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Using a Mobile Device to Deliver Visual Schedules to Young Children with Autism

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USING A MOBILE DEVICE TO DELIVER VISUAL SCHEDULES TO YOUNG CHILDREN WITH AUTISM

By

Leslie Lynn Nelson

Bachelor of Science
University of Nevada, Las Vegas
2007

Master of Education
University of Nevada, Las Vegas
2008

A dissertation submitted in partial fulfillment of the requirements for the

Doctor of Philosophy - Special Education

Department of Educational & Clinical Studies
College of Education
The Graduate College

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THE GRADUATE COLLEGE

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Leslie Nelson

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August 2013
ABSTRACT

Using a Mobile Device to Deliver Visual Schedules to Young Children with Autism

by

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Young children with autism spectrum disorder (ASD) frequently display an inability to self-regulate (use materials appropriately and refrain from self-stimulatory behavior) and self-monitor (complete each step in a task before continuing to the next step) their behavior and therefore experience a great deal of failure within their respective school and home environments and frequently end up receiving instruction in restrictive, self-contained classrooms. Visual schedules have been used to help students with ASD self-regulate their behaviors in academic and community settings (NPDC, 2010; NSR, 2009). The purpose of this study was to determine whether high-tech visual schedules increase the self-regulation and transition behaviors of young children with ASD. Specifically, on-task and on-schedule behaviors were addressed along with the satisfaction of the stakeholders with the high-tech visual schedule intervention. A multiple-baseline across academic tasks (reading, writing, and math) was used to determine the effectiveness of a visual schedule delivered via an iPod touch on on-task and on-schedule behaviors. The participants included three elementary students who were receiving special education services under the category of autism. There were three males (one African American third grader, and two Hispanic fourth graders). The participants
were provided with visual schedules for three academic tasks (reading, writing, and math) delivered via an iPod touch. Given the variability in the data it cannot be said that the visual schedule had an impact on on-task and on-schedule behaviors. The visual schedules did however, generalize to the general education setting and were effective in maintaining on-task and on-schedule behaviors across participants. Additionally, the teaching staff indicated a high level of satisfaction with the implementation of the visual schedule indicated by ongoing use after completion of the study.
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CHAPTER 1
INTRODUCTION

President Gerald R. Ford set into motion the rights of students with disabilities to be educated in the least restrictive environment that is appropriate for their needs when he signed Public Law 94-142, The Education for All Handicapped Children Act (EAHCA, 1974). While the premise has remained the same, the law has evolved to what is now known as the Individuals with Disabilities Education Improvement Act of 2004 (IDEA). This law still requires that students with disabilities be educated in the least restrictive environment (IDEA, 2004). President George W. Bush added another layer of educational requirements with the passage of The No Child Left Behind Act (NCLB, 2002). This act increased the amount of required accountability related to performance outcomes for all students and mandated that teachers use strategies founded on evidence-based research. Meeting the requirements of these laws poses challenges for teachers of young children with autism spectrum disorders (ASD). Students with ASD often have difficulties in general education classroom settings because of their inability to regulate their behaviors (Hodgdon, 1995; Quill, 1995). For young children with ASD to be educated in the least restrictive environment (i.e., general education classroom), they need to develop the skills to regulate their behaviors appropriately (National Research Council [NRC], 2001). The use of visual supports in the form of schedules has been acknowledged as an evidence-based treatment for students with ASD (National Autism Center [NAC], 2009) and has been shown to help students with ASD in self-regulation and task completion (Bryan & Gast, 2000; Cihak, Wright & Ayers, 2010; Dooley, Wilczenski & Torem, 2001; Hodgdon, 1995; Hume & Odom, 2007; MacDuff, Krantz &

**Use of Schedules to Assist Students with ASD**

Teachers of young students with ASD often incorporate schedules to provide predictability to student’s routine thereby reducing behavior problems (Bryan & Gast, 2000). A visual schedule provides a visual reference to assist with task completion (McClannahan & Krantz, 2010) and/or provides a visual reference of what events to expect during the day and the order in which those events will occur (Bondy & Frost, 2001). Visual schedules contain a set of pictures, words, or a combination of both that prompt the user to engage in a sequence of tasks to complete an activity (McClannahan & Krantz). Hayes and colleagues (2010) compared visual supports to Vygotsky’s philosophy of cultural tools in that they “are symbolic and technological tools that aid in communication” (Hayes, Hirano, Marcu, Monibi, Nguyen & Yeganyan, 2010, p. 677). Visual supports, in the form of schedules, assist students to learn and progress by scaffolding educational tasks. As students learn new skills, the visual supports can be modified to meet their new skill level (Hayes et al.). A visual schedule for a student’s arrival may contain pictures in the order of tasks that need to be completed before joining the class at morning circle: (a) hang up backpack, (b) wash hands, (c) get name card, (d) answer question of the day, and (e) sit on circle rug. As the students’ skills increase, the visual schedule may be reduced to (a) arrival, and (b) circle time. Within-task schedules provide students with even more support. If a student is not properly washing his or her hands before getting his or her name card, a visual schedule can be created using a task
analysis or the step-by-step procedures for completing the activity correctly. For proper hand washing procedures, a visual schedule may contain the following pictures: (a) turn on water, (b) wet hands, (c) get soap, (d) lather hands and count to 20, (e) rinse hands, (f) get paper towel, (g) dry hands, (h) turn off water with paper towel, and (i) throw paper towel in trash. As the student masters the task, the within-task schedule is faded through scaffolding.

Although the use of visual schedules has been recommended for years as a strategy to provide predictability in routines and subsequently decrease negative behaviors (NRC, 2001), they were not established as evidence-based practice (Cafiero & Delsack, 2007; Schlosser, 2003; Schlosser, 2006) until the publication of The National Autism Center’s (NAC) National Standards Report (NSR, 2009) followed by the National Professional Development Center on Autism Spectrum Disorders report (NPDC, 2010). Wilczynski (2010) stated that evidence-based practice involves the integration of research findings with (a) professional judgment and data-based clinical decision making, (b) values and preferences of families including the individual on the spectrum, and (c) the capacity to implement an intervention with sufficient treatment fidelity. Understanding these components and their dynamics in relation to one another is important in selecting and implementing evidence-based treatments for students with autism as mandated by law (IDEIA, 2004; NCLB, 2002).

The National Standards Report lists schedules as one of eleven established treatments for individuals with ASD (NSR, 2009). The National Autism Center brought together a panel of 45 experts in the treatment and/or applied research for children with autism birth to 21 years of age (Wilczynski, 2010). Those experts developed a conceptual
model for evaluating the literature on autism and narrowed 7000 abstracts spanning 50 years until 2007 to 775 studies using a predetermined criterion. The panel used the Scientific Merit Rating Scale (SMRS) to score studies on research design, dependent measure, treatment fidelity, participant ascertainment, and generalization. The 775 studies were then grouped into categories by treatment effects: beneficial, unknown, ineffective, and adverse. The results of the SMRS and treatment effects were used to classify the studies into 4 treatment categories: established treatments, emerging treatments, unestablished treatments, and ineffective or harmful treatments (Wilczynski). Established treatments have a sufficient number of high quality published studies to allow scholars to confidently determine that the treatment produced beneficial outcomes. Emerging treatments have one or more studies that produced beneficial outcomes, but not enough high quality studies to clearly demonstrate the effect of the treatment. Unestablished treatments have no studies published or the studies published have poor ratings. There were no studies in the ineffective or harmful treatment category (Wilczynski). The result of this panel’s work is the National Standards Report (NSR). Wilczynski notes that the NSR is important “because knowing what research says about the treatment of ASD is essential for evidence-based practice” (p. 25). The NSR listed twelve studies as meeting the criterion for high quality research on schedules as an effective treatment for individuals with ASD. The NSR did not take into account research published after 2007.

The National Professional Development Center on Autism Spectrum Disorders (NPDC, 2010) goes beyond the eleven evidence-based treatments that the NSR identified by noting an additional thirteen evidence-based practices. The NPDC (2010) provides
briefs on each of the twenty-four evidence-based practices to help professionals identify information beneficial to the selection and implementation of treatment including evidence, target group including age, skills targeted by intervention, and effective settings for implementation. This information was disseminated one year after the NSR was published by NAC. It is important to note that Wilczynski was on the advisory board for both groups – lending credibility to the findings of the NPDC. The NPDC recommends visual supports as one of twenty-four evidence-based practices for working with students with autism. Thirteen high quality studies are cited as the evidence base for visual supports (schedules). The NPDC does not take into account research published after 2008.

The NSR and the NPDC focused on strategies that could be effectively implemented in school settings or behavior treatment programs to meet the needs of students with autism (Luiselli, Russo, Christian, & Wilczynski, 2008; NAC, 2009; NPDC, 2010). Federal mandates have made public schools a beneficial place for students to be educated by requiring instructional practices that are evidence-based. To continue to grow and learn students with autism need to be provided opportunities to generalize new skills (Myles et al., 2009). Schools provide “natural communities of reinforcement” (Baer, 1999) that help students with autism generalize skills they need to become successful (Luiselli et al.). This sets the stage for natural reinforcement and opportunities for generalization which can lead to success for students with autism. Although researchers have documented the benefits of using schedules to help students with ASD self-regulate their behaviors, little is known about the use of high-tech visual schedules.
Given the increase in available technology tools, this is an area that needs further exploration.

**Use of Technology to Assist Students with ASD**

Educators and researchers have noted the benefits of using technology with individuals who have disabilities, including those with autism. Years ago Quill (1997) reported that “existing technology can provide substantial benefit to approximately half of all children with autism” (p. 703). Subsequently, Stromer, Kimball, Kenney and Taylor (2006) conducted research designed to compare computer-delivered instruction to teacher-delivered instruction and found that students with autism had a stronger preference for instruction presented through the use of a computer. They also found that students learned the computer-presented information more quickly than the teacher-presented information, and the students were able to generalize the newly learned information. In spite of these positive results, Kimball et al. also noted several limitations related to using computers for instruction: the computer lacked the portability of a low-tech paper notebook, there was a lack of commercially available programs to use, and it took time to generate the digital content and learn how to operate the software.

With federal mandates requiring access to the general education environment for students with ASD (IDEIA, 2004), it is important these students “fit in” with the natural environment to avoid unnecessary distractions that interrupt the instructional process. This is particularly important related to the use of technology. Bulky augmentative and alternative communication (AAC) devices draw attention to student’s communication needs and thereby result in both self and peer distractions that interfere with learning (Cafiero & Delsack, 2007; Hayes et al., 2010; McClannahan & Krantz, 2010). Mobile
devices such as the iPod Touch and iPad are smaller tools that are easier to handle than educational AAC devices (Wehmeyer et al., 2008), and they blend in with the natural environment because many people with and without disabilities use them (Cafiero & Delsack; Hayes et al.; McClannahan & Krantz).

Recent news reports indicate that parents are successfully using new advances in mobile technology like the Apple® iPod Touch and iPad loaded with software applications commonly referred to as apps to help their children with ASD navigate through daily activities (Moses, 2010; Smoot, 2010; Topo, 2009). To meet the expectations of parents and to help students with ASD, educators and researchers must begin to conduct research on new advances in teaching tools including these new technologies (Cafiero, Acheson, & Zins, 2007; Cafiero & Delsack, 2007). Goldsmith and LeBlanc (2004) and Douglas et al. (2012) propose that researchers and technology developers work together to create better devices and better ways to use the devices to help children with autism function successfully in society. For parents of children with ASD, providing technology to assist their children in achieving daily tasks is imperative (Moses, 2010; Smoot, 2010; Topo, 2009), but parents need to know which tools are effective. Thus, research is needed to investigate the use of specific software applications to answer parents’ questions about how new technology advances can meet the needs of their children while simultaneously adhering to the evidence-based requirements of educational law (Cafiero et al., 2007; Douglas et al., 2012; IDEA, 2004; NCBL, 2002; Parette, Meadan, Doubet, & Hess, 2010; Wehmeyer et al., 2008).

Howard et al. (2012) note that with the growing trend in handheld media devices and apps, there has been a paradigm shift in looking at augmentative and alternative
communication (AAC) for students with autism. Specifically, digital technology is no longer cumbersome, expensive or time-consuming to program (Hayes et al., 2010; Howard et al.; McClannahan & Krantz, 2010). The portability of new devices offers a new modality for language interactions in the natural environment (Howard et al.; McClannahan & Krantz) and provides increased opportunities for important research related to the use of these devices.

There is no research identified in the NSR or NPDC reports related to the use of iPod Touch or iPad because the technology is so new. The iPod Touch was first released in September 2007 and the iPad was first released in April 2010 according to the Apple website (apple.com). The use of this type of technology is in its infancy for individuals with autism. Schmitz (2010) notes that using the iPod Touch is beneficial in the community by providing support for planning the day, following directions, using public transportation, going to school/work/shopping, performing work activities, creating a shopping list, going to a restaurant, and handling difficult social situations. Schmitz also notes that using the iPod Touch with individuals with ASD teaches independence while simultaneously motivating learners. Due to the lack of research related to the delivery of supports via iPod Touch technology, this type of technology-based intervention is considered an emerging treatment (NSR, 2009). Therefore research needs to be conducted to determine whether this type of mobile technology is a viable treatment for individuals with autism. This research will extend the knowledge base related to the use of high-tech tools to improve the performance of individuals with autism.
Statement of the Problem

Autism spectrum disorder (ASD) is a pervasive developmental disorder characterized by a discernible impairment in social interactions and communication with restricted, repetitive, and stereotypical behaviors, including limited interests and activities (American Psychiatric Association, 2000). These impairments in communication, restricted behaviors, and limited interests can pose a problem for young children with ASD when entering school for the first time (Bryan & Gast, 2000; Hodgdon, 1995; NRC, 2001). Federal law mandates that students with disabilities be provided an education in the least restrictive environment possible (IDEA, 2004). For a student with ASD this means they “should be interacting on a regular basis with children without autism, if at all possible, and within a regular classroom, with reverse mainstreaming or in other supervised settings” (NRC, 2001, p. 179). Students with ASD are often unable to access the least restrictive environment possible (i.e., the general education environment) because of their inability to regulate their behaviors (Bryan & Gast; Hodgdon, 1995; Quill, 1995). When students with ASD are unable to make sense of the verbal instructions given to them or cannot predict what is going to occur in their environment, problem behaviors such as tantrums, physical aggression, self-injury, stereotypy and refusal may occur (Bondy & Frost, 2002; McClannahan & Krantz, 2010). These behaviors can be disruptive to the learning of other students in the education environment (Bryan & Gast; Hodgdon, 1995; Quill).

There is general agreement that appropriate access to the general education environment, is an important step in developing skills that will be beneficial to the functioning of individuals with ASD in community-based settings (Mesibov & Shea,
1996; NRC, 2001). To benefit from inclusion in the general education environment students with ASD need to be taught functional skills (e.g., self-regulation, self-monitoring) (NRC). These functional skills are pivotal for young students aged 3 to 8 to succeed in the general education classroom. Unfortunately, young children with ASD frequently display an inability to self-regulate (use materials appropriately and refrain from self-stimulatory behavior) and self-monitor (complete each step in a task before continuing to the next step) their behavior and therefore experience a great deal of failure within their respective school and home environments. This pattern has often led to their placement in restrictive, self-contained classroom environments.

Visual schedules have been used to help students with ASD self-regulate their behaviors in academic and community settings (NPDC, 2010; NSR, 2009). Researchers have noted the benefits of using schedules to help students with autism self-regulate their behaviors. The use of schedules focuses on the visual strengths of students with ASD – students with ASD are able to process visual information better than auditory information (Hodgdon, 1995; McClannahan & Krantz, 2010; Quill, 1997; Quill, 1995). “Children exposed to visual displays of skill sequences can acquire and maintain the skills with less reliance on adult prompting” (Quill, 1997, p. 709). Although preliminary research reveals that the use of schedules is beneficial for establishing self-regulated behavior among students with autism, this body of literature primarily focuses on schedules that are provided in either paper (low-tech) format or large, bulky educational AAC (high-tech) format. Low-tech paper schedules can be time consuming to create, time consuming to modify, easily destroyed and can also cause the user to appear different from peers in the natural environment (Hayes et al., 2009; McClannahan & Krantz). Educational AAC
devices are expensive and often too expensive for families with lower-middle and lower incomes (Hayes et al.). They are also difficult to program and require extensive training for implementation in the classroom (Hayes et al.; McClannahan & Krantz). Many educational AAC devices also require reprogramming when bumped or dropped due to their sensitivity to movement (Hayes). Just as with low-tech paper schedules, educational AAC devices are bulky and make the user appear different from peers in the natural environment (Hayes et al.; McClannahan & Krantz).

Although technology-based treatments have been listed by the NPDC on ASD as an evidence-based practice, the NRC considers technology-based treatments as emerging and requiring more high quality research to move from the emerging to the evidence-based category (NAC, 2009). The emerging category has been defined as “fertile ground for further research” (NAC, p. 20).

The purpose of this study was to determine whether high-tech visual schedules increase the self-regulation and transition behaviors of young children with ASD. Specifically, on-task and on-schedule behaviors were addressed. The study was designed to answer the following research questions.

- Does the use of high-tech visual schedules increase the on-task behavior of elementary students with ASD across academic subject areas?
- Does the use of high-tech visual schedules increase the on-schedule behavior of elementary students with ASD across academic subject areas?
- Does the use of high-tech visual schedules decrease the number of prompts that teachers provide to maintain on-task and on-schedule behaviors?
•Does the use of high-tech visual schedules generalize to the general education classroom setting?
•Does the use of high-tech visual schedules maintain up to three weeks after intervention criterion is met?
•Does the use of high-tech visual schedules among elementary students with ASD result in high levels of stakeholder satisfaction?

Significance of the Study

Many variables are involved in implementing the use of visual schedules when working with young students with ASD including what type of visual schedule will be implemented, will the schedule be stationary or transportable, what training needs to be carried out for implementation, will the visual schedule be high-tech or low-tech, and which students will benefit from the schedule. Compounding these variables are highly publicized advances in technology that have caught the attention of parents of children with ASD (Moses, 2010; Smoot, 2010; Topo, 2009). With the introduction of schedules as an established treatment for individuals with ASD (NAC, 2009; NPDC, 2010), it now is important to determine the effectiveness of the various types of visual schedules to insure that students with ASD are provided with effective treatment in the school setting as mandated by federal law (IDEIA, 2004; NCLB, 2002).

It has been reported that children who are taught to use visual displays of skill sequences acquire and maintain the skills without an overabundance of adult prompting (Quill, 1997). Thus, the use of displays has the potential to result in greater access to the general education environment (Hodgdon, 1995; Mesibov & Shea, 1996; Quill). Appropriate access to the general education environment is an important first step in
developing skills that will be beneficial to the functioning of individuals with ASD in community-based settings (Mesibov & Shea; NRC, 2001). Mobile devices loaded with AAC apps may be particularly appropriate for the provision of visual supports for students with ASD because of their transportability to a variety of settings (Sennott & Bowker, 2009).

Educational AAC devices such as Chatbox and Dynavox that are used to facilitate communication in children with autism can be cumbersome, difficult to use and expensive (Hayes et al., 2009; McClannahan & Krantz, 2010). A Google search revealed this technology costs from $2,500 to well over $8,000 dollars. Parents, who have the means to do so, are willing to pay this high price, but many families are unable to afford this expense (Hayes et al.). The use of mobile devices such as the Apple® iPod touch and iPad provide a less intrusive, more accessible and affordable alternative to educational AAC devices. With a starting price for the iPod touch at $199 and iPad at $499, even with the cost of the most expensive AAC app, Proloquo2go at $189.99, the package is still far less expensive than some of the most inexpensive educational AAC devices. In today’s society many people are using mobile devices for communication, scheduling, seeking information, and navigation assistance. By providing students with autism AAC schedules consisting of visual or textual cues on mobile devices, they “look just like the rest of us” (McClannahan & Krantz, p. 122).

There has been limited peer reviewed literature published on the use of mobile devices to assist students with ASD for the purpose of building functional skills. Based on a meta-analysis related to technology use among individuals with intellectual disabilities, Wehmeyer et al. (2008) reported the need for more research and development
on a wider range of technologies especially the newer electronic and information
technologies. They also noted the need for research on the use of technology to increase
the independence of individuals with disabilities. The current study extends the literature
related to combining evidence-based practices (i.e., visual schedules) with emerging
practices (i.e., technology-based treatment) for children with autism.

Delimitations

A convenience sample from one elementary school within a large southwestern
school district was used in this study. Only students with autism were included in the
study. Thus, generalization of the results to other schools, school districts, older students
with autism, and/or students without autism is limited.

Definition of Terms

Apps: software applications created for mobile devices (i.e., iPod Touch, iPhone, iPad,
touch tablets).

