DISSERTATION

EFFECTS OF INTERACTIVE WHITEBOARD TECHNOLOGY ON THE ACHIEVEMENT AND ENGAGEMENT OF ELEMENTARY-AGED STUDENTS WITH HIGH-FUNCTIONING AUTISM SPECTRUM DISORDER IN THE CONTENT OF READING

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ABSTRACT

EFFECTS OF INTERACTIVE WHITEBOARD TECHNOLOGY ON THE ACHIEVEMENT AND ENGAGEMENT OF ELEMENTARY-AGED STUDENTS WITH HIGH-FUNCTIONING AUTISM SPECTRUM DISORDER IN THE CONTENT OF READING

This dissertation examined the effects of interactive whiteboards (IWB) during reading instruction on student engagement and achievement with three elementary-aged students with identified Autism Spectrum Disorder (ASD). To date, the majority of the literature references regular classroom instruction and not special populations. A quantitative-dominant mixed methods approach was implemented. It included experimental methods to collect achievement and engagement data, and a post-study interview to get a more in-depth understanding of the research. The same participants were used in both the quantitative and qualitative phases. The experimental phase consisted of two methods of delivery of the same reading intervention-traditional paper materials and on an IWB alternated in an A-B-A-B design. During the traditional delivery, students received books and corresponding worksheets in paper form. During the IWB condition, each student read the books and completed corresponding worksheets on the IWB. For the purpose of the study, data were collected on achievement and engagement of these three students. The percent of questions answered correctly answered on bi-weekly comprehension quizzes and word fluency was measured for student achievement. The frequency of joint attention (JA) behaviors was measured for student engagement. The second phase served a supporting qualitative component. At the conclusion of the experimental phase, structured interviews were conducted individually with each participant to examine the perceptions of the students on integration of the IWB into reading instruction.

This study examined between and within-phase patterns of achievement and engagement for each student. It included descriptive statistics of the data, visual analysis with line graphs that displayed data phase-by-phase, and statistical analysis. In total, no noticeable differences or statistical significance was found in achievement or engagement between the two methods of intervention for the students with ASD. While a few correlations were found, they were only found in one variable in each category of achievement and engagement. All three participants did not have correlations for both of the two measurable variables for achievement. Also, all three participants did not have correlations for more than one of the four measured variables for engagement. Students expressed both positive and negative aspects of both conditions; however, a preference was given to the IWB. Suggestions for further research are incorporated as part of the study results.

This dissertation may impact financial decisions related to purchasing technology for school administrators for their buildings. As demand for the use of technology in educational settings increase, along with the need for evidence-based interventions for students with ASD, administrators are faced with making decisions regarding the type of technology, the impact of technology, and the cost/benefits of particular technologies within school settings.

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DEDICATION

This dissertation is dedicated to all of the students with Autism Spectrum Disorder who graced my classroom over the years. Each student truly inspired me to better understand his or her own world and to inquire into different ways to aid each individual to achieve academically and within society.

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CHAPTER 1: INTRODUCTION

The context of education is in a time of unprecedented change. Elementary classroom teachers are faced with the daunting task of teaching classrooms of twenty to thirty students, each with his or her own learning styles, interests, backgrounds, and abilities. These classrooms continue to become even more diverse with the push of inclusion of students with disabilities. Specifically, with the increased number of students with Autism Spectrum Disorder (ASD) included in general education classrooms, some teachers are finding themselves unprepared to meet the unique needs of these students (Brown, Oram-Cardy, & Johnson, 2013). Teachers are expected to design lessons that are accessible to all students, acknowledge students' diversities, and provide optimal learning to diverse groups of learners. Due to the current circumstances, it is imperative that educators adopt teaching and instructional pedagogies that are proven to enhance learning, motivation, and achievement for each learner. Differentiated instruction is good practice (Kluth & Danaher, 2010; Landrum & McDuffie, 2010), and in the United States, it is a matter of law in special education.

Special Education Law

Several segments of federal law refer to students with disabilities' right to equal access to education opportunities and also support inclusive practices. Section 504 of the Rehabilitation Act of 1973 protects the rights of people with disabilities in federally funded programs and facilities including schools. The Americans with Disabilities Act (1990) has similar provisions.

Currently, the most influential federal law is the Individuals with Disabilities Education Act (IDEA), which assures the rights of students with disabilities. It was enacted in 1990, reauthorized in 1997, and again in 2004 and 2007. It was written to protect the rights of students with disabilities by guaranteeing a free appropriate public education (FAPE), regardless of students' abilities. The law states that children must be educated in the least restrictive environment (LRE) with whatever supplementary aids and services are needed, so that they have access to and benefit from the general education curriculum.

Lastly, the No Child Left Behind Act of 2001 had implications for students with disabilities because it included them in achievement accountability. This law required school districts to incorporate technology at both the administrative and instructional levels. The act mandated a national technology plan based on current and future needs of the nation's schools in utilizing technology to provide all students the opportunity to meet rigorous academic standards. In addition to federal mandates, state technology standards emphasized the importance of having educators embed educational technology within their instruction.

These laws acknowledge the rights of all learners to have a high-quality, standards-based education (Mundy, Delgado, Block, Venezia, Hogan, & Seibert, 2003). The laws do not support separate educational agendas for students with disabilities or with diverse needs. They hold educators, schools, districts, and states responsible for assuring that students show progress toward the same learning standards as their peers without disabilities and that teachers are implementing evidence-based practices for all students (Mundy et al., 2003). Kameenui and Simmons (1999) said:

> To meet the goal of equal access to the curriculum for everyone, to enable each student to engage with his or her lessons in a meaningful way, teachers must be prepared to provide useful alternatives in terms of both curricular materials and instructional delivery. (p. 8)

Technology and Universal Design in the Classroom

Appropriate technology may be a vehicle to help schools be responsive and accountable to the diverse needs of their students. Technology is at the center of almost every aspect of our lives and has transformed many systems by making them more efficient, organized and creative. Computers allow analysis of significant amounts of data; furthermore, the ability to communicate with others around the world can be done through the computer. The Internet has given access to information once only retrievable by visiting a library. In many ways, technology and computers make life easier. The educational system is no exception, and technology continues to transform the daily educational experience for students and educators. According to Knight, McKissick, & Saunders (2013), “IPads, iPods, iPhones, and Smartboards are becoming standard instructional tools in classrooms across the country” (p. 2,646).

Many students come to school digitally skilled and experienced. They have spent most of their lives exposed to digital tools and toys. As a result, students are starting to think and process information differently, and schools have to keep up with these changes. Available technologies used in the educational context continue to increase and may include: computers, laptops, cell phones, IPads, clickers, projectors, portable media players, digital cameras, and interactive whiteboards.

According to Gillman (1989), “Educational technology . . . has the power to enhance the instructional program, to improve student academic performance, and to provide effective and efficient classroom, school, and administrative systems” (p. 16). Technology cannot address all of the needs of learners in an inclusive environment, but it can provide for new and innovative ways to teach. Wood (2001) said, “Advances in educational technology have given teachers a new set of tools to add to their repertoire, so that every classroom can be a place where every kid

CAN!" (p. 1). Technology does not need to be specifically designed for students with disabilities (e. g., assistive technology) in order for them to benefit. The concept of universal design for learning UDL) suggests technology should be flexible enough that many students can use it for many different purposes (Coyne, Pisha, Dalton, Zeph, & Smith, 2012; Stockall, Dennis, & Miller, 2012; Wood, 2001).

The Center for Applied Special Technology (2007), a nonprofit research and development organization that empathizes expanding learning opportunities for all individuals, describes UDL as a research-based outline for designing educational-related products and resources that maximize the learning of all students. Applying UDL concepts to all components of instruction, including delivery methods, physical environment, information resources, technology, personal interactions, and assessments, allows access for all students to gain access.

UDL began with the architectural movement for universal design (Stockall et al., 2012), Universal design promoted designing structures and products that could be used equally by everyone, whether or not they had disabilities or limitations. Designing products and resources from the framework of universal design allows them to be usable by all individuals to the greatest degree possible, without the requirement of a variant or alternative design (Stockall et al., 2012; Story, Mueller, & Mace, 1998). The Center for Applied Special Technology (2007) listed the three main UDL principles: (a) providing multiple means of representation, (b) providing multiple means of action and expression, (c) providing multiple means of engagement. By adopting these principles, UDL provides a standard for evaluating the technology product's potential to work best in a variety of learning environments. The product design must be functional, easy to understand and use, and valuable to all types of people. It needs to have the ability to accommodate a wide range of individual needs (Stockall et al., 2012), communicate information successfully, provide little risk of injury or harm, and be easily accessible to its users (Story et al., 1998).

When educational technologies and school curricula embed UDL principles, they help students to access, use, and engage with learning materials in multiple ways. This flexibility more effectively supports the needs of every learner (Rose & Meyer, 2006; Stockall et al., 2012). Materials that incorporate aspects of universal design were not routine in schools in the 1990s (Kameenui & Simmons, 1999). Coyne et al. (2012) noted:

> A potentially promising approach to enabling more students with significant intellectual disabilities to gain access to research-based, balanced literacy approaches is through the integration of UDL and technology to create more supportive and accessible learning environments. (p. 163)

Interactive Whiteboards

One example of UDL in the classroom is interactive whiteboards. Interactive whiteboard (IWB) technology has increasingly become a part of the technologies in classrooms, with interest continuing to grow (Yakubova & Taber-Doughty, 2013). The first IWB was manufactured in 1991 (Ozerbas, 2012; Shenton & Pagett, 2007) and was first developed to satisfy needs identified in office settings (Greiffenhagen, 2002). The IWB is a touch-sensitive electronic presentation device that works in conjunction with a computer and a projector (Shenton & Pagett, 2007). IWB commonly consist of four main parts: A computer, a data projector, appropriate software, and the display panel, which is a large freestanding or wall-mounted screen.

It is well-documented that teachers and students have positive perceptions of IWB use (Şad, 2012; Wall, Higgins, & Smith, 2005), and the literature supports that IWBs offer benefits for both teachers and students (Ormanci, Cepni, Deveci, & Aydin, 2015). A number of developed countries have invested in IWBs, and developing countries are following with this trend (Şad & Özhan, 2012). Such technology offer the teacher many creative opportunities to develop lessons that are engaging, as well as informing and entertaining to help meet the needs of diverse students within one classroom. IWBs accommodate multiple learning styles including engaging the tactile, aural, and visual senses. Higgins, Beauchamp, and Miller (2007) believed these whiteboards were, “The most significant change in the classroom-learning environment in the past decade” (p. 221).

The IWB allows a teacher to interact with software at the front of the class, rather than from a computer. The teacher can utilize the IWB as a multimedia display place to employ a wide range of media tools such as computer disks, digital videos and audio files, PowerPoint slides, or websites. The teacher also has the ability to highlight, annotate, drag, drop, and conceal linguistic units. The large IWB screen acts as a focus for student attention. Presently, research illustrates that IWBs are most commonly used in regular, whole-class settings (Ashfield & Wood, 2007; BEAM, 2002; Hall & Higgins, 2005; Higgins et al., 2005; Kennewell, Tanner, Jones, & Beauchamp, 2007; Shenton & Pagett, 2007; F. Smith, Hardman, & Higgins, 2006; H. Smith, Higgins, Wall, & Miller, 2005).

