internship in university library</td>
<td>9</td>
</tr>
</tbody>
</table>

*Note. At Types = Assistive Technology used in intervention, Inter. Agent = Intervention Agent, and Lesson # = number of lessons in intervention.*
Table 4. (continued).

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<th>Setting</th>
<th>Lesson #</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMahon et al.</td>
<td>Identifying Food Alergens</td>
<td>ipad or iPhone and Red Laser App</td>
<td>Scenario based problems with allergens &amp; real food items used.</td>
<td>investigator</td>
<td>School setting</td>
<td>13-17</td>
</tr>
<tr>
<td>(2013)</td>
<td></td>
<td></td>
<td>Participants taught to use the augmented reality app (Red Laser) to identify possible food allergens of specific food item.</td>
<td></td>
<td>in classroom</td>
<td>sessions</td>
</tr>
<tr>
<td>McMahon et al.</td>
<td>Navigation</td>
<td>augmented reality navigation app, google maps, or a paper map. Participants assigned to one of 3 conditions &amp; traveled to target destinations</td>
<td>Prompting with augmented reality app, google maps, or a paper map. Participants assigned to one of 3 conditions &amp; traveled to target destinations</td>
<td>investigator</td>
<td>Public University Campus</td>
<td>3</td>
</tr>
<tr>
<td>(2015)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<th>Inter. Agent</th>
<th>Setting</th>
<th>Lesson #</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMahon et al. (2015)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>navigation</td>
<td>Layar mobile app</td>
<td>Participant used app to travel to unknown business destination. Intermittent checks along with verbal &amp; gestural prompts were provided by investigator during intervention.</td>
<td>investigator</td>
<td>downtown area</td>
<td>12-14 sessions</td>
</tr>
<tr>
<td>Purrazzella &amp; Mechling (2013)</td>
<td>navigation</td>
<td>iphone 4</td>
<td>Participants watched a video scenario which included an adult model who was &quot;lost&quot; &amp; then they completed five trials in which they use iPhone 4 to take videos.</td>
<td>instructor</td>
<td>downtown area</td>
<td>Not Reported</td>
</tr>
</tbody>
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Note. At Types = Assistive Technology used in intervention, Inter. Agent = Intervention Agent, and Lesson # = number of lessons in intervention.
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<th>Setting</th>
<th>Lesson #</th>
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<tr>
<td>Smith et al.</td>
<td>navigation</td>
<td>iphone 4 and Heads Up</td>
<td>Participants used mobile navigation application with on-screen visual prompts to navigate to a novel location. System of least prompts and reinforcement used</td>
<td>investigator</td>
<td>campus</td>
<td>17-19</td>
</tr>
<tr>
<td>(2017)</td>
<td></td>
<td>Navigator app</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uphold et al.</td>
<td>completing</td>
<td>ipod touch and ePAS app</td>
<td>Constant time delay was used to teach participants how to program the iPod touch® with a picture list of exercises.</td>
<td>investigators</td>
<td>recreational</td>
<td>18-20</td>
</tr>
<tr>
<td>(2016)</td>
<td>recreation tasks</td>
<td></td>
<td></td>
<td></td>
<td>facility on the community</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>college campus</td>
<td></td>
</tr>
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Note. At Types = Assistive Technology used in intervention, Inter. Agent = Intervention Agent, and Lesson # = number of lessons in intervention.
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</tr>
</thead>
<tbody>
<tr>
<td>Jimenez (2014)</td>
<td>making a latte, weeding, watering plants, cleaning the sink, laundry, &amp; riding the bus</td>
<td>ipod touch &amp; inPromptu, app Video</td>
<td>Least-to-most prompting was used along with video modeling</td>
<td>researcher</td>
<td>participants' homes and community</td>
<td>13</td>
</tr>
<tr>
<td>Smith (2013)</td>
<td>digital communication with phone (messages, texting, calling)</td>
<td>Apple iPhone, text activated voiceover, HeyTell &amp; Tango video message</td>
<td>Visual cues with steps for each task. Model-Lead-Test framework used. in teaching skills. Reinforcement and praise used.</td>
<td>research assistants, free time, computer lab, other areas on campus</td>
<td>13</td>
<td></td>
</tr>
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**Note.** At Types = Assistive Technology used in intervention, Inter. Agent = Intervention Agent, and Lesson # = number of lessons in intervention.
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<th>Setting</th>
<th>Lesson #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith (2013)</td>
<td>Navigation</td>
<td>An Apple</td>
<td>Participants used mobile iPhone navigation app, picked</td>
<td>investigator</td>
<td>inclusive settings within the university</td>
<td>Not</td>
</tr>
<tr>
<td></td>
<td></td>
<td>equipped with the Heads Up</td>
<td>destination from the pop-up menu, &amp; used on-screen prompts to travel to a location. A system of least prompts was used.</td>
<td>investigator</td>
<td>inclusive pedestrian walkways, sidewalks, and cross-walks</td>
<td>Reported</td>
</tr>
</tbody>
</table>