Augmentative and alternative communication (AAC): involves “supporting existing
speech or developing independent use of a non-speech symbol system” (NRC, 2001, p.
57) (e.g., sign language, visual symbols, communication boards, voice output
communication devises).

Autism Spectrum Disorder: a pervasive developmental disorder characterized by a
discernible impairment in social skills and communication with restricted, repetitive, and
stereotypical behaviors, including limited interests and activities (APA, 2000).

High-tech AAC: require batteries or an external power source (Hodgdon, 1995).
**Low-tech AAC:** does not require a power source and are commonly created from paper by the individual implementing the communication intervention and may incorporate pictures, text, symbols, line art or other types of graphics (Hodgdon, 1995).

**Mobile Device:** a portable electronic technology that can be easily carried such as a cell phone or hand held computers, these devices often contain operating systems that can run software applications and weigh less than 2 pounds (Mechling & Youhouse, 2012; Wikipedia, 2012).

**Non-Compliant Transition Behaviors:** are exhibited when the student refuses to comply, acts out in a physically aggressive manner, screams, cries, drops to the floor or ignores directions to move on to the next activity. If the student does not complete the first step in the transition within 10 seconds, it is considered an act of non-compliance (Hodgdon, 1995).

**Off-Task Behavior:** occurs when a student is (a) using the materials inappropriately, (b) manipulating but not visually attending to the task (engaging in self-stimulatory behavior), (c) exhibiting inappropriate behavior (tantrums or refusal behaviors), or (d) not working or using any of the materials for the assigned task (Bryan & Gast, 2000).

**Off-Schedule Behavior:** occurs when a student does not complete one of the steps correctly or does not begin the next step within 10 seconds of completing the previous step (Bryan & Gast, 2000).

**Repetitive Behaviors:** behaviors that are conducted repeatedly. Examples include, but are not limited to hand flapping, rocking, twirling, spinning objects, and pacing.

**Restricted Behaviors:** showing limited interests. Examples include a) insistence on same topic of conversation; b) insistence on continuing with the same topic when the listener is
showing signs of disinterest or boredom; c) insistence on using the same item, playing with the same toy, taking the same path, or eating the same food; or d) obsession with one or two domains of interest (Luiselli et al., 2008).

**Schedule:** a visual display that provides students with ASD a sequential guide of steps to follow when attempting to complete tasks (Hodgdon, 1995).

**Social Skills:** the ability to display appropriate behavior in a social setting, communicate with others expressively and receptively, initiate and respond to bids for social attention, appropriately participate in recreational and leisure activities (Luiselli et al., 2008).

**Stereotypical Behaviors:** “restricted, repetitive, maladaptive patterns of behavior or activity... Examples include rocking, twirling, toe-walking, finger-flicking, preoccupation with parts of objects, opening and closing doors, turning lights on and off, insistence on sameness or routines, and difficulty with transitions” (Luiselli et al., 2008, p. 55).

**Tapikeo:** an open-ended app designed to help parents and educators create AAC supports for children.

**Summary**

The use of low-tech AAC in the form of visual schedules has been approved by NAC (2009) and NPDC (2010) as an evidence-based intervention for working with students with autism. Instructing children with ASD to use pictures and symbols has been shown to be an effective intervention for easing transitions (Sulzer-Azaroff, Hoffman, Horton, Bondy, & Frost, 2009), but communication binders and boards can be bulky and look unnatural (Cafiero & Delsack, 2007; Mirenda, 2009; Sennott & Bowker, 2009). Mobile devices look much more natural and can contain many more symbols than a communication binder (Mirenda; Mirenda & Brown, 2007). Thus, mobile devices (e.g.,
smart phones, tablets, iPods, iPads) may be advantageous for students with autism who typically display visual strengths along with their communication deficits (Althaus, De Sonneville, Minderaa, Hensen, & Til, 1996; Howard et al., 2012). Available apps for mobile devices are adaptable and provide new avenues for communication opportunities (Howard et al.). Moreover, these devices and apps are small, low cost, easy to obtain, readily available and socially acceptable (Howard et al.). Shane and Albert (2008) found that students with autism are highly interested in visual content that is delivered via an electronic screen. The use of consumer-level handheld devices enables researchers to produce dynamic and static screen cues at greater frequency, across multiple contexts using visually immersive environments to aid students with autism in understanding and communicating with their environment (Howard et al.). Thus, research related to the effectiveness of these devices for students with autism in both special and general education environments is timely and has the potential to add to the repertoire of evidence-based practices for this population of students.
CHAPTER 2
REVIEW OF LITERATURE

The purpose of this chapter is three fold. The first purpose is to summarize and analyze peer reviewed literature identified as evidence-based practices in the National Autism Committee’s (NAC) National Standards Report (NSR) (2009). Specifically, information related to the use of schedules will be reported. Additionally, information from the National Professional Development Center on Autism (NPDC) (2010) related to evidence that supports the use of visual supports, task analysis, and structured work systems will be discussed. The second purpose is to summarize and analyze experimental studies related to the use of schedules and mobile technology with students with autism. This literature base emerged subsequent to the publication of the NAC and NSR reports. The third purpose for this chapter is to make a connection between the two literature bases (i.e., use of schedules and mobile technology), and to provide a rationale for investigating the effects of a high-tech means to provide an intervention that has sound evidence-based support in a low-tech format. Knowledge related to the first two purposes is needed to develop a firm understanding of a need for research in high-tech interventions.

The chapter begins with a discussion of the literature review procedures used to locate the included studies. Next, after a brief rationale for using evidence-based practices for the provision of instruction to all students including those with autism, research from the NSR related to the use of schedules is summarized. Then, research from the NPDC related to visual supports, task analysis, and structured-work systems are summarized. Following this summary is a review of literature that has been published subsequent to
these two influential national reports (i.e., NSR and NPDC) that addresses additional studies related to schedules, visual supports, structured-work systems. Also included in this section are studies involving mobile devices. The chapter concludes with a review of literature summary.

**Literature Review Procedures**

This review includes studies listed as evidence based practices by National Autism Committee’s (NAC) National Standards Report (NSR) as it relates to schedules and the National Professional Development Center on Autism (NPDC) evidence base for visual supports, task analysis and structured work systems. Studies published after these reports were published, (i.e., 2007-2013) were found through a search using the following databases and search tools: Academic Search Premier, Elton B. Stephens Company (EBSCO), Educational Resources Information Center (ERIC), Google Scholar, ProQuest Dissertations & Theses, and UNLV University Libraries. The following search terms were used: AAC schedules, ASD, activity schedules, autism, high-tech schedules, iPad, iPod, picture activity schedule, schedules, self-regulation, structure, structured routine, structured work system, task analysis, visual structure, and visual supports. An additional search was conducted of studies published since 2007 that cited the articles referenced by NSR and NPDC as evidence based practices for schedules and visual supports. Studies included in this review are limited to elementary age students learning functional academic or community skills through the use of visual schedules, task analysis, structured-work systems and/or mobile technology.
Evidence-Based Practices for Children with Autism

Education of students using evidence-based practices is required by federal law (IDEIA, 2004; NCLB, 2002). The Individuals with Disabilities Education Improvement Act of 2004 and No Child Left Behind Act of 2002 mandate that students be educated in the least restrictive setting appropriate and set forth accountability standards for educational results for all students with and without disabilities. Both of these laws also mandate the use of evidence-based practices for the provision of instruction. The National Autism Center published the National Standards Report (NSR, 2009) and the National Professional Development Center on Autism Spectrum Disorders report (NPDC, 2010) published a list of evidence-based practices for use with students with autism. Both the NSR and NPDC list high-quality studies using schedules or visual supports as substantiation for being evidence-based practices for students with autism.

Summary and Analysis of Studies Related to the use of Schedules for Students with Autism as Articulated in The National Standards Report

The NSR identified the use of schedules as 1 of 11 evidence-based practices for working with students with autism. Schedules are a visual display of sequential graphic information that can be used to provide information about what events to expect, tasks to do, or steps to follow when attempting to complete tasks (Hodgdon, 1995) during routines. There are twelve studies using schedules the NSR noted as meeting the criterion for high quality research. Of the twelve studies, four were conducted with students attending elementary school or who were elementary school age. The NSR does not take into account research published after 2007.
Bryan and Gast (2000) examined the effectiveness of visual schedules on the on-task and on-schedule behavior of young students with autism. Their study included four students who had been determined eligible for special education services under the category of autism: three boys and one girl ranging in age from 7 years 4 months to 8 years 11 months. The participants were chosen because of the dependence on adult prompting to complete academic tasks. The study was conducted during language arts in the student’s resource classroom.

A picture activity schedule was used to guide students through each of four literacy center activities: writing, reading, listening and art. One picture was placed on each page of a small photo album allowing the student to look at the steps in the task one at a time. Each visual schedule was individualized for each student. An ABAB withdrawal design was used in which a graduated guidance procedure was used to teach the use of the visual schedule to the students. Data were collected on on-task (on-task with scheduled materials, on-task with nonscheduled materials, off-task) and on-schedule (on-schedule, off-schedule) using a 1-minute time sampling procedure. Adult prompt levels (orienting student towards materials, hand-over-hand assistance, and minimal physical prompt) were recorded simultaneously. A task analysis was used to record on-task and on-schedule data. Interobserver agreement on student response and teacher fidelity was collected at least once every five days. Social validity was assessed using a questionnaire based on a Likert scale that was given to adults who worked closely with the students at school.

The withdrawal design showed good experimenter control with treatment levels close to 100% for all students and non-treatment conditions dropping below 50% for all
students. Generalization to a novel activity resulted in a range from 98% to 100% for all students. Results of the social validity questionnaire were positive with all stakeholders agreeing or strongly agreeing that visual schedules were a useful management tool for the students participating.

Bryan and Gast (2000) found that use of the graduated guidance procedure assisted the students in quickly learning how to use the visual schedule. Once students learned how to use the visual schedule without adult assistance they were able to maintain their on-task and on-schedule behaviors, and this resulted in a decrease in off-task behaviors. The researchers concluded that visual schedules can be used to decrease student prompt dependence on adults while increasing on-task and on-schedule behaviors.

A possible weakness of this study was that the researcher was also the teacher; thus, she was in a position of authority over the participants. Another possible weakness was the interaction between the student participants as they were all using a visual schedule to rotate through literacy centers at the same time. All students achieved above 90% during the first and second visual schedule session which may represent a ceiling effect (Barlow et al., 2009) indicating that the scheduled tasks were too easy or the students had already mastered the materials. A strength of the article describing this study was the procedures were articulated in such detail they could be replicated by another researcher. Additionally, the study was an attempt to replicate or extend the work of MacDuff et al. (1993) establishing the design and operational definitions of the variables as groundwork for future replications.
Dettmer, Simpson, Myles, and Ganz (2000) examined the effectiveness of visual schedules on transition behaviors of young students with autism. Their study included two participants with a clinical diagnosis of autism. They were 5 and 7 years old. The participants were chosen because of their inability to transition between activities without exhibiting inappropriate behaviors. The study was conducted in a home educational setting and during community based activities.

Two visual schedules were used for each participant. For the participant exhibiting behaviors in the community setting, a linear visual schedule was affixed to the dashboard of the car, and a portable schedule book with identical steps was carried during the community activities. For the participant exhibiting behaviors during academic tasks, a linear visual schedule was created for the task that needed to be completed during the academic training session. A second sub-schedule was created with a finished box to indicate that an activity was completed. An ABAB withdrawal design was used to establish the effectiveness of the intervention through the withdrawal and reinstatement of the intervention. The adults working with the participants controlled the visual schedules; therefore, a training period was not necessary. Two types of data were collected: frequency of prompts (verbal, physical and physical removal) given by the adult and latency (timed using a stopwatch starting with adult prompt then ending with student moving toward the indicated activity). Interobserver reliability was collected on 15% of the transitions resulting in an overall reliability of 95%.

The withdrawal design showed good experimenter control with treatment levels showing a visible drop in duration with a decreasing trend during treatment. The number of physical removals for the first subject dropped from 14 to 2 with the first treatment
session then to 0 with the introduction of the second treatment session. The researchers noted that during the second baseline phase (withdrawal of treatment) the first participant became physically aggressive and asked for his visual schedule. The second participant presented similar behaviors during withdrawal by attempting to physically guide the adult to the area where the visual schedule materials were stored in an attempt to retrieve them. When this was not successful he exhibited tantrum behavior.

Dettmer, Simpson, Myles, and Ganz (2000) found that using visual schedules decreased the latency during transitions and prompt dependency of two participants with autism. Once the visual schedules were withdrawn, both participants exhibited inappropriate behaviors in an attempt to regain the use of their visual schedules. The researchers concluded that visual schedules can be used to decrease transition time and prompt dependency on adults during transitions between activities or tasks.

A possible weakness of this study was that the functional equivalence of the tasks required of the participants was not comparable. One participant was transitioning between activities in the community while the other student was transitioning between academic tasks and breaks from academic tasks. The behaviors of the two participants also were not equivalent. The first participant required physical removal from one task to the other and the second participant required only verbal and minimal physical prompts. The researchers may have been better served presenting each of the participants as a case study instead of presenting them as part of the same study. An opportunity was also missed to measure the social validity of the study, although the researchers did note that the second participant’s mother implemented the use of visual schedules throughout his day and reported a decrease in transition behavior and increase in his independence. A
strength of the article related to this study was that the procedures were described in
detail to allow replication by other researchers.

Hume and Odom (2007) examined the effectiveness of a work system
incorporating visual schedules on on-task behavior of young students with autism. Their
study included three participants with autism. Their ages were 20, 7, and 6. The school
district special education staff recommended the participants for the study because of
their inability to complete tasks independently. This was confirmed through observation
by the researcher. The study was conducted in the work setting (scanning documents in a
public library) of the older participant and in the classroom (participating in functional
play) of the two younger participants.

An individual work system was organized for each student with a visual schedule
that relayed four pieces of information: the task, the amount of work included in the task,
a signal that the task was completed, and a visual of the next activity. An ABAB
withdrawal design was used to establish the effectiveness of the intervention through the
withdrawal and reinstatement of the intervention. Data were collected on on-task, off-
task, task completion, the number of play materials used and the number of prompts
given. Momentary time sampling (10s intervals) was used to record on-task and off-task
behavior, partial interval recording was used to record teacher prompting, and event
recording was used for task completion and number of play materials used. Interobserver
agreement was collected on 27% of all observations with a range of 91% to 100%. Social
validity was assessed using pre and post questionnaires based on a five-point Likert scale
that was given to adults who worked closely with the students at school or in the work
setting.
The withdrawal design showed good experimenter control with treatment levels ranging from 75% to 96% and prompting level decreasing from a range of 23% to 100% to a range of 3% to 17%. A Maintenance probe indicated that treatment levels remained consistent with the second intervention levels. Results of the social validity questionnaire were positive with all stakeholders agreeing that the visual work system had increased their students’ on-task behavior and decreased the prompts needed to stay on-task.

Hume and Odom (2007) found that using a visual schedule work system assisted the participants with time on-task, decreased teacher prompts, increased task completion and increased the number of play materials used. They were able to use the same work system to address both work and play skills, and they provided information for application of a visual schedule work system across a variety of skills. The researchers concluded that a visual schedule work system can be used to increase time on-task for both work and play skills while decreasing student prompt dependence on adults.

A possible weakness of this study was that the researchers did not include a generalization phase for the participants. Another possible weakness was having only one participant in the work completion phase. Although the same visual schedule work system was used, there were two participants in the play skills phase. The added components of the work schedule make it difficult to determine which variable was the antecedent for the behavior change. A strength of the study was that it provided evidence for use of a visual schedule work system in two settings: work and school.

MacDuff, Krantz, and McClannahan (1993) examined the effectiveness of a photographic activity schedule on the on-task and on schedule behavior of youth with autism. Their study included four boys who had an independent diagnosis of autism,
ranging in age from 9 to 14 years. The participants were chosen because of their disruptive behavior and high rates of stereotypic behavior during unstructured time. The study was conducted in a community-based Teaching-Family Model group home.

A photographic activity schedule was used to guide students through a sequence of six activities: three homework followed by three leisure activities. One photograph was mounted on a white paper inserted into a clear page protector. Photographs of activities were taken against a plain background to remove distracting stimulus. Each schedule was individualized for each participant. A multiple baseline across participants was used to determine the effects of using a graduated guidance procedure to teach the use of the visual schedule. Data were collected on on-task and on-schedule behaviors using a 1-minute time sampling procedure. Adult prompting levels (verbal contacts, gestural prompts, and manual prompts) were recorded by a second observer using a 1-minute partial-interval procedure. Interobserver agreement data were collected across all conditions for 30% of the sessions. Social validity was not assessed.

The multiple-baseline design showed good experimenter control with a continuation of average treatment levels above 91% after the resequencing of the visual schedules for all participants. Resequencing of the visual schedule provides evidence that the stimulus was the photographic schedule and participants were not just following familiar routines. Generalization to novel leisure activities resulted in an average range from 91% to 99% for all participants. The researchers noted that no prompts were scored for any of the four participants during the last five sessions.

MacDuff, Krantz, and McClannahan (1993) found that using the graduated guidance procedure assisted the participants in quickly learning how to use the visual
schedule. Once the participants learned how to use the schedule, their on-task and on-schedule behaviors increased dramatically. The researchers concluded that photographic visual schedules can be used to maintain on-task and on-schedule behavior chains of previously mastered skills.

A possible weakness of this study was that the researcher was also the teacher putting him in a position of authority over the participants. Another possible weakness was the inclusion of all levels of prompting into one data point. The authors went into great detail to describe the various levels of prompts, but then recorded all levels as one event. A strength of the article about the study was that it described the procedures in such detail that they could be replicated by another researcher. The researchers also made a point to mention the importance of the graduated guidance procedure coming from behind the participant to minimize possibility of the participants confusing the teaching procedure with reinforcement. MacDuff, Krantz, and McClannahan (1993) designed the study to create a complex chain of behavior using only two teaching components: graduated guidance and a photographic visual schedule. Their design description and operational definitions resulted in an extension of Bryan and Gast (2000) research.

Summary and Analysis of Studies Related to Visual Supports, Task Analysis, and Structured-Work Systems as Articulated by the National Professional Development Center

The NPDC identifies visual supports, task analysis and structured-work systems as 3 of 24 evidence-based practices for working with students with autism. Thirteen studies are cited for visual supports, eight studies are cited for task analysis, and five studies are cited for structured-work systems all of which are components used in
developing visual schedules. Of those studies four for visual supports, two for task analysis, and two for structured work systems were conducted with students attending elementary school or who were elementary school age. Three of these studies, one for visual supports and two for task analysis, will be reviewed, the other studies were reviewed previously in this chapter. The NPDC does not take into account research published after 2008.

**Visual Supports**

Visual supports are tools that provide visual information using pictures, text, objects, labels, environmental arrangement, and other types of visual organization systems that provide information to students during daily activities (Hume, 2008; National Research Council, 2001). In addition to three of the studies identified the NSR (Bryan & Gast, 2000; Dettmer et al., 2000; MacDuff et al., 1993) and discussed in the previous section of this chapter, the NPDC also cites Pierce and Schreibman (1994) as a high quality study that contributes to the evidence base for using visual supports when teaching students with ASD.

Pierce and Schreibman (1994) examined the effectiveness of pictures in the self-management skills of youth with autism. Their study included three boys who had an independent diagnosis of autism and who ranged in age from 6 to 9 years. The participants were chosen because of their need for constant supervision. The study was conducted in the home and clinic training room.

A picture task analysis was used to guide the participants through each of three tasks based on a lack of skills as indicated by their parents. One picture was placed on each page of a photo album allowing students to look at the steps in the task one at a
time. Each picture task analysis was individualized for each student. A multiple baseline across behaviors design was used that included three training phases for teaching the use of the picture task analysis: picture discrimination, self-reinforcement and physical manipulation of picture task analysis, and fading of therapist’s proximity. Post treatment probes were conducted using a withdrawal to baseline. Maintenance probes were conducted two months after the post treatment probes. Data were collected on inappropriate and on-task behaviors using a 10 second time sampling procedure. Interobserver agreement was conducted on one third of all baseline, post treatment, and maintenance probes. Social validity results were not reported.

The multiple baseline design showed good experimenter control with non-treatment on-task behaviors increasing from under 10% to 90% or above for all participants. Results for a decrease in inappropriate behaviors were not as good with points of overlapping data across baseline, post treatment and maintenance probes for all of the students in at least one task analysis. Interobserver agreement for on-task behavior was 100% and ranged from 30% to 100% for inappropriate behavior.