Currently, use of IWB technology is an under-researched domain yet, the United Kingdom’s (UK) government has invested considerably in this equipment. It approved over 50 million pounds (the equivalent of over $25 U.S. million dollars) between 2003 and 2005 for purchasing IWBs to be placed in primary and secondary schools (H. Smith et al., 2005). This decision was made without sound evidence that the integration of IWB technology in classrooms would raise attainment among Britain’s students (Higgins et al., 2005); however, Higgins et al. (2005) did find that students scored higher nationally in math and science in classrooms that had

IWB technology compared to non-IWB classrooms. The difference was statistically significant but small (effect size of 0.10 for math and 0.11 for science). However, to date, there is not a lot of scholarly documented evidence that IWBs have a significant impact on student achievement (Benett & Lockyer, 2008). Thus, Torff and Tirotta (2010) stated there is a huge need for research projects that evaluate the impact of IWB technology on academic performance.

By 2008, over 70% of all primary and secondary classrooms in the UK had IWBs, compared to 16% in the United States (Philips, 2008). According to Kennewell et al. (2007), large scale adoptions of IWB technology in schools were isolated to the UK; however, over time IWB technology has integrated into the educational setting of many countries (Ormanci et al., 2015).

Most of the current research on IWBs has been completed in Canada, the United States, and Britain (Ozerbas, 2012). The introduction of any new technology in classrooms, particularly IWBs, should raise questions regarding how it impacts pedagogic practice for all learners, including those with disabilities. Considering the UK's example of buying before studying, it seems prudent to study the effects of IWBs amid the rapid increase of purchases and use of this technology in American classrooms. Essentially, if IWBs show to be effective and useful, then it is evidence of money well spent and evidence of where future money should be allocated. If IWBs are shown not to aid classroom learning for all, then it is evidence that large quantities of money should not be put into this particular piece of classroom technology and funding should go to more effective tools.

The particular brand of IWB that will be utilized in this study, The Promethean Board, uses electromagnetic sensing technology with an electronic pen. Information can be displayed and manipulated by touching the screen. This company has created various software and peripheral hardware to enhance the use of the IWB, including the ACTIV studio software. The ACTIV studio's features include: handwriting, web browsing, window annotation, dragging, dropping, snapshots, and image searching.

Operational Definitions

The following definitions are provided to ensure uniformity and understanding of these terms throughout the study. The researcher developed definitions not accompanied by a citation based on multiple sources to fit this study.

- *Autism spectrum disorder (ASD)* is a developmental disability defined by difficulties in social interactions and behavior, communication, and restrictive and/or repetitive behaviors, interests, and/or thinking. It is considered a spectrum because there is an extensive span of symptoms and severity (American Psychiatric Association, 2013). Students with ASD have a wide variety of strengths and deficits. They vary in cognitive abilities from below average to above average (Randi, 2010). ASD is a brain-based disorder that impacts how students learn and function (Brown et al., 2013; Christi Carnahan, Musti-Rao, & Bailey, 2009).
- *Interactive whiteboard (IWB)* is a large display board that connects to a computer and/or projector. The computer's screen is projected onto the board and users control the computer using a pen, finger, stylus, or other device from the board. The IWB is typically mounted to a wall or floor stand. Promethean and SmartBoard are brands of IWB that are sometimes referred to in the literature. A Promethean IWB was utilized in this study.
- *Joint attention* (JA) is shared engagement between two individuals (student and teacher) to an exterior object or event (in the classroom) using conventional gestures and eye gaze, with the intention of positive shared interest or social experience (Kasari, Freeman, & Paparella, 2006; MacDonald et al., 2006; Mundy et al., 2003; Taylor & Hoch, 2008; Vismara & Lyons,

2007). Researchers identify two main types of JA: (a) responses to another individual's attempt for JA and (b) initiation of JA (Mundy et al., 2003; Taylor & Hoch, 2008). JA is the observable measure for engagement in this study.

- *Student achievement* is the observable and measurable growth in academics. Researchers often measure achievement through assessments (Higgins et al., 2007; Higgins et al., 2005; Thompson & Flecknoe, 2003). In this study, indicators of reading achievement are measured by word count (numbers of words read in one minute) and reading comprehension (reading for understanding). Reading comprehension requires a student to read a short text and then answer questions to demonstrate understanding of what he or she read (Brown et al., 2013).
- *Universal Design for Instruction (UDI)* is a teaching ideal that involves taking into account the needs of all learners when developing and planning instruction. It recognizes and eliminates unnecessary barriers to teaching and learning while maintaining academic rigor (Rose & Meyer, 2006; Stockall et al., 2012). Universal design sets standards for curriculum that is proactive and benefits all students, in contrast to providing accommodations for a specific student (e.g., providing a sign language interpreter for a student who is deaf).

Rationale

IWBs are a relatively new technology within the educational context and are increasing in popularity; however, substantial amounts of research on their effectiveness do not exist, especially from the perspective of teaching and learning. Therefore, the relevance of this study lies in both its practical and educational value. From a practical perspective, knowing the benefits of IWBs technology for students with disabilities provides information that is valuable to educators (both regular educators and special educators) who are required to implement educational practices supported by rigorous evidence-based research that increases achievement for a spectrum of learners. However, at this time, research supporting the effective integration of IWB with students with disabilities including ASD is minimal (Yakubova & Taber-Doughty, 2013). If one technology is proven substantially better for students with disabilities, then administrators have a basis from which to make informed decisions.

This study would contribute to evidence-based knowledge on an under-researched domain: The impact of IWB technology on students with disabilities from a quantitative perspective. The majority of research on the impact of IWB technology on student learning to date is qualitative and descriptive in nature. Data were gathered mainly from interviews and surveys of teachers and students in K-12 education. This knowledge could be expanded by quantitative data.

In contrast to the majority of the research that is anecdotal (Beauchamp & Parkinson, 2005), this study utilized a single subject research design, which is an experimental method. It also involved a small qualitative component as well. This research design is common in the field of special education and was designed to "investigate the effectiveness of educational practices for students with disabilities" (Tankersley, Harjusola-Webb, & Landrum, 2008, p. 83).

Single subject research methods offer a number of features that make them particularly favorable for use in special education research (Cardon & Azuma, 2011; Horner et al., 2005; Kluth & Danaher, 2010; Tankersley et al., 2008). In particular, randomized control-group designs (Kluth & Danaher, 2010; Research & Council, 2002), and single subject research use experimental controls. This allows the findings to be used to establish evidence-based practices (Horner et al., 2005; Kluth & Danaher, 2010; Tankersley et al., 2008). Single subject research is experimental and its purpose is to document causal or functional relationships between independent and dependent variables. Single subject research employs within- and between-participant comparisons to control for the major threats to internal validity.

This particular single subject design also requires replication of measures to enhance external validity. In this study, an A-B-A-B reversal design (detailed in Chapter 3) was used to analyze the experimental conditions. An A-B-A-B design helps to distinguish if any change in the dependent variable is largely caused by the independent variable, and not by extraneous variables. If not, the introduction and then removal of the independent variable should strongly influence a change in the pattern of the dependent variables.

Interactive whiteboards are a new technology and have become a central aspect of many elementary classrooms, yet their use is under-researched and research is in early stages with students with disabilities. The research study closely examined the impact of IWB technology as a pedagogical tool in the educational setting, particularly with students with ASD. This investigation focused on the impact of IWB technology on student achievement and engagement during reading instruction. Torff and Tirotta (2010) noted a strong need for research on the impact of IWB on academic achievement. At the end of the study, students were interviewed to determine their perspectives on IWB use in the classroom. The majority of current literature, which includes surveys and interviews, focuses on the regular classroom and not on instruction with more specific populations, such as students with English as a second language or students with disabilities. The qualitative component of this study attempted to address this gap in the literature.

This study was intended to inform pedagogic practice by providing evidence supporting whether or not this technology has potential value as a transformative device for enhancing teaching and learning for students with ASD. Demand continues to grow for interventions that support students with ASD in the classroom, as the number of students with disabilities served in more inclusive environments increases (Brown et al., 2013) and the accountability for their academic performance rises (Whitby, Leininger, & Grillo, 2012).

My study, and other studies like it, may also inform financial considerations for school administrators that involve technology. As demands for the use of technology in educational settings increase, along with the need for evidence-based interventions, administrators are faced with important decisions. For example, one issue is the cost/benefits of investing in certain types of technology. The findings in this study contribute to the overall understanding of the instructional use of IWBs with students with ASD and the implications to support inclusion of these students within UDL principles.

Purpose

Mechling, Gast, and Thompson (2009) suggested further research should investigate the effects of teaching additional skills via interactive whiteboard technology and small group instruction on students with disabilities. The current study attempted to answer this question. It also built on previous research that was more anecdotal in nature than rigorous (Beauchamp & Parkinson, 2005). The main purpose of this study was to examine the impact of the use of an IWB on student achievement and JA for elementary-aged students with ASD during reading instruction. The study was a quantitative-dominant mixed methods design (Creswell & Plano Clark, 2007). The first phase included a single subject design that compared the effects of IWB use on elementary-aged students with ASD in one school system by examining the students': (a) frequency of child-initiated JA during instruction; (b) performance on weekly comprehension quizzes; and, (c) percentage of word accuracy on pre/post reading passages during four different phases.

The second phase of the study played a supplemental role by examining the students' preferences on the methods of delivery of the curriculum (IWBs or traditional reading instruction) through a structured interview after completion of the first phase. Past quantitative research is deficient regarding the use of IWB technology with students with disabilities, and findings of this study provided practical contributions to the current pool of research literature on IWB use with students with disabilities. This study attempted to balance the available qualitative and descriptive research with quantitative data, as well as focus on an under-researched population.

The research established the following major research questions to guide this study:

1. To what extent are differences found in student achievement when an IWB is integrated into reading instruction, compared to a control, for students diagnosed with ASD?
2. To what extent are differences found in student engagement when an IWB is integrated into reading instruction, compared to a control, for students diagnosed with ASD?
3. What are the perceptions of students with ASD of the integration of IWB into reading instruction?

Delimitations

The philosophical framework for this study is dialectical pluralism. Its fundamental principle is that researchers must account for differences and therefore results are contextually-bound (Hitchcock, Johnson, & Schoonenboom, 2016a). This study embraced single subject research principles and idiographic level of analysis which focused on the individual and not a sample population. Three students were included in the study. This study was delimited to elementary-students with high-functioning ASD. It did not include students with severe ASD symptomatology, intellectual disabilities, or other types of disabilities. All of the participants had a reading level above a first grade level. The setting was a Northern Colorado elementary school's special education classroom. This was based on convenience because it was the school the researcher was employed as a special education teacher. It is difficult to get the approval to conduct research in an education setting; however, being employed ten years in the Northern Colorado's Thompson School District helped facilitated the necessary support required from both the district and the building principal to conduct the research.

It is acknowledged that all academic subjects are important; however, this study focused on literacy. The specific intervention examined was a reading intervention. This particular intervention was chosen because it provided the option of identical online and traditional book methods. Also, both the research and students had previous experience with it. In order to assure manageability of the collected data, coding instruments included only selected types of JA and the survey included only five questions because the role of the survey was supplemental to the quantitative portion of the study. Lastly, for the sake of time and manageability, the number of repetitions was limited to an A-B-A-B design.