*Note. At Types = Assistive Technology used in intervention, Inter. Agent = Intervention Agent, and Lesson # = number of lessons in intervention.*
Study Design

All of the 11 studies from the eight peer-reviewed articles and two dissertations have employed single-case designs. Cullen et al. (2017), McMahon (2013), Purrazzella and Mechling (2013), and Jimenez (2014) conducted their studies using single-subject designs with multiple probes across subject design. The sample size for these studies were 3, 7, 3, 2 participants respectively. Green et al. (2011), Smith, et al. (2017), Uphold, et al. (2016), and Smith (2013) used a single subject and ABAB research design with 1, 3, 6, 3 participants, respectively. McMahon et al. (2015a), McMahon, et al. (2015b), and Smith (2013) used an adapted alternating treatment design with 6, 4, 4 participants, respectively.

Dependent Variables

Dependent variables for the studies were different since different skills were being investigated. In Cullen, et al. (2017) dependent variables were the percentage of steps of the cleaning task analysis. Green et al. (2011) used timeliness of student arriving to class with time expected to arrive and time of actual arrival as the dependent variable. McMahon et al. (2013) used a correct response on the food allergen scenario-based questions as the dependent variable. The percentage of independent direction checks was the dependent variable in McMahon et al., (2015). The number of task analysis steps performed independently correct was the dependent variable in Purrazzella and Mechling (2013). The number of correct independent way-point decisions was the variable of interest in Smith et al. (2017). Uphold, et al., (2016) used two dependent variables which were: (a) the percent of correct steps of programming the device and (b) the percent of exercises completed correctly. Jimenez (2014) used the percentage of correct iPod use and task completion as the dependent variable in the study. Smith (2013) had two
dependent variables: (a) the number of independently completed task analysis steps to access and reply to a text message and (b) the quality of the text message.

Social Validity

Social validity was reported for 39 participants for 10 out of 11 studies. Purrazzella and Mechling (2013) did not mention social validity results. Cullen et al. (2017) assessed social validity with a social validity questionnaire, and the participants' responses were positive. Green et al. (2011) conducted a social validity questionnaire, and the participant and her job coach indicated that the vibrating watch had high levels of social validation. McMahon et al. (2013) collected participants' ideas towards social validity with a six-item Likert survey, and all participants' responses were either agreed or strongly agreed to use an app for learning potential food allergens in order to make appropriate choices.

McMahon et al. (2015) assessed social validity with informal social validity questions and found that the participants’ answers indicated that the use of mobile devices to navigate was socially acceptable in society. Smith (2017) also used a questionnaire for assessing social validity and reported that all participants responded they strongly agreed. Uphold et al. (2016) interviewed with each individual who participated in the study and collected social validity data. The participants' responses were reported as positive. Jimenez (2014) administered a questionnaire to each student and parents, and the respondents answered with either ‘strongly agree' or ‘agree' responses. Smith (2013) used a social validity questionnaire, and results indicated that all students responded positively to the intervention.

Results

Cullen et al. (2017) found "a functional relationship between the introduction of the intervention and improvement in daily living skills was demonstrated" (p. 975) and that 99.6%
task analysis steps were correctly completed. In Green et al. (2011) results showed that the use of AT resulted in a significant change in mean (i.e., average performance), level (i.e., shift at the point of phase change), and latency (i.e., rapidity of change) in time management skills for a student with ID, all of which are critical characteristics that contribute to judging an effective intervention through visual analysis. The effect size for this study was 1.0.