Pierce and Schreibman (1994) found that using training sessions to teach the use of picture task analysis to complete daily living tasks increased on-task behavior and decreased inappropriate behaviors for students with autism. Once the participants learned how to use the picture task analysis without adult assistance, they were able to maintain their on-task behavior and follow the schedule even when the order of the pictures was changed (i.e., put on socks before pants). The researchers concluded that the picture task analysis can be used to decrease dependence on adult prompts for independent completion of daily living tasks.
A possible weakness of this study was the lack of social validity measures. The parents were asked which tasks required the most adult prompting for their respective child to complete, but there was no follow-up on the effect of treatment in the home setting. Another possible weakness of this study was the low interobserver agreement for inappropriate behaviors. There is a possibility that the operational definition for the inappropriate behaviors was not sufficient for measurement. One strength of the study was that it revealed that stimulus control may be transferred from an adult to a picture for purposes of task completion in daily living tasks. The picture task analysis was also generalized from a clinical setting to different home settings showing stimulus control of the picture task-analysis.

Task Analysis

Task analysis is used to break skills into steps that are more easily managed in the teaching process. Other teaching strategies (i.e., modeling, reinforcement) are used when teaching the steps. As the steps are learned the student becomes more independent in achieving the overall task (Franzone, 2009). Task analysis is used for creating within task visual schedules and video models for teaching skills to students with autism (National Research Council, 2001).

Alcantara (1994) examined the effectiveness of a videotape instructional package on the generalization for community skills (grocery-purchasing ability) of youth with autism. The study included three participants who had an independent diagnosis of autism who ranged in age from 8 to 9 years. The participants were chosen because they were not proficient in grocery shopping skills. The study was conducted in the student’s home schools and community stores.
A picture of each grocery item the student was to purchase was kept in a picture album that was used for baseline and follow-up sessions to show each student what to buy. A 32-step task analysis was created and adjustments were made for the differences in each store. Videos were then created following the task analysis for three different stores and ten identical items that were to be purchased. Treatment procedures included (a) viewing the video of the item that was to be purchased in the school setting, (b) transportation to the community store, and (c) verbal direction to purchase the item. A multiple-baseline across settings and within subjects was used to teach grocery-shopping skills in three different stores. Two treatment phases were used: videotape instruction and videotape instruction plus in vivo training. During the in vivo phase, the researcher used a least to most prompting strategy to guide the student through the correct steps in completing the shopping activity. The 32-step task analysis was used to record steps correct and the number of prompts per step. A stopwatch was used to time the student with time spent waiting in the checkout line subtracted from the overall time. Interobserver agreement was conducted with the experimenter and observer simultaneously and independently recording student responses during each phase of the study.

The multiple-baseline across settings design showed good experimenter control with an immediate jump in correct steps when the treatment was implemented for each different setting for each of the students. Time spent in the stores decreased for all students from baseline with all students cutting their grocery-shopping time by at least 50%.
Alcantara (1994) found that using a video training package created through task analysis transferred to the natural environment (i.e., three different stores). Once participants viewed the video their grocery shopping skills increased, and their time spent shopping decreased. With the addition of the in vivo training to the video, the participants’ grocery shopping skills greatly increased, and their time spent shopping decreased by more than 50% from baseline. Alcantara concluded that in addition to video training, teachers should use prompts and reinforcement to increase the effectiveness of the video training alone.

A possible weakness of this study was that because of the age of the students the researcher was always within one meter of the student when in the community setting. This close proximity could have served as a prompt affecting the number of steps correct. Another possible weakness was that the use of the video was immediately followed by a trip to the store to purchase the items. A time delay procedure was not used to see if the procedure could be used to prepare for a task that does not occur in the immediate future. A possible confounding variable in the study was the use of the in vivo training component as the second treatment. Differential ordering of the in vivo training could have strengthened the study. A strength of the article describing the study was that the procedures were described in such detail that they could be replicated by another researcher or teacher. The study showed the usefulness in teaching unfamiliar skills to students with autism using a video created with a task analysis and including a strategy familiar to classroom teachers (i.e., prompts and reinforcements).

Luscre and Center (1996) examined the effectiveness of a video treatment package on the dental examination behaviors of youth with autism. Their study included
three boys who had an educational diagnosis of autism who ranged in age from 6 to 9 years. The participants’ teacher and the researcher selected these boys because of their aggressive behavior when presented with a dental examination. The study was conducted in an improvised dental office in the school and the actual dental office in the community.

A treatment package was developed that included desensitization, video modeling, and reinforcement. Task analysis was used to create a video of typically developing peers going for their dental exam. An improvised dental office in the school was used for the desensitization phase that included a reclining chair, light stand, dental tools, and a dental assistant who served as the dental examiner. Each student watched the video stopping the video after each step to show the tool that was to be used during that step. Reinforcement was provided upon successful completion of each of the steps in the improvised dental office.

A multiple baseline across subjects design was used to investigate the effects of a treatment package that included reinforcement for successful step completion. Data were collected using a 13-step task analysis for baseline, treatment, and in vivo settings. Once participants reached criterion in any step, they were taken to the dental office. The session at the dental office was terminated when aggression or refusal behaviors occurred or 10 unsuccessful trials for a step occurred. The treatment sessions at the school would then resume, and the student would again attend a session at the dental office once original criterion of 13-steps correct was achieved. Interobserver agreement was collected by a second observer for 50% of the baseline training probes, 83% of the in vivo baseline probes, 20% of the treatment probes, and 83% of the in vivo treatment probes. Interobserver agreement was reported, but social validity was not measured.
Luscre and Center (1996) found that using a video treatment package to teach appropriate dental exam behaviors generalized to the community setting of a dental office. Two of the participants were able to complete 11 out of 13 steps in the dental visit. Because the study time was limited, the third participant did not achieve results this high. The researchers concluded that a video treatment package can be used to teach students with autism to tolerate dental examinations even if they had previously experienced aggressive and avoidance behaviors during dental visits.

A possible weakness of this study was that the researcher was also the teacher putting her in a position of authority over the participating subjects. Another possible weakness was that the use of reinforcement after every step completion was not faded. This raises questions about the interaction effects of the video and reinforcement. Another weakness was the lack of social validity measures. It was noted that one student had to be strapped to a papoose board during previous dental visits, but there was no follow up on attitudes or opinions of his family or dental service providers regarding his change in behavior. A strength of the study was that it was conducted by a classroom teacher and was successful in generalizing to the community setting. This provides evidence that teaching community based skills in the school can generalize to the community setting. A strength of the study article was that the amount of detail provided would likely result in successful replication by a classroom teacher or researcher.

**Structured-Work Systems**

Structured-work systems evolved from Division TEACCH (Treatment and Education of Autistic and related Communication handicapped Children). In structured teaching, visual supports are used to organize the learning environment for the student to
independently work. The visual supports include information on (a) the task to be completed, (b) how much work is to be completed, (c) when the task is completed, and (d) what to do upon completion of the task (Hume, & Carnahan, 2008). The NPDC cites the high quality studies of Dettmer, Simpson, Myles, and Ganz (2000) and Hume and Odom (2007) as evidence based practices under the category of structured-work systems. These same studies were listed under the category of schedules listed by the NSR, and thus were reviewed previously in this chapter.

Summary and Analysis of Studies Published After the NAC and NPDC Reports

Related to the use of Mobile Devices, Visual Supports, Task Analysis, and Structured-Work Systems

Few studies have been published since the release of the evidence-based practices reports by NAC and NPDC. Most studies designed to investigate the effects of using mobile devices such as the iPod and iPad, schedules, visual supports, or structured work systems on individuals with autism have been conducted with participants in preschools or secondary schools. Thus, less is known about using these practices with elementary students with autism.

Use of Mobile Devices Post NAC and NPDC

Neely, Rispoli, Camargo, Davis, and Boles (2012) examined the effectiveness of academic instruction using an iPad on the escape behavior of youth with autism. Their study included two boys who had an independent diagnosis of autism and ranged in age from 3 to 7 years. The participants were chosen because of the escape behaviors they
exhibited when presented with an academic task. The study was conducted in both the home and school setting.

A functional analysis was conducted before treatment was introduced alternating an academic demand then a play item to confirm that the presentation of an academic demand triggered unwanted behavior. It was concluded that after five sessions escape behavior was sparked by an academic demand for both students. An iPad was used to simulate the academic material each student was presented with. An iPad was used with a writing application in which the older participant used a stylus in place of the traditional pencil and paper (that evoked the escape behavior) to complete his math work. For the younger student an iPad with a color matching application replaced color matching cards that evoked the escape behavior. During the ABAB withdrawal design, the academic conditions were presented in the same manner as they were during the functional analysis. Students were told it was time to work, and they were presented with the traditional materials for the A phases and the iPad for the B phases. Data were collected on percentage of academic engagement and challenging behaviors exhibited by the students using a 10 second time sampling procedure. Interobserver agreement and treatment fidelity data were collected on 40% of the sessions.

The withdrawal design showed good experimenter control with treatment levels showing a decrease in challenging behaviors, below 20%, for both participants during the iPad sessions. The academic engagement increased for both participants. The mean increase for both participants was 70.5% and 85.2% respectively. Interobserver agreement ranged from 87-100% for dependent variables and 100% for treatment fidelity.
Although both students were recommended by stakeholders for the treatment, social validity was not measured.

Neely et al. (2012) found that using the iPad in place of traditional academic materials decreased the challenging behaviors of two young boys with autism. Both participants sustained higher levels of academic engagement during treatment. The researchers concluded that the iPad can be used to decrease challenging behaviors that result from the presentation of academic tasks, and that the iPad can be used to increase academic engagement.

A possible weakness of this study was that one of the participants had previously been exposed to the iPad as a reinforcer. This may have been a motivating factor in his positive results. A strength of the study article was that the procedures were described in such a manner they could be easily replicated by another researcher. A positive aspect of the study was the functional assessment of the academic task before implementation of the treatment. By completing the functional assessment, the research directly tied the presentation of the academic task to the challenging behaviors.

Cihak, Fahrenkrog, Ayres, and Smith (2010) examined the effectiveness of video modeling via an iPod on the transition skills of youth with autism. Their study included three boys and one girl who had a diagnosis of autism and ranged in age from 6 to 8 years. The participants were chosen because of their difficulty in transitioning from place to place. The study was conducted in their local elementary schools.

A video model was created for 10 transitions for each student using the student as the model of appropriate behaviors. The ten daily transitions followed the same order each day for all student participants. Participants watched the video of themselves
transitioning before lining up for the transition. If inappropriate behavior occurred during the transition, the student was instructed to watch the video again with the teacher. If the behavior persisted, a least-to-most prompting strategy was used to complete the transition. An ABA withdrawal design was used that included pretraining on use of the video, baseline, treatment, and maintenance. Data were collected on the number of independent transitions; transitions were scored as independent or assisted. Interobserver reliability was scored on 60% of baseline and 33% of the subsequent sessions. Social validity was measured using the Intervention Rating Profile – 15 (IRP-15) completed by the students’ four participating teachers and reported in text form.

The withdrawal design showed good experimenter control with independent transitions decreasing sharply upon withdrawal of the treatment and rising sharply with reinstatement of treatment. Results of the nine week maintenance probe were positive with independent transitions ranging from 90% to 100% for all students. Results of the IRP-15 for social validity resulted in a mean score of 84 out of a possible 90. This high score indicates a high acceptance of the intervention with all teachers agreeing or strongly agreeing with questions relating to the intervention.

Cihak et al. (2010) found that using an iPod for video modeling assisted students in independently transitioning and decreased inappropriate behaviors. Once students learned how to manipulate the iPod to access the videos, they were able to successfully follow the model without added adult prompting or assistance. The researchers concluded that video modeling could be used to increase transition skills and decrease inappropriate transition behaviors for elementary students with autism.
A possible weakness of this study was the amount of time required to produce a video using the participant as the model. This may not be practical in some educational settings. Another possible weakness was that the newness of the iPod for the students may have led to novelty intervention effects. A strength of the study was that it was conducted with general education teachers participating as the implementers in the general education setting, not special education teachers striving for inclusive practices. The researchers reported that the teachers continued with the intervention until the maintenance probe and planned to continue using the iPods for transitions. The study article was written with sufficient detail and procedural explanations that would allow for replication by other researchers.

Use of Visual Supports and Task Analysis Post NAC and NPDC

Parker and Kamps (2011) examined the effectiveness of social scripts and visual schedules on the task completion and activity engagement of youth with autism when interacting with peer groups. Their study included one girl and one boy who had an independent diagnosis of autism. Both participants were 9 years old. The participants were chosen because of their deficits in social skills and high rates of vocal stereotypy. The study was conducted in the school, home, and community fast food restaurant settings.

A task analysis was used to create a visual schedule of three different types of functional activities, games, cooking, and restaurant. The steps in each task analysis varied with 8 steps for the game, 22 steps for cooking, and 12 steps for the restaurant activity. Social scripts in the form of language cards were created for each of the three activities to help all participants engage in conversation while simultaneously engaging in
the activities. A multiple baseline probe across settings design was used that incorporated a participant training session and graduated guidance to teach the participants how to use the visual schedule and language cards. Data were collected on the number of steps completed in each activity and the percent of appropriate language used during each activity. The task analyses were used to record steps completed. A 10 second time sampling was used to record percent of intervals in which the participants used appropriate peer directed verbalizations.

The multiple probe design showed some experimenter control with participants showing an immediate increase in number of steps completed in five out of six activities. Participant engagement resulted in an increase from 11% in baseline to 74% during treatment. Increases in language varied from 0% increases to 47% during the restaurant activity. Results for the language card varied between students and activities.

Parker and Kamps (2011) found that using visual schedules created from task analyses assisted participants with regard to engaging in activities. Their results related to the use of language cards to increase peer language were not as promising. Once the students learned how to use the visual schedule, the words in the task analysis were faded to increase student independence. The researchers concluded that the use of visual schedules created using task analyses increased the engagement and steps completed for students with autism when interacting with peer groups.

A possible weakness of the study was that the peers were not included in the creation of the language cards. The examples of language cards presented in the study did not sound like something a nine year old would say when interacting with his peers. This may have resulted in lower levels of use by all participants in this study. The combination
of activity engagement and language in one study may have provided too many confounding variables; participant training for the use of social language in a different setting may have resulted in better results. Another possible weakness was the activities used had a varying number of steps and were not functionally equivalent. Therefore, the results may have been artificially inflated for easier or harder activities. A strength of the study was that it addressed a need to improve the social and engagement deficits of youth with autism. This study addressed functional engagement and language skills during activities engaged in by typically developing students. This is an area of need for youth with autism.

Use of Structured-Work Systems Post NAC and NPDC

Mavropoulou, Papadopoulou, and Kakana (2011) examined the effectiveness of a structured-work system on the independent play skills of youth with autism. Their study included two boys who had an independent diagnosis of autism. Both participants were 7 years old. These participants were chosen because of their lack of organization and attention to required tasks. The study was conducted in an unused classroom of the participants’ home school.

A structured-work system was used that incorporated finished boxes (i.e., three activity boxes containing materials used for independent play, games, and manipulative play) and a visual schedule for each of the activities in the boxes. The activities in each box were individualized to meet each participant’s interest in materials. An ABAB withdrawal design was used that incorporated three training sessions to teach the use of the work system to the students during the first implementation phase. Data were collected on on-task behavior, prompts, task completion (number of tasks completed each
session), and task performance (completing the task correctly). On-task behaviors were recorded using 10 second time samples. Prompting was recorded during each of the intervals. Event recording was used for task completion and task performance. Stakeholders were provided with a before and after questionnaire to determine social validity.

The withdrawal design did not show good experimenter control with treatment levels questionable for one student. Generalization to the classroom setting resulted in decreased prompting for only one of the students, and the percentage of on-task behavior was only slightly higher than baseline. The social validity measures revealed that stakeholders did not view the intervention as being positive for all study participants. Interobserver agreement was 100%.

Mavropoulou, Papadopoulou, and Kakana (2011) found that using a structured work-system and training session resulted in positive gains for two of the participants with autism and questionable gains for the other participant. The researchers found that visually supported strategies can be beneficial for some students while other students may be non-responders. They concluded that visual supports may provide students with the information necessary to complete tasks correctly, and that this additional support may be better than only providing information verbally.

A possible weakness of the study was the potential for unknown history related to visual supports. It is possible the participants were previously trained to use visual supports incorrectly. Another possible weakness was the number of variables upon which data were collected. The researchers should have focused more narrowly on one aspect of task data and teacher prompting to reduce the possibility of confounding results. A
strength of the study was that the intervention was based on a practice listed as evidence based (Hume & Odom, 2007; MacDuff, Krantz, & McClannahan, 1993) by both the NSR and NPDC. The researchers acknowledge the need to replicate their work using a larger sample size and across different curriculum.

**Literature Review Summary**

Both the National Autism Committee and the National Professional Development Center on Autism identify evidence based practices for individuals with autism. Specifically related to the research described in this dissertation, both groups identify the use of schedules as an evidence-based practice that provides appropriate visual support to students with autism (i.e., the NAC identified the use of schedules specifically whereas the NPDC listed schedules as a subcategory of visual supports). Additional research (Parker & Kamps, 2011), published after the landmark reports of the NAC and NPDC continues to support the use of visual schedules with this population of students.

Specifically with regard to the research on visual schedules, Bryan and Gast (2000) used picture activity schedules to increase on-task and on-schedule behaviors for young students with autism during academic centers. Dettmer, Simpson, Myles, and Ganz (2000) found that the use of visual schedules was effective to decrease prompt dependency on adults during transitions. Hume and Odom (2007) incorporated visual schedules in a work system to increase time on-task, task completion and to decrease the number of adult prompts required during academic and play tasks. MacDuff, Krantz, and McClannahan (1993) used picture activity schedules to increase on-task and on schedule behaviors of youth with autism for academic work and leisure activities while decreasing adult prompting. Pierce and Schreibman (1994) incorporated a picture task analysis
(schedule) to increase daily living tasks and decrease adult prompts in the home and clinic setting. More recently Parker and Kamps (2011) used a visual schedule and language cards to increase the engagement and task completion of youth working in peer group activities. Results from these studies support the use of visual supports in the form of schedules to assist students with autism in maintaining on-task and on schedule behaviors while reducing the dependency on adult prompting.

With regard to task analysis, the NPDC also lists this as evidence based practice and provides multiple studies as evidence. Task analyses are an important part of creating a functional visual schedule and therefore were included in this review. Alcantara (1994) found success when using task analyses to create a videotape instructional package to increase the grocery-purchasing skills of elementary age students with autism. Luscre and Center (1996) successfully used task analyses to create a treatment package that increased elementary students’ abilities to tolerate dental examinations in the community setting. More recently, Cihak, Fahrenkrog, Ayres, and Smith (2010) successfully used task analyses to create transition video models for elementary students with autism as part of a treatment package that increased successful transitions of students in the general education setting. Parker and Kamps (2011) used task analyses to create visual schedules to increase the engagement and task completion of students working in peer group activities. Results from these studies support the use of task analyses to create visual supports to assist students with autism in maintaining on-task and on schedule behaviors while reducing the dependency on adult prompting.

With regard to structured-work systems, the NPDC lists these systems as evidence based practice and provides multiple studies as evidence. One additional study was
conducted with elementary students with autism after the publication of the NPDC and revealed mixed results with regard to the use of a structured-work system (i.e., one participant out of three did not respond to the intervention). Structured-work systems incorporate the use of visual organization, often in the form of schedules. Dettmer, Simpson, Myles, and Ganz (2000) found that the use of visual schedules within a structured-work system increased transition time and decreased prompt dependency on adults during transitions between activities. Hume and Odom (2007) incorporated visual schedules in a work system to increase time on-task, task completion and to decrease the number of adult prompts required during academic and play tasks. More recently Mavropoulou, Papadopoulou, and Kakana (2011) were not as successful in decreasing prompt dependency, time on-task and correct task completion for young students with autism. They noted that because of the small sample size the non-responder had a negative impact on their data; therefore conclusions are limited to the context of the study. Results from these studies, for the most part, support the use of structured-work systems to assist students with autism in maintaining on-task and on schedule behaviors while reducing the dependency on adult prompting.

Computer-aided instruction also is listed as an evidence based practice by the NPDC, but the literature cited was limited to non-mobile technology. Because this study involves using mobile technology to deliver visual schedules, recent studies fitting the search criteria were included. Neely, Rispoli, Camargo, Davis, and Boles (2013) found the use of an iPad to deliver academic tasks to young students with autism decreased escape and aggressive behaviors. Cihak, Fahrenkrog, Ayers, and Smith (2010) achieved success when using an iPod to deliver video models as part of a treatment package to
increase successful transitions of young students with autism in the general education setting. Although the literature is very limited with regard to experimental studies that involve the use of mobile devices for elementary age students with autism, the results from these two studies show positive possibilities for future research.