Researcher's Perspective

I work in a district where new schools are equipped with "top of the line" technology, including IWBs in all the classrooms. When I first applied for a transfer to the "new" elementary school nine years ago, I did not know much about IWBs. However, I was excited to find that the special education classroom was going to be outfitted with one. Since the new elementary school was equipped with IWB technology, it was an expectation during the hiring process that teachers would commit to utilizing and integrating it within their instruction. As I became more familiar with the IWB technology, I began to use it daily and observed how my students were engaged, motivated, and genuinely enjoyed the use of the tool within the learning process.

I started to wonder what research had been done to investigate this technology, especially with the adoption of the Response to Intervention (RTI) philosophy in our district. RTI is the practice of scientific, research-based instruction with interventions to match individual students' needs. For an intervention to be evidence-based, it had to be proven effective through scientific evidence. Evidence-based interventions are even more valid when they have been proven effective with specific populations they are designed to benefit. I became interested in knowing whether IWB technology was an effective intervention for the students I taught: students with moderate to severe disabilities. I was also interested in how this educational technology could influence the inclusion of these students in regular classrooms. Therefore, my interest in this topic can be summarized into these factors: my school's facilities, the push for integration of technology in teaching, the trend of inclusion and evidence-based interventions, the need for products that meet UDL criteria, and the overall potential IWB technology may offer to learning. I felt it was vital that educators have a clear understanding of how IWB technology, as a learning tool, impacted the learning of students. More importantly, I felt it was critical that students with disabilities must be included in the research of any educational-related endeavor. I wanted to translate my daily experiences of working in special education over the past twelve years into scholarly research.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a comprehensive review of the literature that served as the foundation for this study. The literature on the use of interactive whiteboards (IWB) in the school setting was not extensive. IWBs are still a relatively new technology in education and the available academic literature is limited, especially from the perspective of teaching and learning (Armstrong et al., 2005; Fekonja-Peklaj & Marjanovic-Umek, 2015).

Studies in this review were located using (a) electronic searches in several databases, including Academic Search Premier and ERIC, (b) bibliographies of research journal articles read, and (c) searches through research journals that emphasized autism, reading, JA, technology, or/and special education (e.g., *Journal of Autism and Developmental Disorders* and *Exceptional Children*). This chapter contains the following sections: historical framework, usage and advantages of IWB, disadvantages regarding IWB usage, computer assisted instruction (CAI) and IWB with students with disabilities, evidence-based reading strategies for students with ASD, active engagement with students with ASD, and the conclusion.

Historical Framework

IWB technology within the classroom is under-researched; however, the United Kingdom (UK) government had invested considerably in this equipment. The British Educational Communications and Technology Agency (BECTA) have completed a large amount of the research. They have monitored the integration and effectiveness of IWB use in British schools since their widespread adoption across that nation. The UK government approved over 50 million pounds ($25 million U.S.) between 2003 and 2005 for the purchase of IWBs to be placed in primary and secondary schools (H. Smith et al., 2005). This investment was based on the principle that integration of IWB technology in classrooms would raise attainment among Britain's students (Hall & Higgins, 2005). In 2008, over 70% of all primary and secondary classrooms in Britain had IWBs (Philips, 2008).

According to Kennewell et al. (2007), large-scale adoption of IWB technology in schools at the time was isolated to the UK, yet more and more developed countries, including the United States, have invested in IWB technology in recent years. For example, according to Slay, Siebörger, and Hodgkinson-Williams (2008), "At least one of the nine provinces in South Africa had undertaken pilot roll-outs of IWBs in schools" (p. 1,321). Also, the government in New South Wales, Australia made an initiative to install IWBs in every public school by 2011(Maher, 2011). Today, the majority of the research has been conducted in Britain, Canada, and the United States (Ozerbas, 2012).

IWBs are quickly becoming more common in classrooms, both internationally (Ormanci et al., 2015) and in the United States; therefore, research around the world is beginning to emerge that involves the impact of the IWB. In the local Northern Colorado school district where the researcher works, all schools built since 2007 have had IWBs installed in the classrooms with the notion that IWB technology will impact student learning. If there is a positive correlation between IWBs, engagement, and academic achievement, then best practices need to be recorded so that they can be replicated in classrooms worldwide. The introduction of technology in classrooms begins to raise questions regarding the ways in which practice may be supported and enhanced, because in the end, it is the IWB users (students and teachers) that influence its impact, not the technology itself (Kennewell et al., 2007).

Advantages of IWB Usage

It is well-documented that teachers and students have positive perceptions of IWB use (Fekonja-Peklaj & Marjanovic-Umek, 2015; Şad, 2012; Wall et al., 2005) and the literature supports that IWBs offer benefits for both teachers and students (Ormanci et al., 2015). Early data cited were primarily from interviews, surveys, focus groups, and questionnaires. Much of the early literature was descriptive, small-scale, and often used an action research approach (Digregorio & Sobel-Lojeski, 2010; Higgins et al., 2007). These data are rich and informative, but at this time, more qualitative than quantitative research exists on IWB use. However, more rigorous studies and larger-scale research is starting to develop (Benett & Lockyer, 2008; Higgins et al., 2007).

The advantages and drawbacks of IWB technology are relatively consistent across the available literature (Fekonja-Peklaj & Marjanovic-Umek, 2015; Higgins et al., 2007). It is interesting to compare the differences and similarities between how students and teachers each viewed IWB technology, especially because a large portion of research has examined teacher-use rather than student-use (McQuillan, Northcote, & Beamish, 2012). Research has looked at different subject areas including math, literacy (Benett & Lockyer, 2008), and science (Ormanci et al., 2015). Shenton and Pagett (2007) said, “Most of the teachers saw the IWB as an extra resource, albeit a powerful one, to support their teaching” (p. 132).

The following is an overview of research available at the time of writing that bears directly on this project (written Fall 2016). Several common themes can be identified in the literature regarding the positive impacts IWB technology has both on teaching and learning, including efficiency, student motivation, student engagement and attention, student attainment, flexibility and versatility, multimedia and multi-sensory presentation, and student interaction.

Efficiency

Throughout the literature, IWBs are highlighted as aiding efficiency including quickening the pace of lessons (Ball, 2003; BEAM, 2002; Benett & Lockyer, 2008; Kennewell et al., 2007; Levy, 2002; Şad & Özhan, 2012; F. Smith et al., 2006; Torff & Tirotta, 2010; Whitby et al., 2012). In Ashfield and Wood (2007) study, teachers were particularly positive about how the IWB allowed the pace of the lessons to increase. In another study, a fifth-grade teacher commented, "It's so easy to move from one thing to another . . . this keeps the pace going" (Shenton & Pagett, 2007). Another primary teacher articulated in Walker (2002) that the lessons were much 'pacier' because the teacher did not need to go back and look at notes. The teacher can use the board to prompt, so there need not be any interruptions in the flow of the lesson (Slay et al., 2008). In Fekonja-Peklaj and Marjanovic-Umek (2015), teachers pointed out that they can quickly find material on the internet, can quickly access materials that they prepared at home, and can quickly find previous information that was discussed or display when needed.

IWB technology enables smoother transitions among different activities within a single lesson (Benett & Lockyer, 2008; Fekonja-Peklaj & Marjanovic-Umek, 2015). One study that focused on looking at differences between lessons where teachers did and did not use IWBs, conducted a total of 184 structured classroom observations. They commented on a much faster pace in the IWB lessons compared to the non-IWB lessons, and concluded that the quickened pace was due to the increase in the total number of interactions between the teacher and students (Higgins et al., 2005). IWB use contributed to covering lesson content with quicker speed. This provided for more opportunities for elaboration, repetition of content, and test preparation. Primary-aged students reported that lessons were faster paced because of the easy way that the teachers could change screens (Shenton & Pagett, 2007). Similarly, secondary students interviewed in Levy (2002) reported their lessons were quicker (and more fun).

Student Motivation

Research pertaining to the use of IWBs in schools has shown promising results regarding influencing students' motivation, or their desire to partake in the learning process (Fekonja-Peklaj & Marjanovic-Umek, 2015; Huang, Liu, Yan, & Chen, 2009; McQuillan et al., 2012; Şad & Özhan, 2012; Thompson & Flecknoe, 2003; Whitby et al., 2012; Yáñez & Coyle, 2011). The motivational impact of IWBs on students has been credited to the large screen, the multimedia capability, and the element of "fun" enhancing the presentational aspects of a lesson (Miller & Glover, 2002; Şad & Özhan, 2012; Wall et al., 2005). A report by Becta (2003) stated that students are more motivated in lessons that included an IWB because it engages them to a higher extent and stimulates student participation by having students interact with the board and manipulate text and images. Likewise, Levy (2002) and (Şad & Özhan, 2012) indicated that IWBs motivated students because of the strong visual and conceptual appeal of information, and it alloweds students to physically interact with it (Yáñez & Coyle, 2011). A teacher in the study commented on how IWB technology allowed children to get up to the board and interact with it. Teachers also commented that the students enjoyed having their work shown on the IWB itself (Wall et al., 2005). In Fekonja-Peklaj and Marjanovic-Umek (2015), both primary-aged students and their teachers conveyed that the IWB was motivating to student learning. One teacher mentioned, "Pupils like to watch video clips and contents presented in different modalities on the IWB" (p. 1,005).

Sixty-seven of the 68 teachers interviewed by Higgins et al. (2005) reported that using the IWB in their teaching improved students' motivation to learn. Teachers suggested the wider range of resources and formats helped students grasp ideas and learn more easily (Levy, 2002). Richardson (2002) was a proponent of IWBs and highlighted, “Children are always enthusiastic and show heightened motivation when it is used in the classroom and in my experience it creates greater attention and enthusiasm to participate and respond” (p. 12). In Miller and Glover (2002), teachers reported that students’ motivation was clearly enhanced with 14 out of 35 teachers in the study referencing improved behavior for some or all students.

Easily distracted children paid more attention for longer periods of time with the IWB. A treatment/control study that included 773 upper-elementary students and 32 teachers explored the use of IWB technology associated with students’ self-reported levels of motivation in mathematics (Torff & Tirotta, 2010). Student motivation was assessed by a five-question student survey with responses on a four-point Likert scale (strongly disagreed = 1 to strongly agreed = 4). The study concluded that students in the treatment group mentioned higher levels of motivation with the use of an IWB verses students in the control group. However, the effect was extremely weak and teachers’ perceptions of the impact of IWB on motivation were much higher than the students reported. These findings provided some controlled-study evidence that student motivation may be increased by an IWB, but the motivation-enhancing effect was very weak (Torff & Tirotta, 2010).

IWB technology has a positive impact on student motivation to learn; however, long-term impact on motivation has not been examined or analyzed thoroughly. Increased student motivation with IWB use has been linked to increased student participation and interaction (Beeland, 2002b; Şad & Özhan, 2012). Moreover, including motivational components into academic tasks for all students, including students with ASD, can result in higher levels of work completion, decreased problem behavior, and improved interest (Koegel, Singh, & Koegel, 2010). Yet, motivation greatly depends on the quality of teaching, not simply a technology (Digregorio & Sobel-Lojeski, 2010).

Student Interaction

A range of teaching strategies can be used with an IWB that are both teacher-directed and student-centered; however, teacher-directed whole-class teaching was the most commonly observed (Benett & Lockyer, 2008; Digregorio & Sobel-Lojeski, 2010; F. Smith et al., 2006). Often, a teacher demonstrates or models something on the IWB, and then has students do follow-up activities that do not involve the IWB (Benett & Lockyer, 2008). Students are less likely to be observed interacting with the IWB during lessons (Benett & Lockyer, 2008). Students report that it is motivating to use the IWB themselves, but this is rarely allowed (Digregorio & Sobel-Lojeski, 2010; Wall et al., 2005). Additionally, student interactivity was reported to increase with appropriate use of IWB technology (Kennewell et al., 2007).