According to McMahon et al. (2013), a functional relation was found. During baseline, the mean number of correct answers was three. After the app was implemented, the mean number of correct answers was increased to 7.7. When the Red Laser app was withdrawn, the mean number of problems solved correctly decreased to 3.0. The mean number of correctly solved problems increased from 3 to 7.7 (McMahon et al., 2013). In McMahon et al. (2015), a functional relation between improved navigation independence and the two conditions: AR app and paper map was demonstrated, and AR treatment condition was the most effective (100%) (McMahon et al., 2013).

Purrazzella and Mechling (2013) found that participants completed 100% of the steps after the different number of sessions that ranged from 3 to 8 using the video model. In Smith, et al. (2017), a functional relationship was demonstrated. During baseline, the average independent route decisions for all students was 28% (range= 0–50%) (Purrazzella and Mechling, 2013). 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, the independent waypoint decisions for all students decreased to an average of 24% (range =0–42%). The mean independent way-point decisions for all students increased to 99% in this study (Purrazzella and Mechling, 2013).
Results of Uphold et al. (2016) showed that a functional relationship existed between the independent completion of a series of tasks and the two conditions: no ePASS and ePASS intervention were demonstrated through data points, but the researchers did not explicitly note this (Uphold et al., 2016). In addition to this result, all participants completed their exercises with 100% accuracy and completed 100% of these exercises correctly (Uphold, et al., 2016).

Jimenez (2014) found that a functional relationship was demonstrated once the iPod Touch was made available during the self-directed video prompting condition, there was an immediate increase in responding for all three tasks across both participants and these participants used the iPod Touch with an average of 97% accuracy across all three tasks. Smith (2013) showed that 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 (Jimenez, 2014).

In Smith (2013), it is shown that a functional relationship existed and that at baseline, the mean independent navigating decisions for all participants was 28% (range = 0-50%). During the intervention phase, all participants increased their navigating decisions (i.e., waypoint decisions) to an average of 94%. The participants subsequently decreased their average to 24% following the withdrawal of the intervention. Once the intervention was implemented participants' average independent navigation decisions again (i.e., waypoint decisions) increased to 99% (Smith, 2013).
**Fidelity of Implementation**

Two out of 11 studies did not report information regarding fidelity of implementation (i.e., McMahon, et al., 2015; Purrazzella & Mechling, 2013). Cullen et al. (2017) indicated that the treatment integrity was reported as 97% with two raters for at least 25% of sessions. In Green, et al. (2011) it was only mentioned that procedural fidelity was maintained by communicating with the job coach. McMahon et al. (2013) explained that all participants showed 100% accuracy six weeks later with a minimum of 60% of baseline, intervention, and maintenance sessions for each participant.

McMahon et al. (2015) showed that the treatment integrity average reported for intervention implementation with each participant ranged between 96% and 98% for a minimum of 25% of all sessions. Smith et al. (2017) reported that the average for treatment integrity across all sessions was 95%. Uphold et al. (2016) explained that interobserver and procedural reliability data were collected on 30% of each participant’s sessions and were reported as 100%.

Jimenez (2014) found 100% fidelity for task completion and use of the inPromptu app. Interobserver agreement (IOA) data were collected for 31% of all sessions for the correct use of the iPod Touch and task completion. Smith (2013) showed that the overall mean treatment integrity was 96% for at least 50% of sessions. In the other study conducted by Smith (2013), it was reported that the overall mean treatment integrity was 95% (range = 80%-100%) for a minimum of 40% of the sessions of each phase. See Table 5 for a description of study type, dependent variable, results, and fidelity of implementation.

The findings from this systematic review revealed the effectiveness of the use of AT devices coupled with systematic instruction to teach independent living skills to the individuals with ASD and or IDD who participated in these studies. Explicitly, navigation skills were taught in different studies through either augmented reality app or google maps. Different types of
intervention and systematic instructional practices were used; however, least to the most prompting system was used in several different studies. The scores for the fidelity of implementations were high across the majority of studies. The assistive technologies that were used in these studies were reported as socially valid by parents and students.
Table 5. Study type, dependent variables, results and fidelity for studies reviewed.