In summary, the publication of evidence based practices in autism through the NSR and NPDC lists visual supports (schedules), structured-work systems, and task analysis as effective practices for improving transition behaviors (Cihak, Fahrenkrog, Ayers, & Smith, 2010; Dettmer, Simpson, Myles, & Ganz, 2000), increasing time on-task (Bryan & Gast, 2000; Dettmer, Simpson, Myles, & Ganz, 2000; Hume & Odom, 2007; MacDuff, Krantz, & McClannahan, 1993; Mavropoulou, Papadopoulou, & Kakana, 2011; Parker & Kamps, 2011), increasing on-schedule behavior (Alcantara, 1994; Bryan & Gast, 2000; Dettmer, Simpson, Myles, & Ganz, 2000; Hume & Odom, 2007; MacDuff, Krantz, & McClannahan, 1993; Pierce & Schreibman, 1994), decreasing prompt dependency (Alcantara, 1994; Bryan & Gast, 2000; Dettmer, Simpson, Myles, & Ganz, 2000; Hume & Odom, 2007; MacDuff, Krantz, & McClannahan, 1993; Pierce & Schreibman, 1994) and increasing student engagement in activities (Luscre & Center, 1996; Neely, Rispoli, Camargo, Davis, & Boles, 2012; Parker & Kamps, 2011) as effective practices for autism. Limited research has included advances in mobile technology to deliver evidence based practices for improving transition behaviors (Cihak, Fahrenkrog, Ayers, & Smith, 2010) and increasing student engagement (Neely, Rispoli, Camargo, Davis, & Boles, 2012). With new advances in mobile technology the next logical step is to investigate the effects of using this technology to deliver visual supports.
to increase on-task and on-schedule behavior and to decrease prompt dependency for elementary students with autism.
CHAPTER 3

METHODOLOGY

Laws such as the No Child Left Behind Act of 2001 pose challenges for teachers of young children with autism spectrum disorders (ASD) because students with ASD are often unable to participate in general education classroom settings, as supported by the law, because of their inability to regulate their on-schedule and on-task behaviors (Hodgdon, 1995; Quill, 1995). For young children with ASD to be educated in the least restrictive environment appropriate they need to develop the skills to regulate their behaviors (NRC, 2001). Visual schedules have been acknowledged as an evidence-based treatment for students with ASD (NAC, 2009) and have been shown to help students with ASD in self-regulation and task completion (Bryan & Gast, 2000; Cihak, Wright & Ayers, 2010; Dooley, Wilczenski & Torem, 2001; Hodgdon, 1995; Hume & Odom, 2007; MacDuff, Krantz & McClannahan, 1993; Massey & Wheeler, 2000; Mesibov & Shea, 1996; Morrison, Sainto, Benchaaban & Endo, 2002; NRC, 2001; O’Reilly, Sigafoos, Lancioni, Edrisinha & Andrews, 2005; Quill, 1997; Schmit, Alper, Raschke & Ryndak, 2000). This study extends the research on evidence-based practices by using mobile devices to deliver high-tech visual schedules to support young students with ASD with on-task and on-schedule behaviors.

The purpose of this chapter is to provide a detailed overview of the research methodology used in this study. The chapter content is organized within eight sections: review of purpose and research questions, participants, setting, materials and equipment, instrumentation, experimental design, procedures, and data analysis.
Review of Purpose and Research Questions

The purpose of this study was to determine whether high-tech visual schedules increase the self-regulation and transition behaviors of young children with ASD. Specifically, on-task and on-schedule behaviors were addressed. The study was designed to answer the following research questions.

• Does the use of high-tech visual schedules increase the on-task behavior of elementary students with ASD across academic subject areas?
• Does the use of high-tech visual schedules increase the on-schedule behavior of elementary students with ASD across academic subject areas?
• Does the use of high-tech visual schedules decrease the number of prompts that teachers provide to maintain on-task and on-schedule behaviors?
• Does the use of high-tech visual schedules generalize to the general education classroom setting?
• Does the use of high-tech visual schedules maintain up to three weeks after intervention criterion is met?
• Does the use of high-tech visual schedules among elementary students with ASD result in high levels of stakeholder satisfaction?

Participants

Participant Demographic Data

Three students with ASD ranging in age from 8 years 7 months to 10 years 0 months participated in this study. All participants were male. All participants attended the
same self-contained program for students with autism in third through fifth grade. See Table 1 for demographic data.

Table 1

**Participant Demographic Data**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Grade</th>
<th>Ethnicity</th>
<th>Eligibility</th>
<th>Special Education</th>
<th>General Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>9.7</td>
<td>M</td>
<td>4th</td>
<td>Hispanic</td>
<td>Autism</td>
<td>87%</td>
<td>13%</td>
</tr>
<tr>
<td>Participant 2</td>
<td>8.7</td>
<td>M</td>
<td>3rd</td>
<td>Black</td>
<td>Autism</td>
<td>68%</td>
<td>32%</td>
</tr>
<tr>
<td>Participant 3</td>
<td>10.0</td>
<td>M</td>
<td>4th</td>
<td>Hispanic</td>
<td>Autism</td>
<td>75%</td>
<td>25%</td>
</tr>
</tbody>
</table>

*Note.* IEP was used to determine % of time in special education and general education.

**Participant Selection**

The student participants were selected from a sample of convenience. Specific criteria for inclusion in the study were (a) multi-disciplinary team determination of autism, (b) enrollment in a self-contained autism classroom at a public school, and (c) need for frequent adult prompting to remain on-task during academic activities of reading, writing, and math. Additionally, with regard to academic performance, participants (a) were able to follow one-step directions without gestures or physical prompts, (b) had fine motor skills that did not require hand-over-hand assistance for writing, (c) were ambulatory, (d) were off task more than 50% of observation time or required more than four adult prompts per minute (see Table 2), and (e) parents granted permission for their child to participate in the study (see Appendix A).
Table 2

Participant Selection Data

<table>
<thead>
<tr>
<th>Participant</th>
<th>Writing On-Task</th>
<th>Math On-Task</th>
<th>Reading On-Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prompts</td>
<td>Prompts</td>
<td>Prompts</td>
</tr>
<tr>
<td>Participant 1</td>
<td>14%*</td>
<td>55%</td>
<td>59%</td>
</tr>
<tr>
<td></td>
<td>24**</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Participant 2</td>
<td>79%</td>
<td>34%</td>
<td>79%</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Participant 3</td>
<td>52%</td>
<td>52%</td>
<td>55%</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>

Note. *The teacher sitting next to or working directly with students during independent work time was considered a prompt. **The teacher used continuous verbal or physical prompts for more than 5 minutes during observation period.

Setting

The study was conducted in a large school district located in the southwest region of the United States. The school district encompasses rural, urban, and suburban areas covering 7,910 miles. More than 37,000 individuals are employed within the school district, and these individuals serve over 311,000 students. Students attending the 357 schools come from diverse racial, linguistic (i.e., 6.6% Asian, 44% Hispanic, 12% Black/African American, 29.4% White, 1.5% Pacific Islander, 6% Multi-Race, .5% Native American) and economic backgrounds (i.e., 56.6% receive free or reduced lunch). The district is in year one of the category In Need of Improvement with regard to meeting Adequate Yearly Progress (AYP) with 210 schools falling in the In Need of Improvement category.
The participating elementary school serves students in preschool through fifth grade in general and special education settings. There are 751 students enrolled in the school from diverse racial (i.e., 5% Asian, 38% Hispanic, 30% Black/African American, 19% White, 2% Pacific Islander, 6% Multi-Race) and linguistic backgrounds (i.e., 17% are limited English Proficient). The students also come from diverse economic backgrounds (i.e., 62.5% receive free or reduced lunch). There is a 32.8% transiency rate and 12.6% of the students have an Individualized Education Program (IEP). The school is in year 2 of the category *In Need of Improvement* in meeting Adequate Yearly Progress (AYP).

The setting for the study was a self-contained intermediate autism class for students third through fifth grade. The class is designed to use applied behavior analysis procedures and discrete trial teaching to deliver general education curriculum and individualized instruction for IEP goals. The class had one teacher and one paraprofessional. The classroom teacher had a master’s degree in special education with an emphasis in autism, was licensed by the state to teach students with autism, and in her third year of teaching. The paraprofessional had no additional education beyond a high school diploma and outside professional development provided by the local school district. There were eight students assigned to the teacher’s caseload. Students in this class engaged in direct instruction and independent work at their desks or work tables. Three of the students spent more than fifty percent of their time in lesser restrictive settings of general education and resource classrooms. The other five students were in the self-contained autism class from sixty-eight to eighty-seven percent of the day. The self-contained autism classroom was set up with six areas. There were six individual student
desks each assigned to students deemed as higher-functioning by the classroom teacher, two work tables where students deemed as lower-functioning did task-based work, a computer station with two desktop computers used for academic work and reinforcement, two reinforcement stations (one containing a television with an Xbox and one with toys and games), a listening center that included a beanbag chair next to a CD player with various books on tape and music, and a quiet space divided off from the other areas by a 4 drawer filing cabinet and book shelf. Four of the eight students were on a token reinforcement system, and the other four were on a four-point Likert scale system with 3s and 4s receiving the students’ choice of reinforcement.

After the visual schedule intervention was delivered in this self-contained autism classroom, the study setting changed to include the general education physical education classroom (for generalization procedures). This class was chosen because the students attended physical education two times per week and the teacher agreed to allow the researcher to implement the visual schedule treatment in his class as long as it did not add to his workload. This class had one teacher, one teaching assistant and two fourth grade classes for a total of 56 students. The class structure is consistent with students arriving to the physical education classroom, sitting on a carpeted floor in eight parallel rows of five to seven students, hearing an introduction of the daily learning objective, receiving a description of the activity designed to meet the learning objective, and being dismissed to the activity either indoors or outdoors. The visual schedule was created specifically for this portion of the class because it was the only part of the class that was consistent.
Materials and Equipment

Visual Schedules

Task analyses were created for forty-seven of the work materials identified by the classroom teacher as materials used for independent work. Twenty-four schedules were created for math, sixteen for reading, and seven for writing. One additional task analysis was created for the physical education class. Each task analysis contained nine steps with the beginning and ending steps remaining consistent across schedules. The beginning step informed the participant that they would be using their reading, writing, or math schedule. The last step prompted the student to put away their iTouch and move on to the next activity in their daily routine as designated by the classroom teacher. Once the task analyses were completed they were emailed to the classroom teacher for review. Upon teacher approval a visual schedule was created for each task analysis using the Tapikeo HD app. Photos were taken of the learning materials using an iPhone 4S. Each step in the visual schedule was accompanied with written and audio direction created using the task analyses. The same wording was used as the teacher would use to describe the step to the participant (e.g., “get a pencil and your writing journal”). A swiping motion was used, similar to turning the page in a book, to move to the next page and next step in the task. Each schedule was placed in a folder titled “Your Grids” in the Tapikeo HD app. The teacher would open the appropriate schedule before presenting the student with the mobile device. The mobile devices, protective cases, and apps were purchased by the researcher and left with the participants upon completion of the study. Visual schedules were delivered to the students using a 4th Generation iPod Touch encased in a protective Otterbox® Defender Series for Apple® iPod Touch 4th Generation case.
**Recording Device**

All sessions were recorded using a Coby Mini HD Camcorder Kit (CAM5002) set up with a mini tripod. Video was saved onto one of ten 16 GB SanDisk SDHC cards then picked up daily to be downloaded and reviewed. The SDHC cards were labeled with the days of the week with two for each weekday Monday through Friday. Once the video had been downloaded the SCHC card was then reformatted and dropped off at the school for the teacher to use again the next week.

**Instrumentation**

**Task Analysis Data Sheet**

A task analysis data sheet (see Appendix B) was used to record participant behaviors (i.e., on-schedule, off-schedule, on-task with scheduled materials, on-task with non-scheduled materials, off-task) and teacher prompts (i.e., verbal or gestural, physical, hand-over-hand) during all study conditions (i.e., baseline, treatment, generalization, and maintenance). The task analysis data sheet was also used to measure inter-observer agreement. Blank task analysis data sheets were provided to the special education teacher upon completion of the study for continuation of the intervention across other educational settings.

**Fidelity Checklist**

A fidelity checklist (see Appendix C) was used to determine level of fidelity associated with treatment implementation (i.e., high, inconsistent, absent or not observed) across 3 areas (set up/preparation, teacher steps, teacher behaviors). The fidelity checklist
was also used to measure inter-observer agreement with regard to teacher performance. Finally, the fidelity checklist was used during teacher and research assistant training.

**Student Progress Evaluation Form**

Social validity was measured using the student progress evaluation form developed from the work of Massey and Wheeler (2000) (see Appendix D). Those who worked closely (i.e., special education teacher, paraprofessional) with the participants completed the questionnaire to determine social validity related to the treatment.

**Experimental Design**

A multiple baseline design across academic tasks (Barlow et al., 2009; Gast, 2010) was used to determine the effectiveness of high-tech visual schedules on on-task and on-schedule academic behaviors. Experimental control was demonstrated through the collection of data across three academic subjects: reading, writing and math (Barlow et al., Gast). Threats to internal validity were controlled for by the introduction of treatment to one subject area while holding the other two subject areas in the baseline condition (Gast). Threats to internal validity from maturation and history were assumed to be minimized by the short duration (seven weeks) of the study (Gast). The intervention (i.e., use of visual schedules) has a considerable research base in a paper-based format (NAC, 2009; NPDC, 2010) which also minimizes threats to internal validity. Threats to external validity were controlled by measuring treatment across three academic tasks (Horner et al., 2005) – reading, writing, and math – and generalizing the treatment to the general education classroom (Barlow et al.).
The independent variable, high-tech visual schedule, was delivered via an iPod Touch. The dependent variables (on-schedule, off-schedule, on-task with scheduled materials, on-task with non-scheduled materials, and off-task) were modeled after those used by Bryan and Gast (2000) with modifications made using a task analysis (see Appendix E-G) for each subject and academic task (i.e., math, reading, and writing).

**Procedures**

There were four phases in this study: study preparation, final screening procedure, teacher and research assistant training sessions, and data collection.

**Phase One: Study Preparation**

The Study Preparation Phase consisted of (a) obtaining facility authorization from participating school, (b) obtaining research approvals, (c) selection of participants from a convenience sample (i.e., students with a primary diagnosis of autism who attended local school district in an elementary self-contained autism program and who had been recommended by specialized instructional itinerants as needing assistance staying on task, (d) obtaining consent from the teaching staff to participate in the study, and (e) obtaining parent consent for student participation. The participating school was obtained through professional contacts of the student/fellow investigator.

The procedures for requesting permission to conduct research from UNLV IRB were followed (i.e., submission of UNLV IRB Research Application, consent letters, CITI certifications, facility authorization letters). In addition, the procedures required for conducting research within the local school district were also followed (i.e., submission of research application for review by the local school district Research Review Committee).
Once these research approvals were obtained the participant selection process began. The student/fellow investigator contacted the participating school principal and informed her that the study had been approved and that the teacher consent/parent permission process could begin. The student/fellow investigator met with the participating autism teacher and the autism paraprofessional who was assigned to work with the autism teacher at the participating school site and described the study details and then obtained informed consent. The autism teacher identified eight students enrolled in her self-contained autism class as having a primary eligibility of autism and needing assistance to stay on-task. The autism teacher sent home parent consent letters with all students enrolled in her classroom. After reviewing the consent forms and speaking with the classroom teacher or researcher via telephone, all parents returned the forms to the teacher.

Phase Two: Final Screening Procedure

Once it had been determined that potential participants met the initial criteria for participation, a final screening procedure took place within the potential participants’ special education classroom. Observational data were collected on five of the eight potential participants. Three of the potential participants attended a lesser restrictive setting for more than 50% of their day and were excluded from being eligible for participation. The researcher observed the students on three different days for a total of six hours. During the observation time, data were collected on off-task behavior using 10 minute intervals and a 20-second time sampling procedure. Event recording was used to measure adult prompts during the same 10 minute time sample. This procedure was conducted for each of the five potential participants during independent writing, reading
and math tasks. It was determined that all five participants were in need of a visual schedule intervention because they required high levels of adult prompting or were observed being off-task for more than 50% of the time sample. Although all five participants were selected for the study, two of the five had to be dropped from the study after displaying behaviors that indicated a desire to withdraw from the study (per the IRB approved prospectus).

**Phase Three: Teacher and Research Assistant Training Sessions**

**Teacher training.** A total of three training sessions were provided for the participating teaching staff (i.e., teacher and paraprofessional). Specifically, the teaching staff was trained on implementation of the high-tech visual schedule. The first two training sessions were held after school in the autism classroom, one for the teacher and one for the paraprofessional. This was done because both had conflicting schedules. In these sessions, teaching staff were taught the graduated guidance procedures for implementing the visual schedule (i.e., presenting visual schedule along with verbal directions to go to workstation and begin working, using a least to most prompting procedure to assist student with advancing to the next step in the visual schedule). They participated in role-play activities with the researcher to practice the graduated guidance procedure using a five-step visual schedule delivered via an iPod Touch and the Tapikeo HD app. During this session, the fidelity of treatment checklist (see Appendix C) was used to assess the abilities of the teaching staff to use the technology correctly to implement the five-step visual schedule. Role-play activities continued until the teaching staff were comfortable with implementing the visual schedule and the researcher did not have to prompt the staff member through the steps of implementation. After the role play
session, the teaching staff were given their camcorder equipment and taught how to (a) set up the camcorder and tripod, (b) start and stop the recording, and (c) remove the SDHC card for daily pickup.

The third training session was conducted in the autism teacher's classroom with only the researcher and teacher present. The materials were pulled that each participant used during independent work, and a nine-step task analysis was written for each. Second, the locations for the video cameras were determined; one was placed on a six-foot high rolling cabinet, and the other was placed on a four-drawer filing cabinet. The teacher set up both cameras and determined that the camera on the rolling cabinet would capture three of the participants and the camera on the filing cabinet would capture the other two (based on the assumed participation of five instead of three students). Third, the teacher practiced changing the SDHC cards and plugging the cameras into the chargers. Lastly, time was provided for the teacher to ask any further questions about the process for implementing the visual schedule, setting up the video camera or changing the SDHC cards. The teacher was provided with envelopes so the SDHC cards could be left in the front office for the researcher to pick up daily.

Research assistant training. A total of two training sessions were provided for the participating research assistant. Duration of the first training session was two hours. First, the research assistant was shown how to access the task analysis checklists from a Dropbox™ folder. The organization system for matching the correct task analysis to the video was reviewed. Second, the research assistant was provided with a laminated card containing the data collection key (see Appendix H). Each behavior and prompting level was operationally defined followed by time for questions and answers. Third, the
research assistant practiced collecting data using a video of a participant working on an independent reading task (see Appendix F). The research assistant paused the video every 20 seconds to record the observed behavior then compared her observation with the researcher’s observation. Fifteen minutes of video was reviewed over the course of forty-five minutes, agreement between observers during training was 100%. Lastly, the research assistant and researcher discussed a method for delivering the video to the research assistant. It was determined that a high-capacity portable storage device would be used. Duration of the second training session was thirty minutes. First, the research assistant was provided with the fidelity checklist (see Appendix C) and schedule for data collection. Second, each step in the fidelity checklist was reviewed by the research assistant. Third, the researcher answered questions about teacher steps and teacher behaviors. Lastly, the researcher provided the research assistant with a high-capacity storage device containing video to be reviewed.

**Phase Four: Data Collection Procedures**

*Data collection overview.* As previously described, a multiple baseline across academic tasks design (Barlow et al., 2009; Gast, 2010) was used to collect data for this study. The data collection conditions consisted of baseline, implementation of treatment procedures, generalization and maintenance for each of the target students. During each data collection session, teaching staff set up the camcorder in an unobtrusive area where the target participant would be visible for the independent academic task being recorded (reading, writing or math). The camcorder was started before the participant was directed to begin the independent work, and data collection was stopped after 15 minutes (the video was allowed to run so the natural flow of the classroom was not disrupted). The
video was recorded on an SDHC card and was picked up daily by the researcher. No participant work, such as tests, assessments, or class work was collected.

**Recording procedures.** Data collection across the four conditions (i.e., baseline, implementing treatment, generalization, and maintenance) involved watching recorded video and completing a task analysis sheet (see Appendix B) using a time sampling procedure for each assigned academic task. The dependent variables (i.e., on-schedule and on-task behaviors) were recorded simultaneously every 20 seconds. A percentage of the dependent variables for each session were calculated to determine data points. Observers used the clock on their video viewer (i.e., Windows Media Player, QuickTime) to pause the video every 20 seconds to record data. This procedure ensured that data were collected every 20 seconds. Dependent variables were modeled after those used by Bryan and Gast (2000, p. 556) with slight changes related to the task analyses for each student: on-schedule, off-schedule, on-task with scheduled materials, on-task with non-scheduled materials, and off-task. Adult prompting was also recorded for four levels: (a) none, (b) verbal or gestural, (c) physical prompt such as touching the student’s arm or shoulder for orientation, or (d) hand-over-hand assistance. Any verbal praise or reinforcement was not scored as a prompt. Event recording procedures (Gast, 2010) were used to record occurrence and level of adult prompting during intervention sessions. Response recording was the same across observations of baseline, implementation of treatment, generalization and maintenance.