The first move toward interactivity is that teachers must encourage students to come up to the IWB (Beauchamp & Parkinson, 2005), and well-designed software could be an avenue to increase student interaction with the IWB (Digregorio & Sobel-Lojeski, 2010). This same research showed that:

> effective teaching with IWBs requires pedagogy to contain an element of interactivity. Although IWBs are well adapted to whole-class teaching, when not used interactively, IWBs can reinforce teacher-centered pedagogy. (Digregorio & Sobel-Lojeski, 2010, p. 265)

In other words, in an ideal classroom, IWB technology needs to be used by both teachers and students together to create an interactive learning environment (Armstrong et al., 2005; Beauchamp & Parkinson, 2005; Schmid, 2008b).

Student Engagement and Attention

Findings have shown that IWBs may improve student engagement and attention in the learning process (Becta, 2003; Benett & Lockyer, 2008; Fekonja-Peklaj & Marjanovic-Umek, 2015; McQuillan et al., 2012; Miller & Glover, 2002). The multisensory nature of the technology enhances the learning experience (Ashfield & Wood, 2007), and students found the use of multimedia resources stimulating (Levy, 2002; Schmid, 2008a; Wall et al., 2005). It was also found that students' interest in learning was heightened because of the feature of surprise that IWBs brought to lessons (Miller & Glover, 2002).

A substantial study over a two-year period that involved observations of 184 lessons of literacy and numeracy in primary schools suggested that the use of IWBs engaged the students (F. Smith et al., 2006). At least one teacher mentioned that students were full of anticipation and interest for what would come next on the board (Levy, 2002). Students emphasized that the IWB technology was fun, interesting, and brought enjoyment to their learning (Goodison, 2002; Hall & Higgins, 2005; Levy, 2002; McQuillan et al., 2012; Şad & Özhan, 2012; Schmid, 2008a; Shenton & Pagett, 2007; Wall et al., 2005). This was especially reported when students played interactive games on the IWBs (Benett & Lockyer, 2008; Shenton & Pagett, 2007; Wall et al., 2005).

McQuillan et al. (2012) found that overall, when IWBs were used in classrooms compared to classrooms without IWBs, engagement levels were higher; however, it was also observed that alternating between teacher-centered and student-centered tasks on the IWB also enhanced engagement levels. Using an IWB could facilitate a learner-centered learning environment. López (2010) noted that teachers started to share their direct instruction with the

IWB. At times, students were receiving direct instruction solely by the IWB and students interacted with the IWB when they were prompted to do so by a lesson.

IWBs in classrooms encourage class interactions, in particular, between the teacher and the students (Beeland, 2002a; Hall & Higgins, 2005; Levy, 2002; López, 2010). Teacher-student interactions may be one element of an IWB that contributes to the reported improvement of attention and engagement of students.

Both students and teachers reported improvement of student attention and behavior (Beeland, 2002b; Levy, 2002; López, 2010; Schmid, 2008a). Higgins et al. (2005) reported that most of the 70 primary-aged students they interviewed thought the IWB helped them to pay better attention during instruction. Four students with known behavior problems were observed during the intervention for one week, and observers noted positive improvements in all of the students' behavior. Teachers in the Fekonja-Peklaj and Marjanovic-Umek (2015) study noted the IWB allowed them to highlight specific information, so students could focus solely on what really was important. Beeland (2002a) conducted an action research study to find out the effects of the use of IWBs on student engagement. Both teacher and student surveys commented on the positive influences on engagement. Most teachers used phrases such as "engaged" and "very attentive".

Teachers highlighted that active parts of the IWBs included music clips, various sounds, interactivity, and pictures. IWBs supported different ways of learning and different ways of processing information. Students mentioned that they liked the multimedia capabilities and that animations were useful to their learning. A case study by Ashfield and Wood (2007) included subsequent discussions with focus groups that included classroom teachers and students regarding their perceptions of the use of IWB technology in classrooms. They found these common themes: an increase in student concentration, motivation, and attention. The teachers interviewed said that features, such as clipart images and photos, sound, animations, video, and hyperlinks all served to supplement their teaching in positive ways. They felt the use of these features helped to foster the children's attention, maintain their concentration, and motivate them to learn (Ashfield & Wood 2007).

Richardson (2002) described the use of information and communications technology (ICT) in the lesson was such that the children were so enthused by the activity there was no evidence of distractions. However, different results were reported by Solvie (2004) in a study that looked at student attention and participation comparing between literacy instruction with and without the use of a SMART board in a first-grade classroom. Analysis of the data showed no significant difference in student attention when lessons were delivered with the SMART board compared to lessons presented without it, yet students in the study expressed interest in the SMART board and seemed excited about it.

IWBs have been reported to improve both student attention and affect towards learning (Levy, 2002). In the Slay et al. (2008) case study in South Africa, students reported that the IWB improved visibility of classroom content and referenced the "big screen" as one of the IWB's best features, which may contribute to improved student attention. In Fekonja-Peklaj and Marjanovic-Umek (2015), teachers also expressed that students demonstrated better attention when content was displayed on the IWB than when explained only verbally.

Student Attainment

Some researchers conjecture that IWBs may improve student attainment in academics (BEAM, 2002; Ozerbas, 2012). Surveys and interviews from both students and teachers note the positive effects that IWBs have on student achievement (Beeland, 2002b; Higgins et al., 2007;

Levy, 2002; Schmid, 2008a; Slay et al., 2008; Wall et al., 2005); however, there is not a substantial amount of quantitative evidence to confirm this (Ozerbas, 2012; Şad, 2012). Torff and Tirotta (2010) indicated that studies of the academic outcomes of IWBs are needed. Higgins et al. (2005) reported that 85% of the 68 teachers interviewed in their study believed that IWBs would lead to higher student attainment. However, results from studies that have used achievement as their dependent variable have shown mixed results.

A study conducted by Ozerbas (2012)used a pretest-posttest true experimental design with a control group to investigate the impact of the use of a smart board on achievement of college students. The students in the experimental group worked on a project through smart boards and the control group of students worked on the same project through more traditional learning avenues. The results showed statistically significant differences between the pretest and the posttest achievement tests between both groups. However, the experimental group exhibited a slightly higher difference between the posttest scores (M = 77.80, SD = 12.42) to the pretest scores (M = 77.80, SD = 11.37) than the control groups' posttest scores (M = 63.40, SD = 14. 98) to their pretest scores (M = 21.00, SD = 12.33) (Ozerbas, 2012). The author contributed this to the smart board use concluding that the findings yielded that the use of the smart boards positively impacted students' academic performance. However, because there also was a statistically significant result in the control group, Ozerbas (2012) concluded that more traditional methods were also effective for student achievement and should not be completely eliminated either.

Using a quasi-experimental design, López (2010) found statistical significance that IWB usage in third-grade mathematics and fifth-grade mathematics and reading classrooms contributed to increased student achievement for English language learners (ELL) students compared to ELL students in classrooms without IWB usage. Thompson and Flecknoe (2003) conducted a study that examined the effects of an IWB on student attainment in a second-grade classroom. Scores on term assessments were analyzed and student scores at the end of the spring term were compared with fall term scores. The scores on term assessments were again examined at the end of the students' fourth-grade year. In total, there was a 14.1 % improvement in math attainment over the first term and a 22.1 % improvement over the second term. Over the two-term period of the intervention, there was a 39.4 % improvement overall. Thompson and Flecknoe (2003) concluded, "Interactive whiteboard-based teaching has helped pupils to grasp ideas and concepts more easily evidenced by their rapid progress through national curriculum levels" (p. 32).

Huang et al. (2009) found that for sixth-graders, the use of an IWB for instruction in statistics, pie charts, and solid diagrams was the most effective device for learner comprehension and retention when compared to the separate use of a traditional blackboard, overhead projector, and projection screen. This conclusion was reached by measuring higher scores on achievement tests. Similarly, two schools studied by Miller and Glover (2002) showed significant improvement in achievement as measured by National Key Stage One (five and six-year-olds) tests. One teacher, however, pointed out: "You cannot say that the whiteboards have brought about change themselves . . . they have been part of a new approach which has involved us in looking at how children learn" (p. 17).

A major influence for gains in student achievement may be linked to how long students are taught with an IWB. Lewin, Somekh, and Steadman (2008) found that the length of time students were taught with an IWB greatly influenced student achievement. They found evidence that all students in the study, aged seven to 11, made significant progress academically as measured by national tests in literacy when teachers used the IWB for two or more years. At the end of the first phase of data collecting (18 months), there was little evidence of gains in student achievement. However, after the second phase of data collecting (another 18 months later), Lewin, et al. (2008) found there were significant gains in student performance on formal tests. This suggested that once IWB technology was integrated appropriately and became meaningful within instruction, the IWB technology had a positive impact on student achievement. A large increase in teachers' proficiency in ICT skills was also found over the two-year period with daily access to IWBs (Lewin et al., 2008). Yet, other research (F. Smith et al., 2006) shows little to no impact of IWB on student achievement.

Flexibility and Versatility

Another common theme in the research was the flexibility and versatility that teaching with IWB technology allowed (Huang et al., 2009; Kennewell et al., 2007; Miller & Glover, 2002; Shenton & Pagett, 2007; Slay et al., 2008; Yáñez & Coyle, 2011). For example, Beeland (2002b) said, "The boards can be used with any software, they are extremely adaptable for numerous uses and do not require acquisition of additional software" (p. 2). Teachers can use photos, animations, videos, PowerPoint presentations, graphics, any computer software, and the Internet (Benett & Lockyer, 2008; Şad, 2012; Wall et al., 2005). The IWB permits teachers to have instant access to the Internet, which allows them have a variety of websites and videos at their fingertips (Fekonja-Peklaj & Marjanovic-Umek, 2015; Yáñez & Coyle, 2011). One teacher reported that if she had the choice between an IWB or desktop computers for her classroom she would always choose the IWB because of its flexibility in how it provides opportunities for both individual and whole-class assessment (Edwards, Hartnell, & Martin, 2002).

Teachers reported that IWB resources can be used effectively when responding to different student needs, including presentations, which can be easily adapted during lessons to meet the needs of both high and low abilities (Beauchamp & Parkinson, 2005; Levy, 2002). Two studies observed that teachers in classrooms adapted presentations quickly to meet the needs of individual students (Miller & Glover, 2002; Schmid, 2008a). Also, teachers can give more than one direction at the same time to their class (Fekonja-Peklaj & Marjanovic-Umek, 2015). Teachers mentioned the flexibility of the IWB when having a range of needs to meet within one single lesson (Miller & Glover, 2002; Slay et al., 2008; Walker, 2002). Hall and Higgins (2005) study of fifth and sixth-grade students acknowledged that the students were enthusiastic about the versatility of the IWB and its capability of doing many things competently in the classroom. IWBs also allow teachers to move easily and quickly among resources when unplanned needs arise during a lesson and allow teachers to easily link content from various subjects together (Fekonja-Peklaj & Marjanovic-Umek, 2015).