<table>
<thead>
<tr>
<th>Author</th>
<th>Single Case</th>
<th>Dependent V</th>
<th>F Rel.</th>
<th>Results</th>
<th>Fidelity</th>
<th>Social Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cullen, et al.</td>
<td>multiple probe</td>
<td>% of steps of the cleaning task</td>
<td>Yes</td>
<td>99.6% task analysis steps were correctly completed</td>
<td>Treatment integrity score is 97% with 2 raters for at least 25% of sessions</td>
<td>Yes</td>
</tr>
<tr>
<td>(2017)</td>
<td>across subjects</td>
<td>analysis design</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green, et al.</td>
<td>ABAB research</td>
<td>Latency. Time expected to arrive &amp;</td>
<td>Yes</td>
<td>Effect size = 1.0</td>
<td>NR</td>
<td>Yes</td>
</tr>
<tr>
<td>(2011)</td>
<td>design</td>
<td>time of arrival</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>McMahon et al.</td>
<td>Multiple baseline</td>
<td>a correct response on the food allergen scenerio based questions</td>
<td>Yes</td>
<td>The mean number of correctly solved problems increased from 3 to 7.7.</td>
<td>Participants 100% accuracy 6 wks. later for 60% of sessions.</td>
<td>Yes</td>
</tr>
<tr>
<td>(2013)</td>
<td>baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. Dependent V. = Dependent Variable, F Rel.= Functional Relationship, NR = Not Reported, and wks = weeks.*
Table 5 (continued).

<table>
<thead>
<tr>
<th>Author</th>
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<th>F Rel.</th>
<th>Results</th>
<th>Fidelity</th>
<th>Social Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMahon et al. (2015)</td>
<td>Adapted Alternating Treatment Design</td>
<td>The percentage of independent direction checks</td>
<td>Yes</td>
<td>The most effective one is AR treatment.</td>
<td>NR</td>
<td>Yes</td>
</tr>
<tr>
<td>McMahon et al. (2015)</td>
<td>Adapted Alternating Treatment Design</td>
<td>the percentage of correct independent navigation decisions</td>
<td>Yes</td>
<td>AR treatment condition was the most effective (100%).</td>
<td>Average across participants ranged between 96% to 98% for 25% of sessions.</td>
<td>Yes</td>
</tr>
<tr>
<td>Purrazzella &amp; Mechling (2013)</td>
<td>Multiple Probe</td>
<td>The number of task analysis steps performed independently correct</td>
<td>NR</td>
<td>Evaluators recognized 100%, 66.7%, &amp; 33% of video captions (locations) for participants</td>
<td>NR</td>
<td>NR</td>
</tr>
</tbody>
</table>

*Note.* Dependent V. = Dependent Variable, F Rel.= Functional Relationship, NR = Not Reported, and wks = weeks.
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<tr>
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<th>F.Rel.</th>
<th>Results</th>
<th>Fidelity</th>
<th>Social Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith et al.</td>
<td>ABAB reversal</td>
<td>number of correct</td>
<td>Yes</td>
<td>Mean independent way-point decisions for all students increased to 99%.</td>
<td>Overall Mean was 95% for 50% of sessions.</td>
<td>Yes</td>
</tr>
<tr>
<td>(2017)</td>
<td>design</td>
<td>independent way-point decisions</td>
<td></td>
<td>All participants completed their own exercises with 100% accuracy &amp; completed 100% of these exercises correctly.</td>
<td>Interobserver &amp; procedural reliability data were 100% for 30% of all participants’ sessions</td>
<td>Yes</td>
</tr>
<tr>
<td>Uphold et al.</td>
<td>ABAB reversal</td>
<td>percent of correct</td>
<td>Yes</td>
<td>All participants completed their own exercises with 100% accuracy &amp; completed 100% of these exercises correctly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2016)</td>
<td>design</td>
<td>steps programming</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>the device &amp; the percent of exercises</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Author</th>
<th>Single Case</th>
<th>Dependent V</th>
<th>F Rel.</th>
<th>Results</th>
<th>Fidelity</th>
<th>Social Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jimenez</td>
<td>Multiple probe design across participants</td>
<td>the percentage of correct iPod use and task</td>
<td>Yes</td>
<td>Both participants used the iPod Touch with an average of 97% accuracy across all three tasks</td>
<td>Fidelity 100% for task completion &amp; use of inPromptu app for 31% interobserver agreement</td>
<td>Yes</td>
</tr>
<tr>
<td>Smith</td>
<td>An alternating treatments design</td>
<td>number of steps completed independently to reply to a digital communication</td>
<td>NR</td>
<td>iMessage voiceover condition = mean of 70% (25-100%). HeyTell, = mean of 80% (42-100%). Tango, mean of 85% (50-100%).</td>
<td>overall mean treatment integrity was 96% for at least 50% of sessions</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Note.* Dependent V. = Dependent Variable, F Rel.= Functional Relationship, NR = Not Reported, and wks = weeks.
Table 5 (continued).