*On-schedule* was scored if each step in the task analysis was completed: (a) acceptance of the visual schedule (for baseline following of verbal direction was scored), (b) movements to the designated center, (c) beginning of step 1 of the task analysis within
two consecutive time samples (data was collected using a 20 second time sample procedure), (d) beginning of steps 2 through 9 within two consecutive time samples of completing the previous step, and (e) returning the visual schedule and completed materials to their designated location.

*Off-schedule* was scored if the student did not complete the step they were working on correctly or did not begin the next step within 2 consecutive time samples of completing the previous step.

*On-task with scheduled materials* was scored if the student was (a) looking at materials for the assigned task, (b) looking at their visual schedule, (c) using the materials appropriately for the assigned task, and (d) in transition to return the visual schedule and completed materials to their designated location.

*On-task with non-scheduled materials* was scored if the student was (a) not following their visual schedule but working appropriately with other work materials, (b) looking through their picture activity schedule, (c) using any work materials appropriately, or (d) in transition from one activity to another without returning their visual schedule and completed materials to their designated location.

*Off-task* was scored if the student was (a) using the materials inappropriately, (b) manipulating but not visually attending to the task (engaging in self-stimulatory behavior), (c) exhibiting inappropriate behavior (tantrums or refusal behaviors), or (d) not working or using any of the materials for the assigned task.

*Baseline.* Students were observed during three academic tasks – reading, writing and math. Baseline data were collected over multiple sessions until specific criteria were met for one of the three academic tasks (i.e., reading, writing, or math). The first
academic task area (i.e., reading, writing, or math) to show stability or a contratherapeutic trend (Gast, 2010) for three consecutive days, or three out of four consecutive days for each student was the first area used in the visual schedule treatment. The students remained in the baseline phase over multiple sessions for the other two academic task areas until stability or a contratherapeutic trend (Gast) for three consecutive days, or three out of four consecutive days was reached (on task with scheduled materials) in the first task area. Participant three showed a contratherapeutic trend for three consecutive data points therefore was moved into treatment (Gast, 2010). Once this criterion was met the second task area (i.e., reading, writing, or math) entered into the treatment phase. Baseline data collection for the third academic task continued over multiple sessions until stability or a contratherapeutic trend (Gast) was achieved for the second academic task area. Data collection for each session (academic task) did not exceed 15 minutes, but the academic task was allowed to continue because it was already a part of the participant’s daily academic routine.

**Implementation of treatment procedures.** The independent variable (i.e., visual schedule) was introduced once stability or a non-therapeutic trend was established. Participants were informed by the teacher it was time to do independent work (i.e., reading, writing or math). The video recorder was set up overlooking participant desks or work area – at that time the participant entering treatment was presented with the visual schedule at his desk. The visual schedule consisted of the task steps (see visual schedule example in Appendix E). The teacher used a graduated guidance prompting procedure (Bryan & Gast, 2000) the first time the participants were introduced to the treatment to teach the student how to use the visual schedule. The teacher presented the participant
with the visual schedule along with verbal directions to use his schedule to do his academic task (reading, writing, or math). While the participant was at his desk the teacher used a verbal and gestural prompt to show the participant how to advance the visual schedule to the next step (i.e., step 2 of the visual schedule may direct the student to get specific work materials). The teacher then made moment-by-moment decisions about which type of prompt (i.e., verbal or gestural, physical, hand-over-hand) to use with the participant to assist him with advancing and following the next step in the visual schedule. Prompts were faded in frequency and level until the participant could use the visual schedule independently (Bryan & Gast). The teacher was advised to provide reinforcing statements to the students for on-task and on-schedule behaviors on a variable interval 2-minute schedule (VI-2). Reinforcing statements and gestures were provided by the teacher (e.g., “I like how you are using your schedule, good job”, “I like how you are working”, provided high-fives). Reinforcing statements or gestures were not scored as prompts. The teaching staff was instructed to ignore participants when they exhibit inappropriate attention seeking, refusal, or tantrum behaviors. During these behaviors, the Task Analysis Data Sheet (see Appendix B) was used and students were scored as off-task and off-schedule. Any prompts provided by teaching staff or service providers in the class were scored as a prompt using the levels (i.e., verbal or gestural, physical, hand-over-hand assistance) procedures described previously. Students were provided reinforcement upon completing the task outlined in the visual schedule according to the reinforcement schedule already in place in the classroom.

**Generalization.** Once intervention had been implemented for the third academic task, generalization began. A visual schedule was created using a task analysis of the
daily learning objective and activity introduction for physical education. Two sessions were videotaped during a two week period.

**Maintenance.** Maintenance probes were conducted on the visual schedule for each of the academic subjects – reading, writing and math – once during the second and third week after data collection ended for each participant’s third and last academic task area (reading, writing, or math).

**Reliability measures.** The researcher scored student performance data and teacher prompts for 100% of the academic sessions using the Task Analysis Data Sheet (see Appendix B). To determine inter-observer reliability related to these scores, the research assistant scored 33% (randomly assigned) of the same academic sessions. The percentage of interobserver agreement was calculated using the formula (number of agreements) ÷ (number of agreements + disagreements) X 100 (Gast, 2010).

Fidelity of treatment data were collected on 20% (randomly assigned) of the academic sessions by the researcher and research assistant using the treatment fidelity checklist (see Appendix C). Three fidelity categories were scored: (a) set up/preparation, (b) teacher steps, and (c) teacher behaviors. The percentage of interobserver agreement was calculated using the formula (number of agreements) ÷ (number of agreements + disagreements) X 100 (Gast, 2010).

**Social validity measure.** Social validity was measured using the same questions (see Appendix D) as those used by Massey and Wheeler (2000). Those who worked closely with the target students (i.e., teachers and paraprofessional) completed the questionnaire to determine social validity. The resulting data were analyzed using
frequency counts related to the following Likert scale: 4 – strongly disagree; 3 – disagree; 2 – agree; and 1 – strongly agree.

Data Analyses

A graphic display of on-task behavior in each subject area was generated for each student. Each student’s display includes performance data from four conditions: baseline sessions, treatment sessions, generalization sessions, and maintenance sessions. The line graph display was analyzed visually for differences in level (i.e., mean score for data within each condition) and trend (i.e., slope of the best fitting straight line for the data within a condition), and variability (i.e., fluctuation of the data around the mean) to determine the effects of the treatment.

A separate graphic display was created for on-schedule behaviors for each student and each subject area. Again the graph includes performance data for all four conditions (i.e., baseline, treatment, generalization, and maintenance). Data were also graphed for the prompting levels provided to each student by calculating the total per session. A subdivided bar graph was developed to show various levels in prompts (i.e., no prompt, verbal/gestural prompt, physical prompt, hand-over-hand assistance) for each student across conditions (i.e., baseline, treatment, generalization, and maintenance).

The following data sets and analysis procedures were used to answer the research questions in this study.

- Does the use of high-tech visual schedules increase the on-task behavior of elementary students with ASD across academic subject areas?

A separate line graph was used for each participant to display the percent of on-task behavior exhibited in each academic task (i.e., reading, writing, and math). Mean,
standard deviation, and range scores were reported for the baseline and treatment conditions to ascertain a change in level. Trend lines were used to visually analyze trend and variability related to on-task behaviors during the baseline and intervention conditions. Additionally, the percentage of data exceeding the median (PEM) was used to determine effect size. It was predicted that on-task behaviors would increase when the intervention was implemented.

• Does the use of high-tech visual schedules increase the on-schedule behavior of elementary students with ASD across academic subject areas?

A separate line graph was used for each participant to display the percent of on-schedule behavior exhibited for each academic task (i.e., reading, writing, and math). Mean, standard deviation, and range scores were reported for the baseline and treatment conditions to ascertain a change in level. Trend lines were used to visually analyze trend and variability in on-schedule behaviors during the baseline and intervention conditions. Additionally, the percentage of data exceeding the median (PEM) was used to determine effect size. It was predicted that on-schedule behaviors would increase when the intervention was implemented.

• Does the use of high-tech visual schedules decrease the number of prompts that teachers provide to maintain on-task and on-schedule behaviors?

A subdivided bar graph was used to show various levels in prompts (i.e., no prompt, verbal/gestural prompt, physical prompt, hand-over-hand assistance) for each student across conditions (i.e., baseline, treatment, generalization, and maintenance). It was predicted that percentage of prompts delivered would decrease when the intervention was implemented.
• Does the use of high-tech visual schedules generalize to the general education classroom setting?

Each participant’s graphs display the percent of on-task and on-schedule behavior exhibited for each assigned task in the general education setting. Mean and range scores for the intervention and generalization condition were reported and compared to ascertain changes in level. A trend line was used to visually analyze trend and variability in on-task and on-schedule behaviors during the generalization condition. It was predicted that on-task and on-schedule behaviors would generalize from the special education to the general education classroom.

• Does the use of high-tech visual schedules maintain up to three weeks after intervention criterion is met?

Each participant’s graphs display the percent of on-task and on-schedule behavior exhibited for each academic task (i.e., reading, writing, and math) during the maintenance condition. Visual analysis was used to determine level changes after the treatment condition ended.

• Does the use of high-tech visual schedules among elementary students with ASD result in high levels of stakeholder satisfaction?

Data from the Student Progress Evaluation Form was displayed in table format showing questions and number of responses for (a) strongly agree, (b) agree, (c) disagree, and (d) strongly disagree.
CHAPTER 4
RESULTS

The purpose of this study was to determine whether high-tech visual schedules increase the self-regulation and transition behaviors of young children with ASD. Specifically, on-task and on-schedule behaviors were addressed. A total of six questions were answered over the course of this study. Those questions will be restated followed by a description of the data collected, analysis procedure used and results of the analysis. In conclusion, a summary of the findings will highlight important aspects of the presented data.

Research Questions and Related Findings

Research Question 1

Does the use of high-tech visual schedules increase the on-task behavior of elementary students with ASD across academic subject areas?

Data were collected using a 20 second time sampling procedure for on-task behavior across three conditions (reading, writing, and math) for each participant (see Figures 1-3). The line graph display was analyzed visually for differences in level (i.e., mean score for data within each condition), trend (i.e., slope of the best fitting straight line for the data within a condition), and variability (i.e., fluctuation of the data around the mean) to determine the effects of the treatment. A split-middle method was used for the analysis because of variability in data points (Gast, 2010). In addition, the percentage of data exceeding the median (PEM) (Ma, 2006) was used to determine treatment effect size. Percentage of data exceeding the median (PEM) was calculated by a) identifying the
median baseline point, b) drawing a horizontal line through the median baseline point extending from first baseline point to last intervention point, c) counting the number of data points above the line (therapeutic side) for baseline and intervention (numerator), d) counting the number of data points above the line for the intervention (denominator), and e) dividing the numerator by the denominator and multiplying by 100 (Lenz, 2013).

During writing, baseline time on-task data for participant one were variable with an accelerating trend (see Figure 1). Mean percent of time on-task for baseline was 8.2% with a range of 0-41% and standard deviation of 18.34. There was an immediate effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during writing while using the visual schedule intervention was 72.6% with a range of 46-100% and standard deviation of 20.79. There was a relative level change of 0% to 86% from baseline to visual schedule intervention during writing for participant one (see Table 3). The PEM for time on-task during writing for participant one was 93%, which indicates a very effective treatment (Scruggs & Mastropieri, 1998).

During math, baseline time on-task data for participant one were variable with a decelerating trend (see Figure 1). Mean percent of time on-task for baseline was 71.6% with a range of 47-97% and standard deviation of 24. There was an immediate negative effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during math while using the visual schedule intervention was 44.9% with a range of 31-61% and standard deviation of 9.2. There was a relative level change of 72% to 44% from baseline to visual schedule intervention during math for participant one (see Table 3). The PEM for time on-task during math for
### Table 3

**Participant 1 On-Task Behavior Data Analysis**

<table>
<thead>
<tr>
<th>On-Task</th>
<th>Baseline</th>
<th>Intervention</th>
<th>Generalization</th>
<th>Maintenance</th>
</tr>
</thead>
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<td></td>
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</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>Math</td>
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<td>Range= 31-61</td>
<td></td>
<td>Range= 82-92</td>
</tr>
<tr>
<td></td>
<td>SD= 24</td>
<td>SD= 9.2</td>
<td></td>
<td>SD= 8.49</td>
</tr>
<tr>
<td></td>
<td>Level= 72</td>
<td>Level= 44</td>
<td></td>
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</tr>
<tr>
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<td></td>
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<td></td>
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</table>

*Note: Level = relative level change between two adjacent conditions*
participant one was 0%, which indicates the treatment was not effective (Scruggs & Mastropieri, 1998).

During reading, baseline time on-task data for participant one were variable with a slightly accelerating trend (see Figure 1). Mean percent of time on-task for baseline was Figure 1

*Participant 1 On-Task Behavior*
53.1% with a range of 35-66% and standard deviation of 9.7. There was no immediate effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during reading while using the visual schedule intervention was 81.2% with a range of 58-99% and standard deviation of 20.25. There was a relative level change of 52% to 99% from baseline to visual schedule intervention during reading for participant one (see Table 3). The PEM for time on-task during reading for participant one was 56%, which indicates the treatment was debatably effective (Scruggs & Mastropieri, 1998).

During reading, baseline time on-task data for participant two were variable with a sharply decelerating trend (see Figure 2). Mean percent of time on-task for baseline was 31% with a range of 0-45% and standard deviation of 21.02. There was an immediate effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during reading while using the visual schedule intervention was 40.3% with a range of 25-73% and standard deviation of 19.67. There was a relative level change of 40% to 51% from baseline to visual schedule intervention during reading for participant two (see Table 4). The PEM for time on-task during reading for participant two was 40%, which indicates the treatment was not effective (Scruggs & Mastropieri, 1998).

During writing, baseline time on-task data for participant two were variable (see Figure 2). Mean percent of time on-task for baseline was 16.8% with a range of 0-60% and standard deviation of 24.18. There was no immediate effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during writing while using the visual schedule intervention was
Table 4

*Participant 2 On-Task Behavior Data Analysis*

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<th>On-Task</th>
<th>Baseline</th>
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<th>Generalization</th>
<th>Maintenance</th>
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</tr>
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</tr>
<tr>
<td></td>
<td>Level= 41</td>
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</tr>
<tr>
<td>Reading</td>
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<td></td>
<td>SD= 21.02</td>
<td>SD= 19.67</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Level= 40</td>
<td>Level= 51</td>
<td></td>
<td></td>
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<td>PE</td>
<td>Mean= 77.5</td>
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<td></td>
<td>Range= 75-80</td>
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<tr>
<td></td>
<td>SD= 3.54</td>
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</tbody>
</table>

*Note: Level = relative level change between two adjacent conditions*
48.7% with a range of 22-68% and standard deviation of 16.83. There was a relative level change of 30% to 59% from baseline to visual schedule intervention during writing for participant two (see Table 4). The PEM for time on-task during writing for participant two was 77%, which indicates the treatment had a moderate effect (Scruggs & Mastropieri, 1998).

During math, baseline time on-task data for participant two were variable with a slightly accelerating trend (see Figure 2). Mean percent of time on-task for baseline was 47% with a range of 16-70% and standard deviation of 20.26. There was an immediate negative effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during math while using the visual schedule intervention was 31.6% with a range of 23-49% and standard deviation of 9.19. There was a relative level change of 41% to 31% from baseline to visual schedule intervention during math for participant two (see Table 4). The PEM for time on-task during math for participant two was 0%, which indicates the treatment was not effective (Scruggs & Mastropieri, 1998).

During math, baseline time on-task data for participant three were stable with a sharply decelerating trend (see Figure 3). Mean percent of time on-task for baseline was 58% with a range of 36-88% and standard deviation of 26.91. There was an immediate effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during math while using the visual schedule intervention was 84.8% with a range of 66-100% and standard deviation of 13.11. There was a relative level change of 50% to 90% from baseline to visual schedule intervention during math for participant three (see Table 5). The PEM for time on-task during math for
participant three was 93%, which indicates the treatment was very effective (Scruggs & Mastropieri, 1998).

During reading, baseline time on-task data for participant three were stable with an accelerating trend (see Figure 3). Mean percent of time on-task for baseline was 58% Figure 2

*Participant 2 On-Task Behavior*
with a range of 44-76% and standard deviation of 14.58. There was an immediate negative effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during reading while using the visual schedule intervention was 68.1% with a range of 34-98% and standard deviation of 25.1. There

Figure 3

*Participant 3 On-Task Behavior*
was a relative level change of 63% to 66% from baseline to visual schedule intervention during reading for participant three (see Table 5). The PEM for time on-task during reading for participant three was 42%, which indicates the treatment was not effective (Scruggs & Mastropieri, 1998).

During writing, baseline time on-task data for participant three were variable with a slightly accelerating trend (see Figure 3). Mean percent of time on-task for baseline was 58% with a range of 48-65% and standard deviation of 5.97. There was an immediate effect on percent of time on-task when the visual schedule intervention was introduced. Mean percent of time on-task during writing while using the visual schedule intervention was 68% with a range of 44-97% and standard deviation of 19.62. There was a relative level change of 58% to 84% from baseline to visual schedule intervention during writing for participant three (see Table 5). The PEM for time on-task during writing for participant three was 40%, which indicates the treatment was not effective (Scruggs & Mastropieri, 1998).

**Research Question 1 Summary**

Overall the visual schedule intervention was very effective for on-task behaviors for participant one for writing and very effective for participant three in math. In writing participant two exhibited a moderate treatment effect. In reading the visual schedule intervention was debatably effective for on-task behaviors for participant one. The visual schedule was not effective for on-task behaviors for participants one and two in math, not effective for participant two and three in reading, and not effective for participant three in writing. Given the variability in the data it cannot be said that there was a functional
Table 5

*Participant 3 On-Task Behavior Data Analysis*

<table>
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<tr>
<th>On-Task</th>
<th>Baseline</th>
<th>Intervention</th>
<th>Generalization</th>
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<td>Range = 77-100</td>
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<td></td>
<td>SD = 8.49</td>
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</tbody>
</table>

*Note: Level = relative level change between two adjacent conditions*
relationship between the intervention and on-task behaviors across academic subjects for the participants.

**Research Question 2**

Does the use of high-tech visual schedules increase the on-schedule behavior of elementary students with ASD across academic subject areas?

Data were collected using a 20 second time sampling procedure for on-schedule behavior across three conditions (reading, writing, and math) for each participant (see Figures 4-6). The line graph display was analyzed visually for differences in level (i.e., mean score for data within each condition) and trend (i.e., slope of the best fitting straight line for the data within a condition), and variability (i.e., fluctuation of the data around the mean) to determine the effects of the treatment using the split-middle method (Gast, 2010). In addition, the percentage of data exceeding the median (PEM) (Ma, 2006) was used to determine treatment effect size. Percentage of data exceeding the median (PEM) was calculated by a) identifying the median baseline point, b) drawing a horizontal line through the median baseline point extending from first baseline point to last intervention point, c) counting the number of data points above the line (therapeutic side) for baseline and intervention (numerator), d) counting the number of data points above the line for the intervention (denominator), and e) dividing the numerator by the denominator and multiplying by 100 (Lenz, 2013).

During writing, baseline data for participant one were stable with an accelerating trend. Mean percent of time on-schedule for baseline was 8.2% with a range of 0-41% and standard deviation of 18.34. There was an immediate effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of time on-
schedule during writing during use of the visual schedule intervention was 72.3% with a range of 37-100% and standard deviation of 21.64. There was a relative level change of

Table 6

*Participant 1 On-Schedule Behavior Data Analysis*

<table>
<thead>
<tr>
<th>On-Schedule</th>
<th>Baseline</th>
<th>Intervention</th>
<th>Generalization</th>
<th>Maintenance</th>
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</thead>
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<td>SD= 18.34</td>
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<tr>
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<td>Math</td>
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<td>Range= 82-94</td>
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<td>SD= 18.81</td>
<td>SD= 7.66</td>
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<td>SD= 8.49</td>
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<td></td>
<td>Level= 47</td>
<td>Level= 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>Mean= 48.3</td>
<td>Mean= 78.8</td>
<td></td>
<td>Mean= 84</td>
</tr>
<tr>
<td></td>
<td>Range= 38-58</td>
<td>Range= 60-94</td>
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<td>Range= 68-100</td>
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<td>PE</td>
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<td>SD= 2.83</td>
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</tbody>
</table>

*Note: Level = relative level change between two adjacent conditions*
0% to 86% from baseline to visual schedule intervention during writing for participant one. The PEM for time on-schedule during writing for participant one was 93%, which indicated a very effective treatment (Scruggs & Mastropieri, 1998).