Diverse Learning Styles

The use of IWBs enhances the visual, auditory, and kinesthetic learning modalities (López, 2010; McQuillan et al., 2012; Slay et al., 2008; Thompson & Flecknoe, 2003), and IWB technology supports individual needs, which aligns with UDL principles (Stockall et al., 2012). Warren (2003) stated, “Interactive whiteboards can support the full range of learning styles” (p. 3). Several references to multimodality enhancing student learning were found in the literature (Goodison, 2002; Higgins et al., 2005; Maher, 2011; Thompson & Flecknoe, 2003; Wall et al., 2005; Yáñez & Coyle, 2011). For example, Yáñez and Coyle (2011) said:

> This multimodality is a proven advantage of the IWB since it caters for children’s different learning styles. Elements such as the ability to integrate sound, video, text, and animation support individual learning styles, with the possibility of combining these elements in ways that suit particular sets of learners. (p. 4)

Bell (2001), whose research included the use of IWB technology in classrooms, stated, "The board can accommodate different learning styles. Tactile learners benefit from touching and marking on the board, audio learners can have the class discussion, and visual learners can see what is taking place as it develops at the board" (p. 1). Slay et al. (2008) and Levy (2002) also reported that the IWB was able to support a variety of learning styles when teachers integrated a variety of different multimedia sources. Teachers stated they were enthusiastic about the versatility of the IWB, or the capability of the IWB, to do many tasks competently in the classroom. Teachers and students reported that good visual resources help support visual learners (Ashfield & Wood, 2007; BEAM, 2002; Şad & Özhan, 2012; Schmid, 2008a; Shenton & Pagett, 2007; Wall et al., 2005). Teachers can add or enhance color, music, audio, sound effects, speech, or movement to any lesson (Beeland, 2002a; Şad, 2012). This aligns with findings from the Levy (2002) study where teachers thought that the strong visual and conceptual appeal of information from IWBs facilitates improved student participation in whole-class discussions.

Students in the Shenton and Pagett (2007) study and Fekonja-Peklaj and Marjanovic-Umek (2015) stated that the large screen and amplified sound allowed them to see and hear the lessons better. The IWB has many tools that draw visual attention to information, including enlargement with a magnifier, experimentation with text, and the ability to manipulate (Slay et al., 2008). IWBs have a variety of colors that may be used to highlight different features (Wall et al., 2005). The IWB tools include removing and substituting alternative words and phrases and the use of hypertext. Warren (2003) added, "There is a huge range of visual images available on a computer and they are enhanced by introducing movement . . . . This often gives an astonishingly powerful boost to understanding" (Warren, 2003, p. 3). The touch-sensitive screen benefits tactile learners because they can touch the board, write on the board, or draw on the board (Beeland, 2002a). Students in the Fekonja-Peklaj and Marjanovic-Umek (2015) study also expressed that they enjoyed drawing on the IWB with the pen and using the different colors.

Disadvantages Regarding IWB Usage

Numerous themes in the literature illustrate the positive impacts that IWB technology has on teaching and learning; however, in the same literature, disadvantages have been identified that "tend to be of a practical or logistical nature" (Higgins et al., 2007, p. 215). These include: lack of skilled staff, access, professional development and support, technical support, and continual use.

Staff's Technology Skills

In Slay et al. (2008), the most noted disadvantage of the IWB by both teachers and students was the lack of ICT (information and communication technology) skills among staff. For example, Higgins et al. (2007) said:

> Good teaching remains good teaching with or without technology; the technology might enhance the pedagogy only if the teachers and pupils engaged with it and understood its potential in such a way that the technology is not seen as an end in itself but as another pedagogical means to achieve teaching and learning goals. (p. 217)

Teachers must have the fundamental technical skills to use IWB effectively (Hall & Higgins, 2005; Shenton & Pagett, 2007; Slay et al., 2008; H. Smith et al., 2005; Wall et al., 2005). Hall and Higgins (2005) put it this way: "It would be a pity if the benefits that could be gained through the more open, collaborative and imaginative uses of ICT and IWB were thrown away simply for failing to adapt to the demands of the new technology" (p. 114). When teachers have a lack of required skills to use an IWB it can actually cause classroom management difficulties (Ozerbas, 2012).

Becoming technically capable takes practice, experience, and trial and error (Benett & Lockyer, 2008; Higgins et al., 2007). Armstrong et al. (2005) suggested that it is important that teachers have daily access to IWBs in order to benefit from the full range of possibilities they offer. It was also argued (Greiffenhagen, 2002) that IWBs are only beneficial when they become part of the regular everyday classroom. Additional concerns include the possibility that limiting students' access to IWBs interferes with interaction, participation, and familiarity of the technology (Hall & Higgins, 2005; Wall et al., 2005).

Shenton and Pagett (2007) witnessed that primarily teachers, not students, in their rounds of observed lessons, utilized the IWB. They reported that in only two classes were children even invited to use the controls, and only in one class were students interacting with the IWB independently. An educational climate that does not increase student and teacher access means that IWBs will not be utilized to their full potential. Ultimately, the IWB technology needs to be integrated appropriately into instruction and tied to learning outcomes (Armstrong et al., 2005; Benett & Lockyer, 2008).

Professional Development

Şad (2012) concluded, "These negative outcomes of inadequate or improper SB [smart board] use can be prevented at best through teacher training, which is another problem as highlighted in the relevant literature" (p. 902). Most researchers agreed that IWB is a useful tool to have in classrooms, but technology by itself will not bring about change (López, 2010). Teachers need to feel confident and competent in technological matters. F. Smith et al. (2006) agreed, "More reciprocal forms of teaching would only come about with the support for teachers in the professional development" (p. 455).

The necessary training and development for teachers is essential for successful implementation of IWB technology (López, 2010; McQuillan et al., 2012; Miller & Glover, 2002). Formal training on the use of IWBs is extremely important; however, Shenton and Pagett (2007) reported that most of the teachers in their study had minimal initial training. Most teachers learned how to use the IWB while on the job, and as a result, they spent a large amount of time preparing materials. Professional development with IWB appears to be a major factor in teachers' competence with this technology, otherwise, "this rather expensive investment turns out to be unproductive" (Şad, 2012, p. 901).

Continuous IWB support for staff and teachers is important; furthermore, Shenton and Pagett (2007) suggested that the focus of teacher training should include the whole context of teaching interactively with an IWB. Developing differentiated support strategies for teachers in both initial training and on-going developmental support is valuable (Benett & Lockyer, 2008; Higgins et al., 2007; Levy, 2002). In addition, Shenton and Pagett (2007) endorsed assisting teachers toward a more effective use of the IWB. Instead of a traditional or professional model of training, they believed that teachers need a "bottom-up" approach, which is more teacher-focused. Integration of technology into curriculum training is essential for successful implementation (John, 2002).

The research supports that if schools do not train teachers to use IWBs, they could become an underused, expensive piece of equipment. Teachers need adequate time to learn how to use IWB technology, and if that time is not allocated, teachers will not use them (Bell, 2001). Miller and Glover (2002) argued that potential benefits for the introduction of IWBs within schools require specific conditions; teachers have to: (a) be willing to develop and use the technology, and (b) change their thinking about the ways in which classroom activities are designed. Likewise, Beeland (2002a) articulated, “With proper planning, preparation, and training, it is a powerful instructional tool, which can be adapted for use with a wide range of subjects and ages” (p. 2). Equally important, Armstrong et al. (2005) suggested the need for research on ways to effectively support teachers’ IWB professional development.

Technical Support

In addition to a lack of knowledge on how to utilize the IWB, another limitation of IWB technology was the teachers’ difficulties accessing basic technical support (Becta, 2003). Also, IWB technology can waste instructional time and cause behavior problems as a result of unforeseen break-downs (Ozerbas, 2012) and simple equipment troubles, such as with software, the PC, dust on the light bulbs, or pens needing calibration (Beeland, 2002a; Fekonja-Peklaj & Marjanovic-Umek, 2015; Hall & Higgins, 2005; McQuillan et al., 2012; Şad & Özhan, 2012; H. Smith et al., 2005; Wall et al., 2005). These simple technology problems frustrate teachers and decrease their willingness to try technology integration altogether (Levy, 2002). The frequency of calibration problems was one of the major concerns among teachers (Beauchamp, 2004). Other problems were related to installation, including positioning and ease of access not always being ideal, resulting in sunlight reflecting on the screen causing visual difficulties for students (Hall & Higgins, 2005; Levy, 2002; Şad & Özhan, 2012).

Other Challenges

IWBs are likely to become a common piece of equipment in future schools, as they are steadily becoming a feature in more and more classes. Cost related issues of IWB technology were noted as problematic (Ozerbas, 2012; Wall et al., 2005). This could further the digital divide between the schools that can afford the technology and those that cannot. In addition to the cost of initial installation and training teachers, ongoing technical support, upgrades in software, and ongoing teacher training must also be considered. In Fekonja-Peklaj and Marjanovic-Umek (2015), teachers stated that when they were absent it sometimes was problematic because substitutes would not have the technology skills to access pre-prepared material that involved the IWB.

Problems including technical difficulties with equipment, learning demands for some teachers, and the need for both basic technical training and tailored development will influence the use of IWB technology in education (Levy, 2002; Wall et al., 2005); thus, if the technology is not dependable and the teachers are not trained properly to use IWBs, what is their use in classrooms? IWB technology and pedagogy must be blended together for optimal benefits (Beauchamp, 2004; Digregorio & Sobel-Lojeski, 2010; Şad & Özhan, 2012). Şad (2012) concluded, "From a pedagogical perspective, it can be declared that IWBs are an effective and motivating instructional tool for learning, however, only if they are used in accordance with the appropriate teaching strategies, methods, and techniques" (p. 901).

Technology-Based Interventions with Students with Disabilities

The studies regarding IWB technologies that have been discussed up to this point were conducted in general education classrooms; however, "interactive whiteboards have received limited research attention with students with disabilities" (Campbell & Mechling, 2009, p. 8). Due to changes in federal mandates discussed in Chapter 1, students with disabilities must have access to the same general education curriculum, and states are required to test these students based on state standards. These factors have caused a shift in focus to technologies that grant access to the general education content for all students (Pennington, 2010). IWB is one instructional technology that potentially could facilitate this because of its many different capabilities.

Walker (2002) discussed a primary teacher who found the option to flip back and review material on the IWB was especially beneficial for those with lower ability and students with special needs. Also, Ball (2003) documented several teachers who identified the IWB as being particularly good with special education students. The students seemed to pay more attention because they enjoyed touching the board and the interactivity of the IWB. Beeland (2002a) remarked, “Interactive whiteboards may provide a significant potential for meeting the needs of students with diverse learning styles and for engaging students during the learning process” (p. 1).

Computer-Assisted Instruction (CAI)

Computer-assisted instruction (CAI), which is instruction presented on a computer, is one instructional technology shown to benefit students with ASD (Bosseler & Massaro, 2003; Coleman-Martin, Heller, Cihak, & Irvine, 2005; Heimann & Nelson, 1995; Hsu-Min & Yueh-Hsien, 2007; Knight, McKissick, & Saunders, 2013; Mancil, Haydon, & Whitby, 2009; Mechling & Bishop, 2011; Randi, 2010; Rice, Wall, Fogel, & Shic, 2015; Whitcomb, Bass, & Luiselli, 2011; Williams, Wright, Callaghan, & Coughlan, 2002). CAI can embrace the UDL principles, which would allow for teachers to address the unique needs of individual students including students with ASD. UDL principles maximize the level of rigor and support to meet the needs of all learners. Rice et al. (2015) stated:

> CAI provides multisensory interactions, controlled and structured environments, multilevel interactive functions, and the ability to individualize instruction, all of which have been found to be successful in interventions for children with ASD. (p. 2,177)

Research literature focusing on CAI and autism first emerged in the 1970s (Pennington, 2010). CAI information can be accessed in an interactive way using sound, video, animation, and text-enriched features (Y. Lee & Vail, 2005; Mechling et al., 2009). Y. Lee and Vail (2005) generalized this research by stating, “As the number of computers in classrooms increases, researchers and educators have continuously questioned the effectiveness and the proper use of computers to teach children with disabilities” (p. 5). According to Knight et al. (2013) there is a limited amount of quality research supporting the use of technology to teach academic learning, They noted, however, of the “acceptable” studies, all the skills taught were in the content of literacy.