<table>
<thead>
<tr>
<th>Author</th>
<th>Single Case</th>
<th>Dependent V</th>
<th>F Rel.</th>
<th>Results</th>
<th>Fidelity</th>
<th>Social Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith (2013)</td>
<td>ABAB reversal</td>
<td>number of independent way-points recorded when traveling to target destinations.</td>
<td>Yes</td>
<td>overall mean student performance indicated that the mobile application was an effective tool to assist students in making waypoint decisions independently.</td>
<td>overall mean treatment integrity was 95% (80%-100%) for a minimum of 40% of the sessions of each phase.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Note. Dependent V. = Dependent Variable, F Rel.= Functional Relationship, NR = Not Reported, and wks = weeks.*
CHAPTER 5

DISCUSSION

Postsecondary education is crucial for all students including students with disabilities as it improves personal skills, academic skills, employment skills, self-advocacy, and self-confidence (Hart, Grigal, & Weir, 2010). The ultimate goal of postsecondary education for students with ASD and or IDD is to empower students to achieve independent living skills and to improve their social communications (Shogren & Plotner, 2012). According to the National Longitudinal Transition Study-2 (NLTS-2), the independent living rates for young adults with disabilities is lower than those for adults without disabilities. Independent living rates were reported as 16% for young adults with multiple disabilities, 17% for young adults with ASD and 36% for young adults with ID in comparison to 59% of the general adult population reported as living independently (Newman et al., 2011). Assistive technology can be used to support engagement and independence, in academic programs, employment, and recreation (Burgstahler, 2003).

The purpose of this systematic review was to examine what assistive technology-based instruction has been conducted in the area of independent living with college students with ASD and or ID who are enrolled in PSE programs for students with developmental disabilities. Studies were found via a search of electronic databases and professional journals. Next study duplications were removed, and inclusion and exclusion criteria were implemented. A total of eight published peer-reviewed articles and two dissertations were included in this systematic review. One of these dissertations (Smith, 2013) has two different experiments, and both of them were reviewed in this study.
The eight published peer-reviewed articles and two dissertations were investigated in terms of participants’ demographic characteristics, skills, AT types, intervention and systematic instructional practices, study design, method, dependent measures, results, the fidelity of implementation, and social validity.

The findings from this review suggest that although there were a variety of interventions in which multiple types of AT devices were utilized (i.e., iPad, iPod, iPhone, vibrating watch, apps, and an augmented reality app), there was evidence that that assistive technologies were practical teaching tools for individuals with ASD and ID who participated in the studies. Moreover, assistive technologies that were used in the reviewed studies were reported by participants to be accepted and socially valid. Fidelity of implementation was reported for nine out of 11 studies and ranged from 95% to 100%.

The acquisition of independent living skills is essential because it supports students with ASD and IDD to have a quality of life. Various skills were taught with AT devices and or apps in the studies included in this review. The variability in skills indicates that AT devices or apps are not only for a specific type of skills (i.e., navigation, communication) but that they can extend to nutritional and routine chores as well. The different kinds of skills included cleaning (Cullen et al. 2017); time management (Green et al. 2011); identifying food allergens (McMahon et al. 2013); completing recreation tasks (Uphold et al. 2016); making a latte, weeding, and watering plants, cleaning the sink area in the bathroom, doing laundry, and riding the bus (Jimenez, 2014). When individuals with ASD and IDD learn to complete daily tasks with AT devices, such as the iPhone or iPad can enhance their quality of life and increase their independence. Some skills (i.e., completing recreation tasks, becoming digital citizens, and riding the bus) in the studies included in this review reported an increase in students' activity level and social interactions with
others. Students who participated in the studies learned vital skills. Specifically, in McMahon et al. (2013), the target skill was identifying food allergens. Identifying food allergens increases one’s opportunity to become independent in shopping and cooking packed food without the help of others.

**Participants’ Characteristics**

This study has enriched the existing literature in several ways. First, these studies focused on AT interventions for independent living skills conducted in a PSE setting and included adults with ASD and ID. The previous studies that reviewed assistive technology-based instruction for students with ASD and or ID were conducted with the children in K-12 settings (Odom et al., 2014) or focused on AT interventions for academic skills—not independent living skills—of students with learning disabilities (LD), but did not focus on students with ASD and or IDD (Perelmutter et al., 2017; Peterson-Karlan, 2011) or investigated technology-aided interventions for employment skills—not independent living skills—for adults with ASD (Walsh et al., 2017). In this study, the participants’ age range is 18 to 57 years of age 57 here is an outlier; the average age for participants was 23.8. In most cases of the studies, subjects were at the expected age range with college students.