During math, baseline data for participant one were variable with a flat trend. Mean percent of time on-schedule for baseline was 65.6% with a range of 47-93% and standard deviation of 18.81. There was an immediate negative effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of time on-schedule during math while using the visual schedule intervention was 42.4% with a range of 31-57% and standard deviation of 7.66. There was a relative level change of 47% to 42% from baseline to visual schedule intervention during math for participant two. The PEM for time on-schedule during math for participant one was 0%, which indicated the treatment was not effective (Scruggs & Mastropieri, 1998).

During reading, baseline time on-schedule data for participant one were variable with a flat trend. Mean percent of time on-schedule for baseline was 48.3% with a range of 38-58% and standard deviation of 6.99. There was no immediate effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of time on-schedule during writing during use of the visual schedule intervention was 78.8% with a range of 60-94% and standard deviation of 16.53. There was a relative level change of 46% to 92% from baseline to visual schedule intervention during writing for participant one. The PEM for time on-schedule during reading for participant one was 56% indicating a debatably effective treatment effect (Scruggs & Mastropieri, 1998).

During reading, baseline data for participant two were variable with a slightly accelerating trend. Mean percent of time on-schedule for baseline was 23% with a range
of 0-52% and standard deviation of 21.57. There was an immediate effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of time on-schedule during reading while using the visual schedule intervention was 36.8% with a range of 17-73% and standard deviation of 18.24. There was a relative level
change of 26% to 43% increasing from baseline to visual schedule intervention during reading for participant two. The PEM for time on-schedule during reading for participant two was 87% indicating a moderate treatment effect (Scruggs & Mastropieri, 1998).

During writing, baseline data for participant two were variable. Mean percent of time on-schedule for baseline was 17.6% with a range of 0-60% and standard deviation of 25.38. There was no immediate effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of time on-schedule during writing while using the visual schedule intervention was 45.2% with a range of 18-59% and standard deviation of 15.05. There was a relative level change of 30% to 54% from baseline to visual schedule intervention during writing for participant two. The PEM for time on-schedule during writing for participant two was 77% indicating a moderate treatment effect (Scruggs & Mastropieri, 1998).

During math, baseline data for participant two were variable with a decelerating trend. Mean percent of time on-schedule for baseline was 47.1% with a range of 29-60% and standard deviation of 12.23. There was an immediate negative effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of time on-schedule during math while using the visual schedule intervention was 36% with a range of 18-54% and standard deviation of 16.36. There was a relative level change of 45% to 51% baseline to visual schedule intervention during math for participant two. The PEM for time on-schedule during math for participant two was 25% which indicated the treatment was not effective (Scruggs & Mastropieri, 1998).
Table 7

*Participant 2 On-Schedule Behavior Data Analysis*

<table>
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<th>On-Schedule</th>
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<th>Generalization</th>
<th>Maintenance</th>
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</thead>
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<td>Level= 54</td>
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<tr>
<td>Math</td>
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<td>Range= 29-60</td>
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<tr>
<td></td>
<td>SD= 12.23</td>
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<tr>
<td>Reading</td>
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<td>SD= 2.83</td>
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</tbody>
</table>

*Note:* Level = relative level change between two adjacent conditions

During math, baseline data for participant three were stable with a sharp decelerating trend. Mean percent of time on-schedule for baseline was 46% with a range
of 19-77% and standard deviation of 29.21. There was an immediate effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of Figure 5

*Participant 2 On-Schedule Behavior*

![Graph showing on-schedule behavior for different activities over sessions.](image)

Mean percent of time on-schedule during math while using the visual schedule intervention was 80.5% with a range of 57-95% and standard deviation of 14.17. There was a relative level
change of 42% to 89% from baseline to visual schedule intervention during math for participant three. The PEM for time on-schedule during math for participant three was 93% indicating a very effective treatment (Scruggs & Mastropieri, 1998).

During reading, baseline data for participant three were stable with a sharp accelerating trend. Mean percent of time on-schedule for baseline was 53.2% with a range of 35-76% and standard deviation of 15.71. There was no immediate effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of time on-schedule during reading while using the visual schedule intervention was 63.2% with a range of 29-95% and standard deviation of 26.55. There was a relative level change of 60% to 59% from baseline to visual schedule intervention during reading for participant three. The PEM for time on-schedule during reading for participant three was 50% which indicates the treatment was not effective (Scruggs & Mastropieri, 1998).

During writing, baseline data for participant three were stable with a flat trend. Mean percent of time on-schedule for baseline was 52.4% with a range of 47-60% and standard deviation of 4.95. There was an immediate effect on percent of time on-schedule when the visual schedule intervention was introduced. Mean percent of time on-schedule during writing while using the visual schedule intervention was 67.3% with a range of 44-97% and standard deviation of 19.82. There was a relative level change of 48% to 84% from baseline to visual schedule intervention during writing for participant three. The PEM for time on-schedule during writing for participant three was 50% which
Table 8

*Participant 3 On-Schedule Behavior Data Analysis*

<table>
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<td>Range= 78-98</td>
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<tr>
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<td>SD= 15.71</td>
<td>SD= 26.55</td>
<td>SD= 14.14</td>
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</table>

*Note: Level = relative level change between two adjacent conditions*
Research Question 2 Summary

Overall the visual schedule intervention was very effective for on-schedule behaviors for participant one for writing and very effective for participant three in math.

indicates the treatment was not effective (Scruggs & Mastropieri, 1998).
In reading and writing participant two exhibited a moderate treatment effect. In reading, the visual schedule intervention was debatably effective for on-schedule behaviors for participant one. The visual schedule was not effective for on-schedule behaviors for participants one and two in math and not effective for on-schedule behaviors for participant three in reading and writing. Given the variability in the data it cannot be said that there was a functional relationship between the intervention and on-schedule behaviors across academic subjects for the participants.

**Research Question 3**

Does the use of high-tech visual schedules decrease the number of prompts that teachers provide to maintain on-task and on-schedule behaviors?

Data were collected using event recording procedures (Gast, 2010) to record occurrence and level of adult prompting across baseline, intervention, maintenance, and generalization conditions for each participant. The numbers of prompts were averaged by type (verbal or gestural, physical, or hand-over-hand) for reading, writing, and math across conditions (baseline, intervention, maintenance, and generalization) for each participant (see Figures 7, 8, and 9).

During reading, participant one received a baseline mean of 2.9 for verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts decreased to 1.3 with a range of 0 to 3. During maintenance for reading, the mean for verbal or gestural prompts was .5 with a range of 0 to 1. During writing, participant one received a baseline mean of 0 for verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts increased to 4.5 with a range of 0 to 14. During maintenance for writing the
mean for verbal or gestural prompts was 3 with a range of 2 to 4. During math, participant one received a baseline mean of 1.8 for verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts increased to 3.6 with a range of 0 to 9. During maintenance for math the mean for verbal or gestural prompts was 0. During generalization, for participant one, in general education PE, the mean for verbal or gestural prompts was 2 with no range (see Figure 7).

During reading, participant one received a baseline mean of .4 for physical prompts. When the visual schedule intervention was introduced the mean for physical prompts decreased to 0. During maintenance for reading the mean for physical prompts was 2 with a range of 0 to 4. During writing, participant one received a baseline mean of 0 for physical prompts. When the visual schedule intervention was introduced the mean for physical prompts increased to .4 with a range of 0 to 2. During maintenance for writing, the mean for physical prompts was .5 with a range of 0 to 1. During math, participant one received a baseline mean of 0 for physical prompts. When the visual schedule intervention was introduced the mean for physical prompts increased to .4 with
a range of 0 to 2. During maintenance for math the mean for physical prompts was .5 with a range of 0 to 1. During generalization for participant one, in general education PE, the mean for physical prompts was .5 with a range of 0 to 1 (see Figure 7).

During reading for participant one, the verbal or gestural prompts received decreased with the visual schedule intervention and continued to decrease through maintenance. Physical prompts also decreased during the visual schedule intervention but increased above baseline levels during maintenance. During writing for participant one, the verbal or gestural prompts received increased with the visual schedule intervention, decreased during maintenance but did not return to zero levels from baseline. Physical prompts also increased with introduction of the visual schedule intervention and continued to increase through maintenance. During math for participant one, the verbal or gestural prompts received increased with the visual schedule intervention and decreased to zero levels in maintenance. Physical prompts increased with introduction of the visual schedule intervention and continued to increase through maintenance. Participant one did not require any hand-over-hand prompting during the data collection process.

During reading, participant two received a baseline mean of 8.8 for verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts decreased to 8.4 with a range of 2 to 19. During maintenance for reading the mean for verbal or gestural prompts was 4 with no range. During writing participant two received a baseline mean of 9 verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts decreased to 7.7 with a range of 3 to 13. During maintenance for writing the mean for verbal or gestural prompts was 8 with a range of 7 to 9. During math, participant two received a
baseline mean of 4.9 for verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts increased to 5.8 with a range of 2 to 11. During maintenance for math the mean for verbal or gestural prompts was 3.5. During generalization, for participant two, in general education PE, the mean verbal or gestural prompts was 3 with no range (see Figure 8).

Figure 8

Participant 2 Average Number of Prompts

During reading, participant two received a baseline mean of .75 for physical prompts. When the visual schedule intervention was introduced the mean for physical prompts increased to 2.3 with a range of 0 to 8. During maintenance for reading the mean for physical prompts was 2 with a range of 0 to 4. During writing, participant two received a baseline mean of 4 for physical prompts. When the visual schedule intervention was introduced the mean for physical prompts decreased to 2.3 with a range of 0 to 11. During maintenance for writing the mean for physical prompts was 2.5 with a range of 1 to 4. During math, participant two received a baseline mean of .4 for physical prompts. When the visual schedule intervention was introduced the mean for physical prompts increased to .8 with a range of 0 to 2. During maintenance for math the mean for
physical prompts was 0. During generalization for participant two, in general education PE, the mean for physical prompts was 1.5 with a range of 1 to 2 (see Figure 8).

During reading, participant two received a baseline mean of 0 for hand-over-hand prompts. When the visual schedule intervention was introduced the mean for hand-over-hand prompts increased to .1 with a range of 0 to 1. During maintenance for reading the mean for hand-over-hand prompts was 0. Participant two did not require hand-over-hand prompting for writing, math or PE (see Figure 8).

In summary, during reading for participant two the verbal or gestural prompts received decreased with the visual schedule intervention and continued to decrease through maintenance. Physical prompts increased during the visual schedule intervention and decreased in maintenance but not to baseline levels. Hand-over-hand prompts increased during the visual schedule intervention but decreased to zero levels during maintenance. During writing for participant two, the verbal or gestural prompts received decreased with the visual schedule intervention and increased slightly in maintenance. Physical prompts decreased during the visual schedule intervention and increased slightly during maintenance. During math for participant two, the verbal or gestural prompts received increased with the visual schedule intervention and decreased to levels below baseline during in maintenance. Physical prompts increased slightly during the visual schedule intervention but decreased to zero levels during maintenance.

During reading, participant three received a baseline mean of 5.4 for verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts decreased to 3.8 with a range of 1 to 8. During maintenance for reading the mean for verbal or gestural prompts was 1.5 with a range of 1 to 2. During
writing participant three received a baseline mean of 2.1 for verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts increased to 4.3 with a range of 3 to 6. During maintenance for writing the mean for verbal or gestural prompts was 2.5 with a range of 2 to 3. During math, participant three received a baseline mean of 3.8 for verbal or gestural prompts. When the visual schedule intervention was introduced the mean for verbal or gestural prompts decreased to 2.7 with a range of 0 to 7. During maintenance for math the mean for verbal or gestural prompts was 1 with a range of 0 to 2. During generalization, for participant three, in general education PE the mean verbal or gestural prompts was 2 with a range of 1 to 3 (see Figure 9).

Figure 9

*Participant 3 Average Number of Prompts*

During reading, participant three received a baseline mean of .6 for physical prompts. When the visual schedule intervention was introduced the mean for physical prompts remained stable at .6 with a range of 0 to 1. During maintenance for reading the mean for physical prompts was 2 with a range of 1 to 3. During writing, participant three received a baseline mean of .3 for physical prompts. When the visual schedule
intervention was introduced the mean for physical prompts increased to .5 with a range of 0 to 2. During maintenance for writing, the mean for physical prompts was .5 with a range of 0 to 1. During math, participant three received a baseline mean of .5 for physical prompts. When the visual schedule intervention was introduced the mean for physical prompts increased to .8 with a range of 0 to 4. During maintenance for math the mean for physical prompts was 1 with a range of 0 to 2. During generalization for participant three, in general education PE, the mean for physical prompts was 1.5 with a range of 1 to 2 (see Figure 9).

During reading, for participant three received a baseline mean of 0 for hand-over-hand prompts. When the visual schedule intervention was introduced the mean for hand-over-hand prompts increased to .1 with a range of 0 to 1. During maintenance for reading the mean for hand-over-hand prompts was 0. Participant three did not require hand-over-hand prompting for writing, math or PE (see Figure 9).

In summary, during reading for participant three the verbal or gestural prompts received decreased with the visual schedule intervention and continued to decrease through maintenance. Physical prompts remained stable during the visual schedule intervention and increased through maintenance. Hand-over-hand prompts increased during the visual schedule intervention but decreased to zero levels during maintenance. During writing for participant three, the verbal or gestural prompts received increased with the visual schedule intervention, decreased during maintenance but did not return to baseline levels. Physical prompts increased with the visual schedule intervention and remained stable through maintenance. During math for participant three, the verbal or gestural prompts received decreased with the visual schedule intervention and continued
to decrease in maintenance. Physical prompts increased with the visual schedule intervention and continued to increase through maintenance.

**Research Question 3 Summary**

The visual schedule intervention was effective in decreasing verbal or gestural prompts during reading for participant one but not during writing or math. Physical prompts also decreased during reading but increased again during maintenance. Physical prompts increased during writing and math. The visual schedule intervention was effective in decreasing verbal or gestural prompts during reading and writing for participant two but not during math. Physical prompts decreased during writing but increased during reading and math for participant two. Hand-over-hand prompts also increased during reading for participant two. The visual schedule intervention was effective in decreasing verbal or gestural prompts during reading and math for participant three but not during writing. Physical prompts increased with the visual schedule intervention across writing and math for participant three. Hand-over-hand prompts increased during reading for participant three. Overall the visual schedule was effective in decreasing verbal or gestural prompts for all three participants in reading. The visual schedule was effective for reducing verbal or gestural and physical prompts in writing for one participant and verbal or gestural prompts in math for one participant.

**Research Question 4**

Does the use of high-tech visual schedules generalize to the general education classroom setting?

During PE generalization time, on-task data for participant one reflected a decreasing trend (see Figure 1). Mean percent of time on-task for generalization was 97%
with a range of 96-98% (SD = 1.41) (see Table 3). The mean percent of time on-task during PE generalization was 24.4 percentage points above mean time on-task during writing, 15.8 percentage points above mean time on-task for reading, and 52.1 percentage points above mean time on-task for math for participant one during the use of the visual schedule intervention.

During PE generalization time, on-schedule data for participant one reflected a decreasing trend (see Figure 4). The mean percent of time on-schedule for generalization was 98% with a range of 96-100% (SD = 2.83) (see Table 6). The mean percent of time on-schedule during PE generalization was 25.7 percentage points above mean time on-schedule during writing, 19.2 percentage points above mean time on-schedule for reading, and 55.6 percentage points above mean time on-schedule for math for participant one during the use of the visual schedule intervention.

During PE generalization time, on-task data for participant two reflected a decreasing trend (see Figure 2). Mean percent of time on-task for generalization was 77.5% with a range of 75-80% (SD = 3.54) (see Table 4). The mean percent of time on-task during PE generalization was 28.8 percentage points above mean time on-task during writing, 37.5 percentage points above mean time on-task for reading, and 37.5 percentage points above mean time on-schedule for math for participant two during the use of the visual schedule intervention.

During PE generalization time, on-schedule data for participant two reflected a decreasing trend (see Figure 5). Mean percent of time on-schedule for generalization was 80% with a range of 78-82% (SD = 2.83) (see Table 7). The mean percent of time on-schedule during PE generalization was 34.8 percentage points above mean time on-
schedule during writing, 43.5 percentage points above mean time on-schedule for reading, and 44 percentage points above mean time on-schedule for math for participant two during the use of the visual schedule intervention.

During PE generalization time, on-task data for participant three reflected an increasing trend (see Figure 3). Mean percent of time on-task for generalization was 87% with a range of 81-93% (SD = 8.49) (see Table 5). The mean percent of time on-task during PE generalization was 19 percentage points above mean time on-task during writing, 18.9 percentage points above mean time on-schedule for reading, and 2.2 percentage points above mean time on-task for math for participant three during the use of the visual schedule intervention.

During PE generalization time, on-schedule data for participant three reflected an increasing trend (see Figure 6). Mean percent of time on-schedule for generalization was 91% with a range of 88-93% (SD = 3.54) (see Table 8). The mean percent of time on-schedule during PE generalization was 23.2 percentage points above mean time on-schedule during writing, 26.9 percentage points above mean time on-schedule for reading, and 10 percentage points above mean time on-schedule for math for participant three during the use of the visual schedule intervention.

**Research Question 4 Summary**

Use of the visual schedule generalized to the general education PE classroom for all three participants. Mean percent of time on-task for all three participants during generalization was 87% with a range of 75-98%. Mean percent of time on-schedule during generalization for all three participants was 90% with a range of 78-100%. The
visual schedule was effective in generalizing on-task and on-schedule behavior during initial group instruction introducing the learning objective and activity for the day.

**Research Question 5**

Does the use of high-tech visual schedules maintain up to three weeks after intervention criterion is met?

During maintenance for math time, on-task data for participant one reflected an increasing trend (see Figure 1). Mean percent of time on-task for maintenance on math was 88% with a range of 82-94% and standard deviation of 8.49. Mean percent of time on-task increased 43.1 percentage points (i.e., 88 – 44.9) for math three weeks after data collection for the visual schedule intervention in the classroom concluded for participant one (see Table 3).

During maintenance for reading time, on-task data for participant one reflected a decreasing trend (see Figure 1). Mean percent of time on-task for maintenance on reading was 84% with a range of 68-100% and standard deviation of 23. Mean percent of time on-task increased 2.8 percentage points (i.e., 84 – 81.2) for reading three weeks after data collection for the visual schedule intervention in the classroom concluded for participant one (see Table 3).

During maintenance for writing time, on-task data for participant one reflected a decreasing trend (see Figure 1). Mean percent of time on-task for maintenance on writing was 70% with a range of 49-91% and standard deviation of 29.7. Mean percent of time on-task decreased 2.6 percentage points (70 – 72.6) for writing three weeks after data collection for the visual schedule intervention in the classroom concluded for participant one (see Table 3).
During maintenance for math time, on-schedule data for participant one reflected an increasing trend (see Figure 4). Mean percent of time on-schedule for maintenance on math was 88% with a range of 82-94% and standard deviation of 8.49. Mean percent of time on-schedule increased 45.6 percentage points (i.e., 88 – 42.4) for math three weeks after data collection for the visual schedule intervention in the classroom concluded for participant one (see Table 6).

During maintenance for reading time, on-schedule data for participant one reflected a decreasing trend (see Figure 4). Mean percent of time on-schedule for maintenance on reading was 84% with a range of 68-100% and standard deviation of 22.63. Mean percent of time on-schedule increased 5.2 percentage points (i.e., 84 – 78.8) for reading three weeks after data collection for the visual schedule intervention in the classroom concluded for participant one (see Table 6).

During maintenance for writing time, on-schedule data for participant one reflected a decreasing trend (see Figure 4). Mean percent of time on-schedule for maintenance on writing was 68% with a range of 49-87% and standard deviation of 26.87. Mean percent of time on-schedule decreased 4.3 percentage points (i.e., 68 – 72.3) for writing three weeks after data collection for the visual schedule intervention in the classroom concluded for participant one (see Table 6).

During maintenance for math time, on-task data for participant two reflected a decreasing trend (see Figure 2). Mean percent of time on-task for maintenance on math was 79.5% with a range of 73-86% and standard deviation of 9.19. Mean percent of time on-task increased 47.9 percentage points (i.e., 79.5 – 31.6) for math three weeks after
data collection for the visual schedule intervention in the classroom concluded for participant two (see Table 4).

During maintenance for reading time, on-task data for participant two reflected a decreasing trend (see Figure 2). Mean percent of time on-task for maintenance on reading was 33.5% with a range of 31-36% and standard deviation of 3.54. Mean percent of time on-task decreased 6.5 percentage points (i.e., 33.5 – 40) for reading three weeks after data collection for the visual schedule intervention in the classroom concluded for participant two (see Table 4).