Pennington (2010) conducted a review of literature between 1997 and 2008 on CAI use in academics for students with autism spectrum disorders (ASD). The review included fifteen journal articles and a total of 52 participants. Eleven studies had three or fewer participants and the others had between four and 14 participants. All of the studies focused on literacy, and eight specifically involved reading instructions; however, a variety of computer software was used. Analysis of the review concluded that CAI might have positive effects on learning for students with autism. All participants learned target skills when CAI was integrated into instruction; however, a majority of the studies did not show a functional relation between the use of CAI and skills acquisition.

Several comparative studies have yielded that computer-based instruction have increased motivation, attention, decreased negative behavior, and occasionally increased academic achievement compared to more traditional methods (Goldsmith & LeBlanc, 2004).

Coleman-Martin et al. (2005) investigated the effects of teaching word identification using the Nonverbal Reading Approach (NRA) with three students who had severe speech impairments and concomitant physical disabilities and/or autism across three conditions: (a) teacher instruction only, (b) teacher and CAI, and (c) CAI only. The participants were provided decoding and word identification instruction using the NRA across the three conditions simulating the natural progression of classroom instruction from teacher-directed to computer-assisted instruction. Coleman-Martin et al. (2005) found that each of the three participants was able to acquire words across all three conditions; however, two of the three students took longer to learn the words in the teacher-only condition.

Similar results were found in a pilot study that examined literacy instruction with children with autism by comparing CAI (computer format) with traditional book methods (book format) (Williams et al., 2002). Eight children aged three to five participated in the study. Four were assigned to the computer format instruction group and four to the book format group. Assessment measures were performed at baseline, experimental, crossover, and final. Children with autism spent more time on reading material when they accessed it through a computer than in the book format. Also, all of the children in the study spent more time on-task in the computer format (mean 9.9 minutes) than in the book format (mean 2.8 minutes). Williams et al., (2002) reported that if generalized over an entire school year, this would mean that if the same children received fifteen minutes of attempted reading instruction a day, then they would read 30.5 hours with a computer and 8.5 hours using paper books.

Mancil et al. (2009) conducted an ABABCBC single subject design that examined the difference in effects when teaching social stories in book format versus a computer format with students with autism. Children spoke more than twice the number of words during the computer format intervention than in the book format (Mancil et al., 2009). Whitcomb et al. (2011) found using a multiple baseline design that a computer-based early reading program (Head sprout) was associated with improved reading accuracy on word lists and text reading skills for a nine-year old student with autism. Percentage of reading accuracy was recorded for two dependent measures during baseline and intervention phases.

Other Technology-Based Interventions

Even though computer-based interventions were the most studied technology-based intervention for students with ASD (Goldsmith & LeBlanc, 2004), there are a growing number of studies that have focused on the impact of other technology-based interventions with children with ASD based on the previous research of CAI. This is due to the increased advancements in technology in the last ten years (Goldsmith & LeBlanc, 2004). Other technologies that have shown promising results of teaching reading skills to students with ASD include tablet devices such as i-Pod Touch (Carlile, Reeves, Reeves, & Debar, 2013) and the iPad (Bouck, Savage, Meyer, Taber-Doughty, & Hunley, 2014; Lee et al., 2015; Neely, Rispoli, Camargo, Davis, & Boles, 2013).

Kagohara et al. (2013) conducted a literature review of 15 studies that involved iPods, iPads, and other technologies as interventions for individuals with developmental disabilities to inform evidence-based practice. The results of these studies were overall very positive in regards to academic learning; however, it was noted that the success of these devices was also largely influenced by the use of evidence-based practices with these technologies (Kagohara et al., 2013).

With the substantial amount of research yielding positive effects of CAI, and other technology-based interventions, particularly for children with ASD, it is logical that research on the effects of IWBs for children with ASD would also yield positive results; however, Knight et al. (2013) suggested that "technology-based interventions for teaching academic skills to students with ASD should be used with caution" (p. 2,644). Knight et al. (2013) conducted a comprehensive literature review on studies from 1993-2012 to examine whether technology-based interventions could be considered evidence-based practice for teaching academics to students with ASD. Of the 25 studies included in the review, only four single subject designed studies showed a functional relationship and none of the group designs met the inclusion standards. In a majority of the studies, students demonstrated growth in academic skills; however, due to the lack of quality research, the authors suggested technology should be used with caution until more worthy research was added in the literature.

IWB Technology

One difference between CAI and teaching with an IWB is that IWBs are designed to accommodate large groups, compared to personal computers and iPads that are designed for individual use. Group instruction yields opportunities for teaching social skills, as well as academic content (Whitby et al., 2012). Fortunately, researchers have found that both teachers and students find IWBs to be particularly effective with students in special education (Ball, 2003; Wall et al., 2005).

A study conducted by Mechling, Gast, and Krupa (2007) examined the use of computer-assisted instruction with SMART board (a brand of IWBs) technology, and the use of a three-second constant time delay (CTD) procedure to teach sight-word reading within a small group arrangement of students with moderate intellectual disabilities. Results indicated all of the students showed the ability to read their targeted sets of words with the use of SMART Board technology and the three-second CTD procedure (Mechling et al., 2007).

By delivering the information on the large screen, it may make the images more clear and increase students' attention to the task. The large screen of an IWB may also benefit students with visual impairments because of its ability to zoom and magnify content. Backgrounds and texts on the large screen can be highlighted or colored (Lopez, 2006). Research shows that technology can boost students' comprehension of content through visual support (Mechling et al., 2009; Pennington, 2010). For example, one study of a blind student who used IWB software in a distance learning class reported that using a screen reader, in conjunction with an IWB, allowed the student to access classroom material without other needed supports (Freire, Linhalis, Bianchini, Fortes, & Pimentel, 2010). IWB technology could also benefit students who are homebound because of the distance learning possibilities of IWB-based technology (Lopez, 2006).

Campbell and Mechling (2009) examined the effectiveness of teaching the sounds of the alphabet in a small-group arrangement using SMART board technology with three students with identified learning disabilities. Students were able to learn the sounds by using the IWB technology. The large interactive touch screen allowed students to see, say, hear, and touch the information they were learning (Campbell & Mechling, 2009). This supports research on the importance of multisensory learning.

Another study examined whether three students with profound multiple disabilities (PMD) had a preference for stimuli being displayed on a computer screen or a large whiteboard screen (Mechling & Bishop, 2011). Findings indicated a possibility that some students are more engaged when information was presented on a large whiteboard rather than on a computer screen. This is the only study found that has evaluated varied sizes of computer screens with students with PMD.

Mechling et al. (2009) conducted a study that compared differences between a SMART Board and traditional flash cards in teaching sight-words in a small group of three students with moderate intellectual disabilities. They suggested that both interventions were effective in teaching target sight-words; however, what was interesting from the results was that sight-words on the SMART Board were more effective for promoting observational learning of other students' information for the three students. A large amount of learning of non-target words (group mean 89.6 %) occurred using the SMART board compared to flash card instruction (group mean 50 %). This meant that the use of the IWB might increase the amount of information presented so that a student learns more during the same amount of instructional time.

A qualitative study by Xin and Sutman (2011) examined the use of a SMART board when teaching social stories to students with autism. The report revealed that the use of the board appeared to motivate the students to learn and had the potential to increase engagement for children with ASD. Campbell and Mechling (2009) clearly stated, "Research should continue to evaluate this form of delivery of instruction across disability types and varying group sizes" (p. 56).

Yakubova and Taber-Doughty (2013) conducted a study that looked at the effects of a multi-component intervention, conveyed on an IWB, on student performance and interaction behavior of two students with autism and one student with moderate intellectual disability. A multi-probe across student design was utilized. The results of the study showed that all three students were able to learn the targeted skills with the intervention through the use of an IWB rather than a typical teacher-led instruction. Each student was able to perform each task independently and engage in using the IWB. Yakubova and Taber-Doughty (2013) concluded that their results showed promising results for using the IWB as a mechanism for showing instructional interventions.

Evidence-Based Reading Practices for Students with ASD

As noted earlier, research supports computer-assisted instruction (CAI) as an evidence-based practice for students with Autism Spectrum Disorder (ASD). However, CAI, like, interactive whiteboard (IWB) technology, must be appropriately integrated into evidence-based instruction. CAI can be a sound instructional tool when paired with quality teaching methods, such as universal design learning (UDL). Technology and media can support UDL because they are versatile and flexible (Rose & Meyer, 2006; Stockall et al., 2012). However, technology does not naturally provide UDL; it is only achieved by appropriate instructional design. Clark (1985) said, "The change in a student's performance is the result of instruction (i.e., instructional design), not the use of the media per se" (as cited in Lee & Vail, 2005, p. 16).

The growing demand in identifying evidence-based practices for children with ASD has rooted from three main reasons. First, there has been a dramatic increase in the number of young children identified with ASD that have required early intervention/early childhood special education (EI/ECSE) services. It is estimated that one in 68 children have ASD (Centers for Disease Control and Prevention, 2014). This has resulted in the need for school districts, teachers, and families to establish effective educational practices (Iovannone, Dunlap, Huber, & Kincaid, 2003; Koegel, Matos-Freden, Lang, & Koegel, 2012). Second, the field of education and federal mandates now places greater emphasis on identifying practices that have scientific evidence for their effectiveness (Iovannone et al., 2003; Koegel et al., 2012; Mundy et al., 2003; Odom et al., 2003). Third, ASD is the fastest growing disability among cases going into litigation within special education (Iovannone et al., 2003).

The research suggests six identified elements that should be included and/or considered in any educational program for students of all ages with ASD that have empirical support. These components consist of: (a) individualized supports and services for students and families (Koegel et al., 2012), (b) systematic instruction, (c) comprehensible and/or structured environments, (d) specialized curriculum content, (e) a functional approach to problem behaviors, and (f) family involvement (Iovannone et al., 2003; Koegel et al., 2012; Mundy et al., 2003).

Research on Evidence-Based Practices in Reading

Hua et al. (2012) stated, "Regardless of disability severity, reading is an essential instructional goal for all students" (p. 135). Federal laws mandate that all children, including those with ASD, are taught with evidence-based reading interventions (Mundy et al., 2003) that incorporate the five essential elements of quality, balanced literacy instruction: phonics, phonic awareness, vocabulary, fluency, and comprehension (Whalon, Al Otaiba, & Delano, 2009). Often, general education teachers in inclusive classrooms have not been educated on how to teach reading to students with ASD, but students with higher functioning autism are increasingly placed in general education classrooms (Hsu-Min & Yueh-Hsien, 2007).