**Skills Taught Using AT**

One of the significant benefits of AT based interventions is to lessen difficulties and foster success, independence, productivity and participation in academic programs, employment, recreation, and other adult activities (Burgstahler, 2003). These studies support this finding as participants showed improved skills. As students becoming digital citizens and communicating via the mobile applications, or navigating independently, cleaning, managing their times, identifying food allergens, completing recreation tasks, making a latte, weeding, and watering
plants, doing laundry sessions, and riding the bus, they became more independent and more socially active in their lives.

**Settings**

Studies included in this systematic review occurred in an inclusive campus setting or home and community setting or downtown where participants were faced with natural supports and peers without disabilities. An inclusive campus setting is essential and beneficial for participants in several ways: (1) they can easily find positive peer role models, (2) make these interventions more natural, and (3) help to generalize and maintain the new skills.

**Types of AT Devices**

These studies used mobile technologies like the iPhone, iPad, apps which are common mobile technologies among college students. The social validity of the devices and applications encourage students to use these AT devices in any setting at any time. Becoming independent in a skill affects other skills. For example, when students navigate through a college campus or know how to respond text, call, and video call, they become socially active, and their language abilities may be improved, academic skills may be positively affected. As previously mentioned, iPhone, iPad, and apps are common mobile technologies used among college students and knowing how to use every day mobile tools (i.e., iPad, iPhone) may support inclusion at college.

**Intervention Types and Length of Instructional Sessions**

These studies showed a variety of intervention types and strategies (i.e., self-directed video prompting, role play, video modeling, explicit instruction, Model-Lead-Test procedure, a least-to-most prompting hierarchy, and constant time delay) while teaching independent living skills with the use of an AT device. Practitioners can find effective intervention types for them, and
this increases the possibility that teachers would teach independent living skills by using these intervention types in the PSE setting.

The majority of reviewed studies indicated the number of instructional sessions (i.e., Green et al., 2011; McMahon et al., 2013; McMahon et al., 2015a; McMahon et al., 2015b; Purrazzella & Mechling 2013; Smith et al., 2017; Uphold et al., 2016; Jimenez 2014; Smith 2013). The average number of instructional sessions was 12.8 and ranged from 3 to 20. Within these sessions, the instruction was supported by researchers in 10 studies, job coaches in 1 studies (i.e., Green et al., 2011).

**Study Design and Method**

The reviewed studies used single-subject research design; specifically, reversal designs (i.e., multiple-treatment reversal design, alternating treatments design) were used in these studies; (Green, Hughes & Ryan, 2011; McMahon et al., 2015; McMahon, Cihak & Wright, 2015; Smith et al., 2017; Uphold, Douglas, & Loseke, 2016; Jimenez, 2014; Smith, 2013). The other reviewed studies used a multiple-baseline design (i.e., Cullen, Simmons-Reed, Weaver, 2017; McMahon et al., 2013; Purrazzella & Mechling, 2013; Jimenez, 2014).

**Dependent Measures**

The dependent measures of these studies were determined by the targeted skill measured. The targeted skills aimed to increase independent living outcomes for the study participants. Some studies used the number of task analysis steps that were performed independently correct; some used the percentage of correctly completed steps of task analysis, one study used timeliness of student measured through latency, while one study used a correct response to scenario-based questions as dependent measures.
Postsecondary Education Programs and Their Growth

The number of PSE programs which offer inclusive college experiences to people with ID has increased dramatically between 2004 and 2017, from 25 to 268 in the United States (Grigal, 2018). Almost half of these programs emerged after 2009. This rapid growth emerged the need for studies to establish evidence-based instructional practices.

The Need to Identify Effective Instructional Practices for Teaching Independent Living

Providing support to young adults with ID and ASD who participate in PSE for independent living skills is vital in PSE programs (Grigal & Hart, 2010). The process of identifying effective instructional practices includes identifying target skills and strategies, finding opportunities to practice and maintain target skills, and the organization of reinforcers and accommodations for generalization of the skills in various settings (Wehmeyer & Schalock, 2001). This systematic literature review provides an overview of empirical investigations which used AT and instructional strategies to teach independent living skills to college students who were enrolled in PSE programs for students with IDD.