During maintenance for writing time, on-task data for participant two reflected a decreasing trend (see Figure 2). Mean percent of time on-task for maintenance on writing was 33% with a range of 27-39% and standard deviation of 8.49. Mean percent of time on-task decreased 15.7 percentage points (i.e., 33 – 48.7) for writing three weeks after data collection for the visual schedule intervention in the classroom concluded for participant two (see Table 4).

During maintenance for math time, on-schedule data for participant two reflected a decreasing trend (see Figure 5). Mean percent of time on-schedule for maintenance on math was 79.5% with a range of 73-86% and standard deviation of 9.19. Mean percent of time on-schedule increased 43.5 percentage points (i.e., 79.5 – 36) for math three weeks after data collection for the visual schedule intervention in the classroom concluded for participant two (see Table 7).

During maintenance for reading time, on-schedule data for participant two reflected a decreasing trend (see Figure 5). Mean percent of time on-schedule for maintenance on reading was 33.5% with a range of 31-36% and standard deviation of
3.54. Mean percent of time on-schedule decreased 3 percentage points (i.e., 33.5 – 36.5) reading three weeks after data collection for the visual schedule intervention in the classroom concluded for participant two (see Table 7).

During maintenance for writing time, on-schedule data for participant two reflected a decreasing trend (see Figure 5). Mean percent of time on-schedule for maintenance on writing was 33.5% with a range of 27-40% and standard deviation of 9.19. Mean percent of time on-schedule decreased 11.7 percentage points (i.e., 33.5 – 45.2) for writing three weeks after data collection for the visual schedule intervention in the classroom concluded for participant two (see Table 7).

During maintenance for math time, on-task data for participant three reflected a decreasing trend (Figure 3). Mean percent of time on-task for maintenance on math was 88.5% with a range of 77-100% and standard deviation of 16.23. Mean percent of time on-task increased 3.7 percentage points (i.e., 88.5 – 84.8) for math three weeks after data collection for the visual schedule intervention in the classroom concluded for participant three (see Table 5).

During maintenance for reading time, on-task data for participant three reflected a decreasing trend (see Figure 3). Mean percent of time on-task for maintenance on reading was 88% with a range of 78-98% and standard deviation of 14.14. Mean percent of time on-task increased 19.9 percentage points (i.e., 88 – 68.1) for reading three weeks after data collection for the visual schedule intervention in the classroom concluded for participant three (see Table 5).

During maintenance for writing time, on-task data for participant three reflected a decreasing trend (see Figure 3). Mean percent of time on-task for maintenance on writing
was 59% with a range of 47-71% and standard deviation of 16.97. Mean percent of time on-task decreased 9 percentage points (i.e., 59 – 68) for writing three weeks after data collection for the visual schedule intervention in the classroom concluded for participant three (see Table 5).

During maintenance for math time, on-schedule data for participant three reflected a decreasing trend (see Figure 6). Mean percent of time on-schedule for maintenance on math was 88.5% with a range of 77-100% and standard deviation of 16.26. Mean percent of time on-schedule increased 8 percentage points (i.e., 88.5 – 80.5) for math three weeks after data collection for the visual schedule intervention in the classroom concluded for participant three (see Table 8).

During maintenance for reading time, on-schedule data for participant three reflected a decreasing trend (see Figure 6). Mean percent of time on-schedule for maintenance on reading was 88% with a range of 78-98% and standard deviation of 14.14. Mean percent of time on-schedule increased 24.4 percentage points (i.e., 88 – 63.6) for reading three weeks after data collection for the visual schedule intervention in the classroom concluded for participant three (see Table 8).

During maintenance for writing time, on-schedule data for participant three reflected a decreasing trend (see Figure 6). Mean percent of time on-schedule for maintenance on writing was 58% with a range of 47-69% and standard deviation of 15.56. Mean percent of time on-schedule decreased 9.3 percentage points (i.e., 58 – 67.3) writing three weeks after data collection for the visual schedule intervention in the classroom concluded for participant three (see Table 8).
Research Question 5 Summary

On-task behaviors maintained for participant one in math and reading, on-task behaviors did not maintain for writing but did stay 61 percentage points above baseline (see Table 3). On-task behaviors maintained for participant two in math, on-task behaviors did not maintain for reading dropping back down to baseline levels but did stay 15 percentage points above baseline for writing (see Table 4). On-task behaviors maintained for participant three in math and reading, on-task behaviors did not maintain for writing but dropped back down to baseline levels (see Table 5).

On-schedule behaviors maintained for participant one in math and reading, on-schedule behaviors did not maintain for writing but did stay 60 percentage points above baseline (see Table 6). On-schedule behaviors maintained for participant two in math, on-schedule behaviors did not maintain for writing and reading but did stay more than 10 percentage points above baseline (see Table 7). On-schedule behaviors maintained for participant three in math and reading, on-schedule behaviors did not maintain for writing but did stay 6 percentage points above baseline (see Table 8).

Research Question 6

Does the use of high-tech visual schedules among elementary students with ASD result in high levels of stakeholder satisfaction?
The Student Progress Evaluation Form (see Appendix D) was given to the teaching staff after data collection was completed. The Student Progress Evaluation Form was used to determine the level of satisfaction the teaching staff had with the intervention. The Student Progress Evaluation Form was used by Massey and Wheeler (2000) to assess stakeholder satisfaction with using visual schedules to increase task engagement for young students with autism. A four-point Likert scale was used: 1 = strongly agree, 2 = agree, 3 = disagree, and 4 = strongly disagree. The teacher, paraprofessional, and general education PE teacher each completed the eight questions on the Student Progress Evaluation Form by marking the number that corresponded with their opinion (see Table 9). All teaching staff indicated a rating of strongly agreed on

Table 9

*Social Validity Frequency Count and Mean Scores*

<table>
<thead>
<tr>
<th>Inquiry</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acceptability to staff</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2. Individuality of visual support</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3. Practicality of implementation</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4. Student enjoyment</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>5. Significant student progress</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>6. Assist student in the future</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>1.3</td>
</tr>
<tr>
<td>7. Measurable improvement in skills</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>1.3</td>
</tr>
<tr>
<td>8. Overall satisfaction with intervention</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

*Note: 1 = strongly agree; 2 = agree; 3 = disagree; 4 = strongly disagree*
questions 1-4 and 8. These items were (1) The educational intervention used in the project was acceptable to you, (2) The design and use of the visual supports for your student were individualized and child-centered based on his/her needs, (3) The visual supports were practical and easy to implement, (4) In your opinion, your student appeared to enjoy the use of the visual support strategies in his/her educational program, and (8) Overall, rate your level of satisfaction with the outcome of this project on behalf of your student. The teaching staff differed in their responses to three questions. Answers ranged from strongly agree to agree for questions 5-7. These items were (5) In your opinion, your student has made significant progress during the intervention, (6) In your opinion, having learned the use of visual support strategies, your student will enjoy increased options and freedoms now and in the future when learning new skills, and (7) Since the introduction of visual support strategies in your student’s educational program, you have witnessed measurable improvement in his/her skills. Overall results of the Student Progress Evaluation Form completed by the teaching staff indicate a high level of satisfaction with the visual schedule intervention.

**Interobserver Agreement**

The student researcher scored all video recorded sessions using a corresponding Task Analysis Data Sheet for the subject and activity to score on-task and on-schedule behaviors (see Appendix B). The research assistant scored 25% of the sessions chosen using a random selection number generator. Interobserver agreement (IOA) levels were determined by taking the number of agreements ÷ (agreements + disagreements) x 100 (Gast, 2010). The IOA for on-task behaviors was 99%, and IOA for off-task behaviors
was 98%. The IOA for on-schedule behaviors was 94%, and IOA for off-schedule behaviors was 95%.

**Treatment Fidelity**

The teacher used a digital video camera to record each session. The video was used to determine treatment fidelity using the Fidelity Checklist (see Appendix C). Treatment fidelity was collected across three areas: (a) set up and preparation, (b) teacher steps, and (c) teacher behaviors. Treatment fidelity areas were awarded points for implementation; 2 for high level, 1 for inconsistent level, or 0 for element absent or not observed. The student researcher scored treatment fidelity on one randomly selected session from each academic subject (reading, writing, and math) daily. The research assistant scored 30% of the selected sessions to determine IOA.

The mean score for treatment fidelity in set up and preparation was 1.9 representing a high level of implementation (see Table 10). The mean score for teacher steps was 1.8 representing a high level of implementation (see Table 11). The mean score Table 10

*Fidelity Checklist Data for Setup and Preparation*

<table>
<thead>
<tr>
<th>Setup/Preparation</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Camera started before group signaled</td>
<td>38</td>
<td>0</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>2. AAC within teacher reach before transition</td>
<td>36</td>
<td>0</td>
<td>4</td>
<td>1.8</td>
</tr>
<tr>
<td>3. Student in group before presented with AAC</td>
<td>38</td>
<td>0</td>
<td>2</td>
<td>1.9</td>
</tr>
</tbody>
</table>

*Note: 2 = high level of implementation; 1 = inconsistent level of implementation; 0 = element absent or not observed*
for teacher behaviors was .9 representing an inconsistent level of implementation (see Table 12). The IOA for treatment fidelity was 100% for set up and preparation, 100% for teacher steps, and 89% for teacher behaviors.

Table 11

*Fidelity Checklist for Data for Teacher Steps*

<table>
<thead>
<tr>
<th>Teacher Steps</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Call students to group</td>
<td>36</td>
<td>0</td>
<td>4</td>
<td>1.8</td>
</tr>
<tr>
<td>2. Transition prompt</td>
<td>37</td>
<td>0</td>
<td>3</td>
<td>1.9</td>
</tr>
<tr>
<td>3. When target students name is called give student</td>
<td>33</td>
<td>3</td>
<td>4</td>
<td>1.7</td>
</tr>
<tr>
<td>AAC device</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Continue dismissing students from group</td>
<td>36</td>
<td>0</td>
<td>4</td>
<td>1.8</td>
</tr>
<tr>
<td>5. Collect AAC device from student when student</td>
<td>38</td>
<td>1</td>
<td>1</td>
<td>1.9</td>
</tr>
</tbody>
</table>

*Note:* 2 = high level of implementation; 1 = inconsistent level of implementation; 0 = element absent or not observed

**Summary of Findings**

Given the variability in the data it cannot be said that there was a functional relationship between the visual schedule intervention on the on-task and on-schedule behaviors across academic subjects for all three participants. Participant one showed improvement in on-task and on-schedule behaviors during writing and participant three showed substantial improvement in on-task and on-schedule behaviors during math. Participant two did not show substantial improvement in on-task or on-schedule behaviors in any subject area.
Table 12

_Fidelity Checklist Data for Teacher Behaviors_

<table>
<thead>
<tr>
<th>Teacher Behaviors</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Teacher presents student with AAC device</td>
<td>38</td>
<td>1</td>
<td>1</td>
<td>1.93</td>
</tr>
<tr>
<td>2. Signals are appropriate to the task</td>
<td>8</td>
<td>23</td>
<td>9</td>
<td>0.98</td>
</tr>
<tr>
<td>3. Teacher allows processing time when appropriate</td>
<td>4</td>
<td>26</td>
<td>10</td>
<td>0.85</td>
</tr>
<tr>
<td>4. Teacher refrains from prompting between steps for at least 15 seconds</td>
<td>6</td>
<td>21</td>
<td>13</td>
<td>0.83</td>
</tr>
<tr>
<td>5. All errors corrected using the least to most prompting strategy</td>
<td>4</td>
<td>22</td>
<td>14</td>
<td>0.75</td>
</tr>
<tr>
<td>6. Teacher ignores inappropriate behaviors</td>
<td>7</td>
<td>13</td>
<td>20</td>
<td>0.70</td>
</tr>
<tr>
<td>7. Reinforce target behaviors on a VI-2 schedule</td>
<td>4</td>
<td>13</td>
<td>23</td>
<td>0.53</td>
</tr>
</tbody>
</table>

_Note:_ 2 = high level of implementation; 1 = inconsistent level of implementation; 0 = element absent or not observed

The visual schedule intervention was effective in decreasing verbal or gestural prompts for two out of three participants (i.e., participants two and three) in reading and math, reducing physical prompts for one participant (i.e., participant one). Given the variability in the data it cannot be said that there was a functional relationship between the visual schedule intervention and the decrease in the number and level of prompts provided to the participants during academic tasks.
Use of the visual schedule generalized to the general education PE classroom for all three participants. Mean time on-task was 87% and mean time on-schedule was 90% for the three participants. The visual schedule intervention was effective in maintaining on-task and on-schedule behavior during initial group instruction introducing the learning objective and activity for the day.

There was also variability in the maintenance of on-task and on-schedule behaviors for all three participants. On-schedule and on-task behaviors maintained for participant one in math and reading, dropped for writing but stayed 60 percentage points above baseline levels for both on-schedule and on-task. On-schedule and on-task behaviors maintained for participant two in math but dropped back down near baseline for reading and writing. On-schedule and on-task behaviors maintained for participant three in math and reading but dropped back to baseline levels in writing. Again the variability in the data do not indicate a functional relationship between the visual schedule treatment and on-task and on-schedule behaviors.

Overall results of the Student Progress Evaluation Form completed by the teaching staff indicate a high level of satisfaction with the visual schedule intervention. The teaching staff strongly agreed that the intervention was acceptable, individualized and child-centered based on student needs, practical and easy to implement, enjoyed by the students, and resulted in satisfactory student outcomes. Teaching staff satisfaction was evident with the ongoing use of the visual schedule intervention after data collection for the research study concluded.
CHAPTER 5
DISCUSSION

Young children with autism are often educated in restrictive environments (i.e., self-contained classrooms) instead of in general education classrooms because of their inability to regulate their on-schedule and on-task behaviors (Hodgdon, 1995; Quill, 1995). Visual schedules have been used successfully to help students with ASD complete tasks and self-regulate their behaviors (Bryan & Gast, 2000; Cihak, Wright & Ayers, 2010; Dooley, Wilczenski & Torem, 2001; Hodgdon, 1995; Hume & Odom, 2007; MacDuff et al., 1993; Massey & Wheeler, 2000; Mesibov & Shae, 1996; Morrison et al., 2002; NRC, 2001; O’Reilly, Sigafoos et al., 2005; Quill, 1997; Schmit et al., 2000). When used in a low-tech format, visual schedules are considered as evidence-based treatments for students with ASD (NAC, 2009). This study was conducted to extend the research on evidence-based practices by using mobile devices to deliver high-tech visual schedules to assist young students with ASD with on-task and on-schedule behaviors. The findings related to the research questions are discussed in the next section of this chapter. Then, conclusions derived from the findings are reviewed. Finally, practical implications of the study are reviewed and recommendations for future research are offered.

Research Discussion

The purpose of this study was to determine whether high-tech visual schedules increase the self-regulation and transition behaviors of young students with ASD. A review of the outcomes of the study is discussed question by question along with
explanations for results that conflict with previous studies. Limitations related to the findings are also addressed.

**Research Question 1**

Does the use of high-tech visual schedules increase the on-task behavior of elementary students with ASD across academic subject areas?

Given the variability in the data it cannot be said that there was a functional relationship between the intervention and on-task behaviors across academic subjects for the participants. Although results for participants one and three showed substantial improvement in at least one academic task there was not sufficient evidence across other academic areas to pinpoint the visual schedule treatment as the cause. The results differed from those of Bryan and Gast (2000) in that all four of their participants had a significant increase in time on-task once the use of the visual schedule had been taught through a graduated guidance procedure. Although the current study was modeled after the procedures used by Bryan and Gast with two major differences, the materials used and the research design.

The materials used in the Bryan and Gast (2000) study were file folder games, puzzles, handwriting worksheets, and books on tape. These materials may have been easier for the participants in their study to complete as compared to the complicated learning materials used in the current study. Two of the three reading materials used most by the students in the current study had writing components that were added by the classroom teacher. The writing components required the students to choose a word, use it in a sentence, and then write it in their journals. On 34 occasions, the activity for the participants timed out while they were on the step in their schedule that required writing
one or more sentences. In other words, the participants were unable to complete their reading center schedule steps within the 15-minute intervention period, and it appeared as though the addition of a writing component within the reading center added a level of complexity that prevented participants from being consistently on-task. Moreover, it appeared that the participants had not mastered use of the academic materials as previously implied by the teaching staff. This may have contributed to the variability in participant on-task performance as well.

Another plausible explanation for the difference in outcomes between the Bryan and Gast (2000) study and the current study is the difference in designs used. Bryan and Gast used a withdrawal design to measure on-task behaviors. The materials the students used were randomly chosen from different academic centers. The research design used in the current study was a multiple baseline across academic subjects that were likely more difficult than the tasks used in the Bryan and Gast study. It is more difficult for participants to stay on task when tasks are challenging and/or non-preferred. Another factor that may have influenced students’ on-task behaviors was periodic interruptions due to upcoming standardized testing and 3 year IEP reviews. The participants were required to deviate from their typical class routines to prepare for the state mandated testing and the IEP reviews. Thus, the study had to be shortened. It is possible that on-task behavior would have been higher if the study was allowed to continue until data stabilization was reached.

**Research Question 2**

Does the use of high-tech visual schedules increase the on-schedule behavior of elementary students with ASD across academic subject areas?
Given the variability in the data it cannot be said that there was a functional relationship between the intervention and on-schedule behaviors across academic subjects for the participants. Although results for participants one and three showed substantial improvement in at least one academic task, there was not sufficient evidence across other academic areas to pinpoint the visual schedule treatment as the cause. The results differed from those of Bryan and Gast (2000) in that all four participants had a significant increase in time on-schedule once the use of the visual schedule had been taught through a graduated guidance procedure. Although the current study was modeled after the procedures used by Bryan and Gast there were two major differences: the materials used and the research design.

The materials used in the Bryan and Gast (2000) study were file folder games, puzzles, handwriting worksheets, and books on tape. As noted in previous discussion related to research question one, these materials used in Bryan and Gast may have been easier for the participants to complete than the complicated learning materials used in the current study. The same variables noted previously (i.e., writing component added to the reading center tasks in the current study, lack of mastery related to the materials being used in the current study, difference in types of designs used in the two studies) may have influenced the on-schedule outcomes of the participants.

**Research Question 3**

Does the use of high-tech visual schedules decrease the number of prompts that teachers provide to maintain on-task and on-schedule behaviors?

Results of the current study indicate that the visual schedule intervention was effective in decreasing verbal or gestural prompts and hand-over-hand prompts in reading.
for two participants. Prompting was not decreased across all levels and participants as in the Bryan and Gast (2000) study. Low levels of prompting in baseline across participants can be attributed to teaching staff behaviors (see Table 12). During the initial in-vivo observations (see Table 2) students were selected because of high levels of off-task behaviors as well as high levels of adult prompting. After the second in-vivo observation, the teacher told the researcher that she was very nervous because she was afraid the research may be judging her teaching skills. There has been a fair amount of tension within the participating school district surrounding appropriate measures to evaluate teachers and their effectiveness based on student performance. This seems to be especially true for special education teachers who are concerned that their evaluations will be based on the performance of their students which is likely to be lower than the performance of students without disabilities.

Although not directly measured in this study, teacher fears and anxiety about being watched or videotaped may have a negative impact on their ability to perform. The teacher behaviors in the current study were inconsistent related to the levels and numbers of prompts used during data collection. During the initial in-vivo observation periods the ratio of prompts to on-task behaviors appeared to be consistent with keeping participants on-task during independent academic work (see Table 2). Once the data collection began for baseline a video camera was used and the researcher was no longer present in the classroom. The recordings revealed that the teacher spent more time at her desk and less time attending to student off-task and off-schedule behaviors than when the researcher was physically present (see Table 12).
Inconsistencies in teacher behaviors for using a least to most prompting strategy, ignoring inappropriate participant behaviors, and reinforcing on-task and on-schedule behaviors on a VI-2 schedule may have directly impacted the results of the study (see Table 12). In several different studies, researchers have made a point to discuss the importance of the teacher prompting strategy, ignoring undesired behaviors, and the reinforcement of desired behaviors when using a visual schedule for complex behaviors such as academic tasks (Bryan & Gast, 2000; MacDuff et al., 1993). In both studies the classroom teacher also served as the primary researcher and had a vested interest in the success of the study. As the primary researchers these teachers may have had a better knowledge base of how to effectively use a least to most prompting strategy, ignore unwanted behaviors, and reinforce targeted behaviors. In the current study the teacher did not have a vested interest in implementing the treatment with fidelity. Instead she may have been more concerned about the potential for disruptive inappropriate student behaviors (e.g., acting out, tantrums) that would reflect on her teacher performance evaluation.