While there is a substantial amount of research on quality reading instruction for students without disabilities, most studies have not included children with ASD (Mundy et al., 2003; Whalon et al., 2009). Current research in reading instruction for students with autism and Asperger's syndrome is minimal and has not been a research priority (Hsu-Min & Yueh-Hsien, 2007; Hua et al., 2012). Yet, it is essential that teachers have a clear understanding of how all students, including those with development disabilities, achieve reading mastery. Reading is an essential skill for being independent and social in society (Lanter et al., 2012; Y. Lee & Vail, 2005; Mundy et al., 2003), yet reading for comprehension is a complex skill that requires numerous cognitive abilities (Kameenui & Simmons, 1999; Mundy et al., 2003).

Reading Commonalities in Students with ASD

Significant confusion and misunderstanding surrounds ASD. ASD "remains a unique and perplexing disability" (Iovannone et al., 2003, p. 150). As a developmental disability, ASD impairs social, language, and communication skills. Also, individuals with ASD exhibit restrictive and/or repetitive behaviors, interests, and/or thinking. It is considered a spectrum because there is an extensive span of symptoms and severity (American Psychiatric Association, 2013). Individuals with ASD vary in cognitive abilities from below average to above average (Randi, 2010). ASD is a brain-based disorder that impacts how students learn and function (Brown et al., 2013; Christi Carnahan et al., 2009). ASD is usually diagnosed before the age of three, and there is no identified cause or cure for ASD (Iovannone et al., 2003). Students with ASD have a wide variety of strengths and deficits; therefore, ASD can look very different from child to child (Tissott & Evans, 2003). Due to the range of diversity in ASD, one type of reading intervention that works for one child may not be suitable to all other children with ASD (M. A. Bono, T. Daley, & M. Sigman, 2004). Yet, as Randi (2010) pointed out:

> Understanding the component skills and processes involved in reading for understanding, apart from decoding, has important implications for designing instruction in reading comprehension for all children as well as for designing interventions to strengthen reading comprehension skills in children with ASD and development disabilities. (p. 891)

Children with ASD often exhibit a discrepancy between decoding skills and comprehension skills (Ricketts, Jones, Happe, & Charman, 2013; Yin, 2006). Their decoding skills tend to be more developed than their comprehension skill, which is known as hyperlexia (Brown et al., 2013; Lanter et al., 2012). Hyperlexia has been suggested to be associated with autism (Hsu-Min & Yueh-Hsien, 2007; Kameenui & Simmons, 1999; Nation, Clarke, Wright, & Williams, 2006). Children with ASD exhibit strong word recognition skills, but low abilities in comprehension (Randi, 2010; Whalon et al., 2009; Yin, 2006). Nation et al. (2006) completed a study that looked closely at the reading capabilities of 41 children on the spectrum aged six to 15 (13 identified pervasive development disorder-not-otherwise specified, 16 with autism, and 12 with Asperger's syndrome). Nation et al. (2006) assessed single-word recognition in isolation, pseudo-word or non-word recognition, text accuracy, and text comprehension. The overall pattern showed that the children had strengths in reading words, but demonstrated poor comprehension. More than 65 % of the children with ASD, who had measurable reading abilities, had comprehension difficulties (Nation et al., 2006). For children with ASD, discrete skills such as naming letters and reading environmental print are strengths, while skills that require application or understanding meaning (i.e., the function of print) are more difficult (Lanter et al., 2012; Yin, 2006). However, other research found word recognition difficult for children with ASD (Mundy et al., 2003).

Children with ASD may perform poorly in reading comprehension due to delays in communication and language and because their brains process and understand information differently (Hsu-Min & Yueh-Hsien, 2007; Kameenui & Simmons, 1999; Lanter et al., 2012; Nation et al., 2006; Ricketts et al., 2013; Yin, 2006). There is a strong relationship between reading comprehension and oral language skills (Nation et al., 2006; Ricketts et al., 2013). However, not every child diagnosed with ASD exhibits this pattern of skillful word recognition and low comprehension skills. Being diagnosed with ASD does not solely predict that a child will or will not have difficulties with reading comprehension. Other skill sets, such as language capabilities regarding semantic knowledge, also influence this (Brown et al., 2013).
Like all children, individuals with ASD can have strengths in some areas and challenges in other areas; therefore, reading interventions should be tailored to individual needs based on assessment (Koegel et al., 2012). ASD can look very different from child to child due to many factors including cognitive abilities, language and communication skills, and severity of impairments (Crosland & Dunlap, 2012); however, all students with ASD exhibit some level of difficult with social, emotional, and communication skills. Because students with ASD have language

difficulties, they have more significant deficiencies in reading comprehension (Brown et al., 2013). Although symptoms vary, many students with ASD need explicit instruction in reading comprehension.

Components of reading. The ultimate goal of reading is to understand what one reads: comprehension. This is the most important academic skill children can learn (Hsu-Min & Yueh-Hsien, 2007). Randi (2010) stated, "Understanding language, whether in written or oral discourse, is essential for communicative interactions. Yet, learning how to read for understanding can be difficult for typically developing children and even more challenging for children with autism" (p. 900). Traditionally, for students with ASD and significant intellectual disabilities, literacy instruction included teaching basic reading skills in isolation. Often, these approaches emphasized teaching sight-word recognition and did not take a balanced literacy approach or focus on reading comprehension (Coyne et al., 2012; Mundy et al., 2003).

Whalon et al. (2009) conducted a literature review that analyzed reading instruction for children with ASD. The studies reviewed included one or more of the five elements of evidence-based reading instruction identified by the National Reading Panel: phonemic awareness, phonics, vocabulary, fluency, and comprehension. The review examined 11 studies that included 61 children aged four to 17 who were diagnosed with ASD. The studies examined varied in quality, but overall, the analysis concluded that literacy practices that incorporated the five essential elements positively influence children with ASD in early grades. Whalon et al. (2009) also concluded, "Because of the unstable reading profile associated with ASD, some learners will have difficulty developing both word reading and comprehension skills. Therefore, it is important that reading instruction emphasizes both code and meaning-focused skills" (p. 12).

Integrating CAI and Evidence-Based Reading Practices

In Whalon et al.'s (2009) literature review, they found four studies that investigated whether decoding-based interventions yielded improved reading. All four of these studies used CAI with pre-test/post-test designs. The Coleman-Martin et al. (2005) study, described in more detail previously, was one of the four studies in the review. Like the findings in Coleman-Martin et al. (2005), which suggested that CAI may be a way for children with ASD to practice decoding skills, findings of the other three studies with CAI showed similar student improvement in coding-focused learning. Whalon et al. (2009), however, added, “Evidence is insufficient to advocate using computer-assisted instruction as a sole instructional mode but rather suggests this method can support and enhance the learning of children with ASD” (p. 13).

As Randi (2010) noted, “Reading comprehension is a complex cognitive process and the ability to understand text is dependent upon a confluence of factors” (p. 892). Research has, nevertheless, set the foundation that the combination of CAI and a balanced reading program (that includes the five essential elements), within an UDL framework, may have positive impacts on reading achievement with students with ASD and other developmental disabilities (Coyne et al., 2012). UDL attempts to lower possible barriers in learning while increasing opportunities to learn. Instruction designed to address the needs of a variety of different learners yields better learning achievement for all and a more inclusive classroom (Stockall et al., 2012).

Research has further highlighted that integrating technology with evidence-based instruction is promising. Coyne et al. (2012) compared the effects of a UDL technology-based reading approach to a traditional reading instruction approach (control) on students with significant intellectual disabilities in kindergarten to second-grade on the five essential elements of reading. The results of the study found a statistically significant difference between the posttest scores of the UDL groups and the control groups in passage comprehension at the p = .02 level on one subtest and an effect size of 1.4. Other subtests that also had effect sizes close to 1 were work attack at 0.9, listening comprehension at 1.0, and concepts about print at 0.92 (Coyne et al. 2012).

Research found effective reading instruction for students without disabilities can benefit students with disabilities (Hsu-Min & Yueh-Hsien, 2007), but even after learning new skills, such as reading, students with ASD may find it difficult to generalize their new knowledge to new situations. Therefore, interventions for students with ASD must also promote generalization of learned skills (Bosseler & Massaro, 2003). Whalon et al. (2009) suggested future research should answer the question of, "How can computer-assisted instruction supplement a comprehensive reading program?" (p. 14). They added, "Future research should investigate not only the effects of comprehension strategies interventions on reading comprehension but also language, social communication and engagement levels of children with ASD" (p. 14).

Academic Engagement with Students with ASD

Student engagement, the level of attention or interests that students show when they are learning, is imperative for academic success for students with and without disabilities (Fredricks, Blumenfeld, & Paris, 2004; Greenwood, Horton, & Utley, 2002; Iovannone et al., 2003; Skinner & Belmont, 1993). Active engagement in addition to student engagement is especially important for children with ASD (Carnahan, Basham, & Musti-Rao, 2009; Iovannone et al., 2003; Koegel et al., 2010) children with ASD have difficulties with social and communication skills, which results in being less likely to engage during academic instruction (Christi Carnahan et al., 2009; Hume & Reynolds, 2010; Iovannone et al., 2003); consequently, students with ASD "have greater success when teachers have high expectations, use evidence-based practices, and design engaging learning experiences" (Christi Carnahan et al., 2009, p. 37). Teaching strategies for students with ASD must focus not only on learning, but actively engaging them in the learning process (Koegel et al., 2010). Active engagement in academic tasks has been associated with better outcomes for students with autism (Fredricks et al., 2004; Hume & Reynolds, 2010; Iovannone et al., 2003; Koegel et al., 2010).

Defining Engagement

Engagement can be defined in different ways within an educational setting. Often, for students with ASD, researchers typically define active engagement from the behavior perspective as on-task behavior or a decrease in problem behavior (Koegel et al., 2010). Behavior engagement focuses on participation and involvement in learning activities (Fredricks et al., 2004). Examples of on-task behavior include: attending to a teacher, involvement in learning tasks, sitting with body and eyes in the direction of learning material, using learning materials appropriately, making verbal comments, absence of self-stimulatory behaviors, and JA (Adamson, Bakeman, Deckner, & Romski, 2009; Carnahan et al., 2009; Koegel et al., 2010; Skinner & Belmont, 1993). However engagement is quantified, certain teaching strategies help to increase engagement for students with ASD, including a variety of technology tools (Carnahan et al., 2009; Greenwood et al., 2002; Iovannone et al., 2003).

Evidence-Based Interventions for Student Engagement

In traditional classrooms, verbal language is the primary mode of instruction, yet children with ASD often have difficulties processing complete verbal information and need visual cues to help facilitate understanding and comprehension. Visual supports may help eliminate language difficulties for children with autism and allow them to gain communication through an alternative way (Mundy et al., 2003; Tissott & Evans, 2003). For instance, visual schedules can be utilized to visually communicate a routine, show changes in activities, and preview upcoming events (Crosland & Dunlap, 2012). Carnahan (2006) said, "Decreasing the reliance on verbal instruction and increasing the use of visual learning materials creates opportunities for students with autism to engage in joint attention activities and increase attention to learning materials" (p. 44).