The Need to Provide Systematic Instructional Strategies Along with AT to Promote Acquisition of Skills

Opportunities of using new technology in interventions for students with severe disabilities have been increased (Browder et al., 2014). Specifically, the recent development of mobile phone or iPhone and tablet or iPad are convenient in handling daily issues (Smith et al., 2017). The use of systematic instructional strategies along with AT to promote the acquisition, maintenance, and generalization of daily living skills can be an effective way to deliver instruction to PSE students with ASD and/or ID. Researchers suggest that mobile technology can support students to live independently with using specific skills (i.e., navigation, identifying food allergens, time
management, digital communication; Green et al., 2011; McMahon et al., 2013; McMahon et al., 2015a; McMahon et al., 2015b; Purrazzella & Mechling, 2013; Smith, 2017; Smith, 2013).

Although it is a common belief that using AT effectively can support living skills of students with ASD and ID, the use of instructional strategies to support AT is equally essential. The studies included in this systematic review used instructional strategies such as least to most prompting and constant time delay along with AT devices to teach independent living skills. Self-directed video prompting, video modeling, and role play were examples of other systematic instructional strategies and technology-based interventions used in the studies reviewed.

**Practical Implications**

The AT devices and apps in these reviewed studies were inexpensive, versatile and socially acceptable. The reviewed studies had various targeted skills and showed that AT based instructions had been used to teach a range of independent living skills to postsecondary students with ASD and IDD. This information could be helpful to teachers and or supervisors who teach individuals with ASD and IDD independent living skills. The studies reviewed reveal ways these devices can be used for teaching a variety of skills. By including AT devices that are commonly used by individuals, teachers could save their time and energy by not having to create specific materials for particular skills. Instead, AT tools used by individuals with ASD, IDD, and individuals without disabilities within the natural environment such as smartphones could be utilized to support independent living skills.

Another important implication is using AT devices to support one’s participation in inclusive settings. The AT devices in the reviewed studies are ordinary tools among college students. When postsecondary education students with ASD and or ID learn how to use these
devices and make good use of such devices to learn different kinds of living skills, students’ social interactions with other college students may be increased.

This study can also be helpful with providing several considerations while implementing technology-based instructions to promote living skills. First, implementing systematic instructional strategies along with AT can support the acquisition of further tasks. When postsecondary students with ASD and ID participate for the selection of AT and crucial tasks for them, their self-determination skills are improved. However, teachers and or supervisors who teach living skills to individuals with ASD and IDD need this kind of systematic review that may provide them a framework of living skills and AT opportunities along with systematic instructional strategies. Second, providing AT opportunities to PSE students with ASD and/or ID, and supporting teachers and or supervisors to make evidence-based decisions may decrease demands on caregivers. When students are not dependent on caregivers, their self-esteem will increase.

Moreover, AT is so readily available than adult supports. This study of the systematic literature review will provide information about which technologies including devices and apps are available in store. Offering options to students increase the possibility of using AT devices for improving living skills.

Another critical point of utilizing systematic instructional strategies along with AT is a generalization. As students become an expert of a specific task, they expand it to a variety of settings such as job sites, and academic classes. For example, one of the target tasks in Jimenez (2014) was "making a latte for yourself." A student can transfer this skill to his/her vocational setting and maybe become a barista. Whenever a student needs help while making a latte, he/she
quickly get support from iPod touch and inPromptu app. This example is valid for all other targeted skills that the reviewed studies included.

**Limitations**

The review has several limitations for consideration. First, there was not an additional independent rater to aid in the coding of articles. Having another rater would have improved the reliability of the results and would aid in reducing bias in the coding process. The second limitation was that every effort was made to be sure that the identified keywords used would gather all relevant studies; however, future researchers should continue to expand upon keyword identification and use to avoid the absence of relevant studies.

**Future Investigations**

This review showed the significance of using AT based interventions while teaching daily tasks. Further research can investigate either the variety of AT devices for one specific skill (i.e., navigation) or the diversity of skills that are taught with one specific AT device. The reviewed studies highlighted the functional relation of AT based interventions and targeted skill; however, these findings are not considered as evidence-based practices in teaching independent living skills to postsecondary education students with ASD and or IDD. Future research may examine the practices to broaden the evidence base.