**Research Question 4**

Does the use of high-tech visual schedules generalize to the general education classroom setting?

The visual schedule generalized to the general education PE classroom for all three participants. The adaptive PE teacher commented on the success of the schedule. Specifically, she told the researcher she was amazed at the improved behavior the students exhibited when using their iPods. It should be noted, however, that the schedule was not used for an academic task but instead for a set of classroom behavioral...
expectations. This was quite different than the academic tasks used in the special education classroom. The schedule for PE used the same number of steps but those steps contained behavior components (i.e., line up, sit in line nine, look at the teacher) instead of academic components (i.e., choose a word, write it in a sentence, read the word). The first and last steps in the schedule were identical in that the participants were required to use their visual schedule and put away their iPod touch upon completion of activity. The remaining seven steps were all behavioral actions (i.e., walk in the hall, calm body, sit on the floor). The results are similar to the conclusions drawn by Mavropoulou et al. (2011) that visual supports may provide participants with the information necessary to complete tasks correctly, and that this additional support may be better than only providing information verbally.

The PE location for generalization was selected because the PE teacher was the only general education teacher willing to participate in the study and conduct the generalization procedures. The behavioral expectations for the participants were outlined in the PE schedule; therefore, this may have been the cause of the improved on-task and on-schedule behavior in the general education setting as compared to on-task and on-schedule behaviors in the self-contained classroom. A different setting requiring students to perform an academic task would have resulted in a more functionally equivalent comparison between the special education setting and the general education setting.

**Research Question 5**

Does the use of high-tech visual schedules maintain up to three weeks after intervention criterion is met?
All three participants maintained levels above baseline in at least two academic tasks. This was a surprising outcome because the participants had not been consistently using their visual schedules across the three academic tasks (reading, writing, and math) for two and three weeks. Additionally, the participants were being pulled from reading, writing, and math practice to prepare for state mandated testing and to be assessed for 3 year IEP reviews. Thus, they didn’t even have the benefit of continuous academic instruction. These results are consistent with the conclusions drawn by Mavaropoulou et al. (2011) that some participants with ASD may benefit from visually supported strategies whereas some participants may be non-responders and positive results may be the result of participants receiving supports in addition to verbal information only. The maintenance of the visual schedule intervention in only two of three academic tasks for the participants may indicate a need for additional support in the non-maintained academic tasks.

**Research Question 6**

Does the use of high-tech visual schedules among elementary students with ASD result in high levels of stakeholder satisfaction?

Results from the Student Progress Evaluation Form (see Appendix D) indicate high levels of stakeholder satisfaction. This high social validity is consistent with the findings of Cihak et al. (2010) when using mobile devices to deliver visual supports. At the conclusion of the last maintenance probe the special education teacher asked the researcher to create visual schedules for materials the students had not used before. This indicated that she wanted to continue using visual schedules with the iPods. The researcher spent 45 minutes with the teacher demonstrating how to use one device to
create multiple schedules, upload those schedules and then to a folder in iTunes for transfer to other devices. It was also explained to the teacher how she could use her personal iPhone® to create schedules over summer break to prepare for the upcoming school year. The teacher expressed concerns about the students not bringing their iPods back at the beginning of the next school year. It was suggested to the teacher that she speak to the participant’s parents about keeping the iPods for use during the extended school year; thus, she would be able to maintain control over the use and contents of the devices. If the parents were not in agreement, the teacher had the option to write a classroom grant through various education foundations, use some of her classroom budget to purchase new devices, or make a request to borrow devices from one of the school district’s special education departments.

Although participant satisfaction was not measured, the participants thanked the researcher when she visited their classroom for giving them an iPod. Participant one would touch the iPod screen and say “listen, that’s you” each time the researcher visited the classroom. The assistant researcher also commented that the participants seemed to enjoy using their devices and mentioned to the primary researcher how amusing it was when the participants would speak to their iPods saying “Yes, Ms. Nelson” after hearing a verbal direction in their schedule.

The last visit the researcher made to the classroom the teacher shared with her several visual schedules she had created for reading and writing tasks. She stated that she had used the visual schedules with younger students with ASD who had been visiting her class to prepare for the upcoming school year when they would become her students. She also stated that the study participants became concerned that they were not going to get
their iPod back when they saw another student using “their iPod”. The development of new visual schedules, consideration of the devices in long range planning, and extended uses of the high-tech visual schedules are indicators of high levels of stakeholder satisfaction.

Conclusions

Conclusions that can be drawn based on the results from this study are:

1. Stimulus control can be transferred from teacher to visual schedule delivered via mobile device for elementary students with autism.

2. Teachers can use task analysis to develop a visual schedule for academic materials.

3. The delivery of visual schedules via a mobile device results in high levels of stakeholder satisfaction.

4. Elementary students with autism appear to enjoy using visual schedules delivered via mobile devices to manage academic tasks.

5. Elementary students with autism are able to use mobile technology to read and follow visual schedules.

6. Based on data variability, there was no functional relationship demonstrated between the use of iPod visual schedules for math, reading, and writing and the on-task and on-schedule behaviors of young children with ASD.

7. Based on the inconsistencies in data between in-vivo observations, baseline and intervention, there was no functional relationship demonstrated between the use of the iPod visual schedule and teaching staff prompts.
8. On-task and on-schedule behaviors maintain up to three weeks with the use of a visual schedule delivered via mobile technology in some academic tasks.

9. Elementary students with autism are able to generalize the use of a visual schedule delivered via mobile technology to follow behavioral expectations in the general education PE classroom.

**Practical Implications**

Several practical implications surfaced during the study. First, when conducting research in the educational setting, the researcher needs to assess mastery of prerequisite academic tasks. While collecting data, it was noted on several occasions that the students were using the learning materials for the first time. Statements made by the participants lead the researcher to assume that the teacher was using the visual schedule intervention to teach new learning materials to the participants during the study. While this was not the purpose of the research it became evident that using visual schedules to teach new academic materials to young students with ASD was not effective.

A second practical implication involves the ease at which the participants learned how to manipulate the iPod touch mobile devices. Participants were able to look at a list of academic activities posted on the white board and then find the corresponding visual schedule using their mobile device. While this was not the purpose of the research it was apparent that layering visual schedules to assist young student with ASD in completing a list of academic tasks is possible and easy for students to understand.

**Recommendations for Future Research**

Recommendations for future research that emerged from this study are:
1. Research should be conducted on using a visual schedule delivered via a mobile device for self-regulation during non-academic tasks in the general education environment. Possible tasks include but are not limited to physical education, lunch or nutrition breaks, school assemblies, bus transportation to and from school, and recess.

2. Research should be conducted on using a visual schedule delivered via a mobile device for providing procedural information during daily academic routines to young students with ASD. Such information should provide the student with information about what task is to be completed, how much time is allowed for task completion, what to do with the task once it is completed, and what task to start next.

3. Research should be conducted on training teaching staff of young students with ASD in using graduated guidance to teach new academic skills. Teacher training should include but not be limited to least-to-most prompting procedures, error correction, and prompt fading to promote independence.

4. A true replication of Bryan and Gast (2000) should be conducted using a high-tech visual schedule delivered via a mobile device. In their research Bryan and Gast did not differentiate between academic tasks and instead used a withdrawal design. This eliminates the problems that arise when students are required to work on academic tasks that are potentially not equivalent related to level of difficulty and level of task preference.

5. If results from a high-tech replication of Bryan and Gast (2000) are positive, then an alternating treatment design should be used to compare the effectiveness of high-tech and low-tech visual schedules.
Appendix A

UNLV
PARENT PERMISSION FORM
Educational & Clinical Studies

TITLE OF STUDY: Effect of High-Tech Visual Schedules on Young Children with Autism
CONTACT PHONE NUMBER: Susan Miller, Ph.D., at 702-895-1108, or Leslie Nelson, at 702-630-8933.

Purpose of the Study
Your child is invited to participate in a research study. The purpose of this study is to determine the
effect on using high-tech visual schedules on time-on-schedule and time-on-task for young children
with autism.

Participants
Your child is being asked to participate in the study because he/she currently is enrolled in a self-
contained autism class.

Procedures
If you allow your child to volunteer to participate in this study, a researcher will observe your child in
his/her classroom for a total of 135 minutes to determine the percentage of time that he/she is on task
and following the steps needed to complete academic tasks related to reading, writing, and math. If
your child is on task less than 50% of the observation time, he/she will be eligible to participate in the
study. If your child is eligible to participate in the study, he/she will be taught to use a visual schedule
delivered using an iPod Touch to complete academic tasks (math, reading, and writing) that are
assigned as a part of the normal school day. A visual schedule is a list of steps that need to be followed
to successfully complete a specific assignment. Your child’s visual schedules will include photos,
written directions, and verbal directions to remind him or her of the steps that need to be completed in
reading, writing, and math tasks. Currently, your child’s teacher uses verbal prompts without the use of
any visual schedule, but she is interested in providing this extra support (i.e., visual schedules
displayed via iPod technology) to your child.

You child will be videotaped as he uses the visual schedules at three different academic centers (math,
reading, and writing) within his classroom. The video recorder will be placed in an inconspicuous
location in the classroom to reduce the likelihood of student distraction. The video will only be viewed
by the researchers to determine that teacher directions were accurate and to determine whether or not
the visual schedule benefited your child.

Participant Initials _____

Approved by the UNLV IRB. Protocol #1209-4258M
Received: 10-01-12 Approved: 10-02-12Expiration: 10-01-13
**Title of Study:** Effect of High-Tech Visual Schedules on Young Children with Autism

**Benefits of Participation**
There *may* be direct benefits to your child as a participant in this study. We hope to learn if your child and other young children with autism will be able to use a visual schedule delivered using an iPod Touch to increase his/her independence during academic tasks in school. This will likely help your child complete his academic tasks without as many teacher prompts.

**Risks of Participation**
There are risks involved in all research studies. This study may include only minimal risks. *It is possible your child may experience minimal stress when first learning how to use the visual schedule and/or might feel slightly embarrassed if he/she pushes the wrong icon.*

**Cost / Compensation**
There *will not* be financial cost to you to participate in this study. The study will take none of your child’s time as the visual schedule will be provided as a part of daily academic routines. The study will be completed within 8 weeks. Your child will be videotaped during three academic tasks (math, reading, and writing) for no more that 45 minutes per day. Your child *will not* be compensated for their time, however they will be able to keep the iPod that was used for their visual schedule after the study is completed. If your child is unable to complete the study or withdraws from the study they will return the iPod because it will be needed for a new student participant.

**Contact Information**
If you or your child have any questions or concerns about the study, you may contact Susan Miller, Ph.D. at 702-895-1108. For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794, or via email at IRB@unlv.edu.

**Voluntary Participation**
Your child’s participation in this study is voluntary. Your child may refuse to participate in this study or in any part of this study. Your child may withdraw at any time without prejudice to your relations with the university. You or your child is encouraged to ask questions about this study at the beginning or any time during the research study.

**Confidentiality**
All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link your child to this study. All records will be stored in a locked facility at UNLV for 3 years after completion of the study. After the storage time the information gathered will be destroyed.

Participant Initials _____

Approved by the UNLV IRB. Protocol #1209-4258M
Received: 10-01-12 Approved: 10-02-12 Expiration: 10-01-13
TITLE OF STUDY: Effect of High-Tech Visual Schedules on Young Children with Autism

Participant Consent:
I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

_________________________  __________________________
Signature of Parent        Child’s Name (Please print)

_________________________  __________________________
Parent Name (Please Print)  Date

Approved by the UNLV IRB. Protocol #1209-4258M
Received: 10-01-12 Approved: 10-02-12 Expiration: 10-01-13

Participant Initials _____
### Task Analysis Data Sheet

<table>
<thead>
<tr>
<th>Observer</th>
<th>Subject</th>
<th>Activity</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Steps

<table>
<thead>
<tr>
<th>Steps</th>
<th>Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1 -</td>
<td></td>
</tr>
<tr>
<td>2 -</td>
<td></td>
</tr>
<tr>
<td>3 -</td>
<td></td>
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<tr>
<td>4 -</td>
<td></td>
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<tr>
<td>5 -</td>
<td></td>
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<tr>
<td>6 -</td>
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<tr>
<td>7 -</td>
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<td>8 -</td>
<td></td>
</tr>
<tr>
<td>9 -</td>
<td></td>
</tr>
<tr>
<td>10 -</td>
<td></td>
</tr>
</tbody>
</table>

### Prompts

### Code:

- **OS** = on-schedule
- **FS** = off-schedule
- **OT** = on-task with scheduled materials
- **OTN** = on-task with non-scheduled materials
- **FT** = off-task
- **V** = verbal or gestural
- **P** = physical
- **H** = hand-over-hand
Appendix C

Fidelity Checklist

Name of Observer: ____________________ Date: ____________________

Start Time (clock time): ___________  Stop Time (clock Time): _______

Code: 2-points: High level of implementation

1-point: Inconsistent level of implementation

0-points: Element absent or not observed

<table>
<thead>
<tr>
<th>Area</th>
<th>Level of Implementation</th>
<th>Comments/ Things to work on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera started before group signaled</td>
<td>2 1 0</td>
<td></td>
</tr>
<tr>
<td>AAC within teacher reach before transition</td>
<td>2 1 0</td>
<td></td>
</tr>
<tr>
<td>Student in group before presented with AAC</td>
<td>2 1 0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEACHER STEPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call students to group</td>
</tr>
<tr>
<td>Transition prompt</td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>When target students name is called give student AAC device</td>
</tr>
<tr>
<td>Continue dismissing students from group</td>
</tr>
<tr>
<td>Collect AAC device from student when student indicates work is completed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEACHER BEHAVIORS</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher presents student with AAC device</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Signals are appropriate to the task</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Teacher allows processing time when appropriate</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Teacher refrains from prompting between steps for at least 15 seconds</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>All errors corrected using the least to most prompting strategy</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Task</td>
<td>Frequency</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>Teacher ignores inappropriate behaviors</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Reinforce target behaviors on VI-2 schedule</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Appendix D

Student's Progress Evaluation Form (Massey & Wheeler, 2000)

Key:

4 - Strongly disagree
3 - Disagree
2 - Agree
1 - Strongly agree

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The educational intervention used in the project was acceptable to you.</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2. The design and use of visual supports for your student were individualized and child-centered based on his/her needs.</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3. The visual supports were practical and easy to implement.</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4. In your opinion, your student appeared to enjoy the use of visual support strategies in his/her educational program.</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>5. In your opinion, your student has made significant progress during the intervention.</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>6. In your opinion, having learned the use of visual support strategies, your student will enjoy increased options and freedoms now and in the future when learning new skills</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>7. Since the introduction of visual support strategies in your student’s educational program, you have witnessed measurable improvement in his/her skills.</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8. Overall, rate your level of satisfaction with the outcome of this project on behalf of your student.</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
Appendix E

Task Analysis Data Sheet Math

Observer__________________ Subject Math Activity Money Matching Set Date____

<table>
<thead>
<tr>
<th>Participant</th>
<th>20 s DV Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps</td>
<td>0 2 3 4 5 6 7 8 9 0 1 2</td>
</tr>
<tr>
<td>1 – Get the Money Matching Activity and use your math schedule.</td>
<td></td>
</tr>
<tr>
<td>2 – Find all the pictures of money and lay them out.</td>
<td></td>
</tr>
<tr>
<td>3 – Sort the cards by type, cent, dollar, words.</td>
<td></td>
</tr>
<tr>
<td>4 – Match the word cards to the money.</td>
<td></td>
</tr>
<tr>
<td>5 – Match the $ cards to the money.</td>
<td></td>
</tr>
<tr>
<td>6 – Match the ¢ cards to the money.</td>
<td></td>
</tr>
<tr>
<td>7 – Point to each card, check your work.</td>
<td></td>
</tr>
<tr>
<td>8 – Put away the Money Matching.</td>
<td></td>
</tr>
<tr>
<td>9 – Put your iTouch in the basket then start next activity on your list.</td>
<td></td>
</tr>
</tbody>
</table>

Video Start _______End Time_____. Prompts

Code:

OS = on-schedule    FS = off-schedule
OT = on-task with scheduled materials    OTN = on-task with non-scheduled materials
FT = off-task
V = verbal or gestural    P = physical    H —= hand-over-hand
## Appendix F

**Task Analysis Data Sheet Reading**

<table>
<thead>
<tr>
<th></th>
<th>Observer</th>
<th>Subject</th>
<th>Reading</th>
<th>Activity</th>
<th>Roll &amp; Read</th>
<th>Date</th>
</tr>
</thead>
</table>

### Participant

<table>
<thead>
<tr>
<th>Steps</th>
<th>0</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Get Roll &amp; Read and use your schedule.</td>
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<tr>
<td>2 – Put dice in cup.</td>
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<tr>
<td>3 – Choose 3 cards.</td>
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<tr>
<td>4 – Do the first card in 3 minutes.</td>
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<tr>
<td>5 - Do the second card in 3 minutes.</td>
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<tr>
<td>6 - Do the last card in 3 minutes.</td>
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<tr>
<td>7 – Erase cards.</td>
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</tr>
<tr>
<td>8 – Put away Roll &amp; Read.</td>
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<td></td>
</tr>
<tr>
<td>9 – Put your iTouch in the basket then start next activity on your list.</td>
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</tr>
</tbody>
</table>

**Video Start ______ End Time______ .**

**Prompts**

**Code:**

- OS = on-schedule
- FS = off-schedule
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- FT = off-task
- V = verbal or gestural
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- H = hand-over-hand
### Appendix G

#### Task Analysis Data Sheet Writing

<table>
<thead>
<tr>
<th>Participant</th>
<th>20 s DV Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steps</td>
<td>0 2 3 4 5 6 7 8 9 0 1 2</td>
</tr>
</tbody>
</table>

1. Get the Sentence Builder and use your writing schedule.
2. Pick a sentence with 2 or 3 spaces.
3. Choose cards that match the spaces.
4. Read your sentence.
5. Does your sentence make sense?
6. Write your sentence in your notebook.
7. Make 2 more sentences to write.
8. Put away Sentence Builder.
9. Put your iTouch in the basket then start next activity on your list.

**Video Start ______ End Time _______.**

**Prompts**

**Code:**

- OS = on-schedule  
  - FS = off-schedule
- OT = on-task with scheduled materials  
  - OTN = on-task with non-scheduled materials
- FT = off-task
- V = verbal or gestural  
  - P = physical  
  - H = hand-over-hand
Appendix H

Data Collection Key

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Prompt</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS = on-schedule</td>
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<td></td>
</tr>
<tr>
<td>FT = off-task</td>
<td></td>
</tr>
</tbody>
</table>

- Reinforcing statements will be provided to the students for on-task and on-schedule behaviors on a variable interval 2-minute schedule (VI-2).
- The length of each session (academic task) will not exceed 15 minutes – if time goes over score remaining steps as FS (off-schedule)
- Observers will use the clock on their video viewer (i.e., Windows Media Player, QuickTime) to pause the video every 20 seconds to record behavior data, this will ensure that data is collected every 20 seconds. Prompting data will be scored continuously.

**On-schedule** will be scored if each step in the task analysis was completed: (a) acceptance of the visual schedule (for baseline following verbal direction was scored), (b) movements to the designated center; (c) beginning of step 1 of the task analysis within two consecutive time samples (data will be collected using a 20 second time sample procedure), (d) beginning of steps 2 through 9 within two consecutive time samples of completing the previous step, and (e) returning the visual schedule and completed assignment to the teacher for reinforcement.

**Off-schedule** will be scored if the student does not complete the step they are working on correctly or does not begin the next step within 2 consecutive time samples of completing the previous step.

**On-task with scheduled materials** will be scored if the student is: (a) looking at materials for the assigned task; (b) looking at their visual schedule, (c) using the materials appropriately for the assigned task, and (d) in transition with the completed materials and visual schedule to the teacher.

**On-task with non-scheduled materials** will be scored if the student is: (a) not following their visual schedule but working appropriately with other work materials, (b) looking through their picture activity schedule, (c) using any work materials appropriately, or (d) in transition from one activity to another without turning in their completed assignment and visual schedule to the teacher.

**Off-task** will be scored if the student is (a) using the materials inappropriately, (b) manipulating but not visually attending to the task (engaging in self-stimulatory behavior), (c) exhibiting inappropriate behavior (tantrums or refusal behaviors), or (d) not working or using any of the materials for the assigned task.
References


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http://autismpdc.fpg.unc.edu/content/evidence-based-practices


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Professional Presentations:
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Wikis in the Early Childhood Classroom: Implementing Digital Journaling

Tiered Reading Lesson Plans: Planning for Effective Tier I Literacy Instruction
presented at International Conference of Learning Disabilities on October 9, 2010.

Words on Wikis: WOW! presented at Conference of Nevada Association for the Education of Young Children on April 17, 2010.

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