**Conclusion**

Overall, this systematic review described the results of assistive technology-based instructions for independent living skills. It has found that assistive technology-based interventions were effective for teaching living skills to adults with ASD and IDD. Different skills have been taught in the reviewed studies, and this diversity showed us that the target skill can be diversified in
future studies or practice. Independent living is vital for everyone; however, the independent living rate for young adults with autism (17%), for young adults with intellectual disabilities (36%) (Newman et al., 2011). Therefore, we need evidence-based interventions that teach the necessary skills for independent living. By doing so, we may increase the independent living rate for young adults with ASD and/ or ID.

The acquisition and generalization of independent living skills are important because it helps students with ASD and IDD to improve their life quality consistently. This study has shown that PSE students of all ages can improve their quality of life using the advantages of AT devices and apps.
REFERENCES


*Assistive technology: Principles and applications or communication disorders and special education,* 1-22.

APPENDIX A

References from ERIC (EBSCOhost version)


References from ERIC (Education Source version)


References from ERIC (ProQuest version)


**References from Google Scholar**


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Hayes, G. R., Robert, A., & Kleist, B. L. Using Wearables to Augment Social Interactions and Teach Social Skills for Adults with Autism.


Macy, D. (2015). Aligning iPad and iPod technology with evidence based practices in inclusive and special education classrooms to support students with autism spectrum disorders. Humboldt State University,


Pustejovsky, K. (2012). *The effects of iPad and visual representations in establishing positive transitions for individuals with Autism Spectrum Disorder (ASD).*


APPENDIX B

GLOSSARY

**Assistive Technology**: Technology designed to be utilized in an assistive technology device or assistive technology service. [Sect 2, Assistive Technology Act of 2004].

**Assistive Technology Device**: 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. [Sect 2, Assistive Technology Act of 2004]. **Assistive Technology Service**: Any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device. [Sect 2, Assistive Technology Act of 2004].

**Autism Spectrum Disorder (ASD)**: A developmental disability significantly affecting verbal and nonverbal communication and social interaction, usually evident before age 3 that adversely affects a child’s educational performance. Other characteristics often associated with ASD are engagement in repetitive activities and stereotyped movements, resistance to environmental change or change in daily routines, and unusual responses to sensory experiences. The term does not apply if a child’s educational performance is adversely affected primarily because the child has an emotional disturbance, as defined in paragraph (c)(4) of this section. A child who manifests the characteristics of autism after age three could be identified as having autism if the criteria in paragraph (c)(1)(i) of this section are satisfied.” [34 C.F.R. 300.8(c)(1)] (IDEA, 2004)

**Individual with Significant Disability**: (i) who has a severe physical or mental impairment which severely limits one or more functional capacities (such as mobility, communication, self-care, self-direction, interpersonal skills, work tolerance, or work skills) regarding an employment
outcome; (ii) whose vocational rehabilitation can be expected to require multiple vocational rehabilitation services over an extended period; and (iii) who has one or more physical or mental disabilities resulting from amputation, arthritis, autism, blindness, burn injury, cancer, cerebral palsy, cystic fibrosis, deafness, head injury, heart disease, hemiplegia, hemophilia, respiratory or pulmonary dysfunction, intellectual disability, mental illness, multiple sclerosis, muscular dystrophy, muscular-skeletal disorders, neurological disorders (including stroke and epilepsy), paraplegia, quadriplegia, and other spinal cord conditions, sickle cell anemia, specific learning disability, end-stage renal disease, or another disability or combination of disabilities determined on the basis of an assessment for determining eligibility and vocational rehabilitation needs described in subparagraphs (A) and (B) of paragraph (2) to cause comparable substantial functional limitation. (Rehabilitation Act, 1973) (PL 93-112)

Universal Design: The term 'universal design' means a concept or philosophy for designing and delivering products and services that are usable by people with the broadest possible range of functional capabilities, which include products and services that are directly accessible (without requiring assistive technologies) and products and services that are interoperable with assistive technologies."

Universal Design for Learning The term "universal design for learning" means a scientifically valid framework for guiding educational practice that —

"(A) provides flexibility in the ways information is presented, in the ways, students respond or demonstrate knowledge and skills, and in the ways, students are engaged; and

"(B) reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including
students with disabilities and students who are limited English proficient.” (Assistive Technology Act, 1998)