Visual materials and supports are effective intervention because visual perception skills are often areas of relative strength in students with ASD (C. Carnahan, 2006; Lanter et al., 2012). There are two main types of visual strategies: visual supports that focus on movement or gestures (e.g., American Sign Language), and others that use external materials including pictures (e.g., Picture Exchange System PECS, visual schedules). Materials-based systems are also based on behavioral theories, including pairing environment or tasks with preferred reinforcers (Mundy et al., 2003; Tissott & Evans, 2003). Strategies that use visual learning materials, music, and/or both, promote increased engagement in students with autism (Carnahan, 2006; Carnahan et al., 2009; M. l. Heimann & K. Nelson, 1995; Hume & Reynolds, 2010). These same studies found that students with ASD and other learning difficulties have higher levels of academic engagement during activities that incorporated visual, interactive materials, and music. Bouck et al. (2014) said that as a result, "students with ASD might show higher levels of engagement using high-tech devices compared to lower-tech options" (Bouck et al., 2014). Teachers must pick a variety of materials including technologies that focus on children's visual, tactile, and auditory needs (Stockall et al., 2012). Technology that integrates the UDL principles, such as an IWB, might help in creating multiple and flexible ways for teachers to present information for students with ASD.

Instructional strategies need to be designed to incorporate a student's strengths, interests, and individual needs (Carnahan, 2006; Greenwood et al., 2002; Hume & Reynolds, 2010; Iovannone et al., 2003; Koegel et al., 2012; Tissott & Evans, 2003). Also, research shows that when motivational components such as choice are included in academic tasks for students with ASD, there is an increase in work completion, a decrease in problem or off-task behavior, and a positive effect on overall interest in learning (Koegel et al., 2010). One possibility is called Pivotal Response Training (PRT), which is an empirically-supported teaching technique that facilitates motivation and engagement (Koegel et al., 2012). PRT includes following a child's lead, providing choices using preferred items or activities, teaching in natural settings, pairing environment and materials with reinforcement, using natural reinforcers instead of artificial reinforcers, varying the presentation of tasks, interspersing difficult and easy tasks, and errorless teaching (reinforcing all attempts even if incorrect) (Iovannone et al., 2003).

Systematic instruction, which is a carefully planned sequence of instruction, is another research-supported intervention for students with ASD that can aid in high-level engagement. It involves having clear and concise student objectives that are driven by ongoing assessment. Teaching methods using applied behavior analysis (ABA) have shown to be effective in teaching specific aimed behaviors (Iovannone et al., 2003; Kagohara et al., 2013; Mundy et al., 2003).

Teachers can easily increase levels of active engagement if they increase the amount of time students are exposed to learning activities that incorporate the above teaching methods. Most students with ASD are visual learners and require material to be presented to them visually. Interventions need to be strength-based, explicit, and sequential, and should include simple, concise directions for completing tasks. According to Kasari et al. (2006) research-supported interventions, paired with visual or music aids, may be the best vehicles to teach students with ASD who have significant deficits in social communication skills, including joint attention.

Joint Attention

Joint attention (JA), which is the construct for engagement in this study, is shared attention between two individuals (student and teacher) to an exterior object or event (in the classroom) using conventional gestures and eye gaze, with the intention of positive shared interest or social experience (M. A. Bono et al., 2004; MacDonald et al., 2006; Mundy, Sigman, & Kasari, 1990; Taylor & Hoch, 2008; Vismara & Lyons, 2007). Basic JA behaviors include eye contact, gaze shifting, and pointing gestures. There are two types of JA: (a) responding to JA and (b) initiating joint attention (IJA). In typical development, responding to JA transpires before initiating (M. A. Bono et al., 2004; Mundy & Newell, 2007). It is suggested by M. A. Bono et al. (2004) that joint behavior response is a critical indicator of an intervention's effectiveness. When a child demonstrates increased response to JA, it likely yields improved language skills, especially when a child is involved in early and intense interventions. Vismara and Lyons (2007) also stated, "The ability to follow another person's focus of attention, as well as direct that person's focus of attention, allows children to establish a common topic with the communicative partner and thus to make sense of language" (Vismara & Lyons, 2007, p. 214).

JA skills are essential for language development (M. A. Bono et al., 2004). Also, JA skills help children to experience affect with others (Mundy et al., 1990). Children with autism typically exhibit JA deficits (M. A. Bono et al., 2004; MacDonald et al., 2006; Mundy & Newell, 2007; Mundy et al., 1990; Taylor & Hoch, 2008; Vismara & Lyons, 2007), which may make it hard for them to observe and imitate staff and peer behavior (Hume & Reynolds, 2010).

“Without the capacity for joint attention,” Mundy and Newell (2007) stated, “success in many pedagogical contexts would be difficult to achieve” (p. 269).

Significant associations have been found between JA and later language abilities (Adamson et al., 2009; Kasari et al., 2006; Mundy et al., 1990), and language development is essential for the ability to learn to read. If a student is not socially engaged, he or she will exhibit more difficulties in gaining new learning associated with language and reading skills. M. Bono, T. Daley, and M. Sigman (2004) said, “It is critical. . . for children with autism to be able to respond and follow an adult’s bid for joint attention to access the intervention curriculum and become engaged in social interactions that are linked to language development” (p. 496).

Typically, JA skills develop within the first year of life for normally developing children (M. A. Bono et al., 2004; Mundy et al., 1990). Eye contact is the earliest and most major form of JA. Children who are typically developing first learn to engage in JA by following the line of visual regard of another social partner. Children who react more often to others’ bid for joint attention have been associated with the greatest gains in language capabilities (M. A. Bono et al., 2004). By the end of the first year of life, they have the ability to initiate JA with eye contact and gestures to share the experience of an interesting object or event with another person.

Initiated JA is thought to reflect the child’s increased motivation to interact with others. The use of highly-preferred materials, topics, activities, and toys in learning opportunities have been found to increase the child’s intrinsic motivation to participate in social interactions. Some students with ASD are capable of producing JA, but lack the social motivation to share their interests with others. Vismara and Lyons (2007) found JA initiations were increased when highly preferred interests were incorporated within the motivational techniques of PRT. When interactions are focused on their preferred interests, children with ASD are more likely to engage a social interaction with their caregivers.

The development of JA is described as a critical milestone in a child's social and communicative development because it develops a foundation for language development and social competence (Mundy & Newell, 2007; Mundy et al., 1990; Taylor & Hoch, 2008). JA is established and maintained by environmental events and social contingencies; likewise, JA skills are associated with better language abilities (M. A. Bono et al., 2004).

Children will ASD exhibit difficulties with social communication. Challenges with JA, an essential element of social communication, has been identified as a commonality among children diagnosed with ASD as well (Hobson & Hobson, 2007). Addressing these challenges is crucial for a child with autism, as Taylor and Hoch (2008) stated, "For a child with autism, learning joint attention responses may open up a different door: one to interactive communication and shared social experiences" (p. 390).

Conclusion

This literature review examined the links between IWBs and its relevance within educational settings and other topics relevant to the development of this research project. Many positive benefits of incorporating IWB technology within instruction were found. Technology and computer-based instruction (CBI) may be a prevailing way to provide instruction to students with disabilities (Mechling et al., 2009).The benefits seem to outweigh the potential negative impacts, which mostly can be avoided by careful, strategic planning and teacher training. Educational administrations must be committed to teaching training and technical support to foster a rich IWB school environment (Digregorio & Sobel-Lojeski, 2010). Common themes in the research included positive impacts on student motivation, engagement, and attention. IWBs are reported to be efficient and flexible, which allows them to meet the needs of a range of learning styles.

The research has showed, however, mixed results regarding how IWB technology impacts student achievement. Higgins et al. (2005) said, “The literature review has revealed a clear preference for IWB use by both teachers and pupils. It remains unclear, however, as to whether such enthusiasm is being translated into effective and purposeful practices” (p. 8). Thus, students are positive about the overall educational experience (Levy, 2002) and more importantly, “teachers bring a much-needed critical perspective to the research process” (Armstrong et al., 2005, p. 466). Previous research has yielded positive results on the impact of other technology-based interventions, such as computer-assisted-instruction, with children with ASD, which yields promising results for IWBs. However, research on IWBs and students with disabilities, especially students with ASD, has not been sufficient (Digregorio & Sobel-Lojeski, 2010; Yakubova & Taber-Doughty, 2013), and as Torff and Tirotta (2010) have concluded, research needs to employ more experimental methods. This study adds to the existing literature by addressing these limitations.

The scarcity of research regarding IWB use and its influence on students with disabilities’ learning is directly applicable to this project. This extensive literature review has provided a solid theoretical basis for the research that follows, which aimed to investigate the links between the usages of an IWB within the special education context by using a quantitative-dominant mixed methods research design. The main purpose of this study was to examine the impact of the use of an IWB on student achievement and engagement for elementary-aged students with ASD in reading instruction.

CHAPTER 3: METHODS

Greater emphasis on implementing teaching practices based on effectiveness from scientific evidence is placed on the current educational system. These requirements were in the provisions of the No Child Left Behind (NCLB) Act of 2001 that mandated federally funded educational programs be designed on evidence-based research. As a consequence, the way schools make critical decisions regarding curriculum, instruction, and the use of technology to support instruction, are largely weighed on whether an intervention is supported by rigorous research.

The majority of the literature on the integration of interactive whiteboard (IWB)technology in the classroom is qualitative and yields positive results, yet the research lacks scientific components which is essential to establishing evidence-based practices. Furthermore, the literature is relatively sparse on the effects of IWB use on students with disabilities. As the incidence of Autism Spectrum Disorder (ASD) continues to rise, the need for effective interventions continues to increase as well (Brown et al., 2013); thus, more research that yields causal inference in special education is needed (Hitchcock, Johnson, & Schoonenboom, 2016b). Therefore, the goal of this project is to contribute to the development of evidence-based practices within special education through quantitative methods to support previous qualitative findings. Reichow, Volkmar, and Cicchetti (2008) created six critical quality indicators and six secondary quality indicators for evaluating research studies looking to identify evidence based practices for students with ASD. These include in-depth descriptions of participant characteristics, independent variables and dependent variables, measures for creating baselines, usage of visual analysis in data analysis, and intent for experimental control. Secondary quality indicators include: requirements of interobserver agreement, calculation of kappa, procedural fidelity assessed, usage of blind raters, evaluation of generalization/maintenance of skills, and social validity addressed. These quality indicators were considered when creating this study's research design and are referenced in this chapter when the quality indicators were met. According to Reichow et al. (2008), a strong single subject research design receives high ratings on all critical quality indicators and demonstrates evidence of three or more secondary quality indicators.

This study combines experimentation and a survey, creating a research project that embeds mixed methods thinking design (Yin, 2006). Mixed methods combine the rigor and precision of experimental designs with the depth of understanding of qualitative data (Hitchcock et al., 2016b).

Research Design

This study investigated three research questions:

1. To what extent are differences found in student achievement when an IWB is integrated into reading instruction, compared to a control, for students diagnosed with high-functioning ASD?
2. To what extent are differences found in student engagement when an IWB is integrated into reading instruction, compared to a control, for students diagnosed with high-functioning ASD?
3. What are the perceptions of students with high-functioning ASD toward the integration of IWB into reading instruction?

This study used mixed methods ideology, which when used within a single study "can simultaneously broaden and strengthen the study" (Yin, 2006, p. 41). Mixed-method methodologies have often been utilized by social scientists to evaluate theories that cannot be done by quantitative ways alone (Krathwohl, 2009). Used in combination, quantitative and qualitative methods complement each other and allow for more complete analysis. A quantitative-dominant mixed methods research approach was appropriate for this study because the intent was to research the effect of the IWB technology on achievement and engagement as well as examine perceptions of the participants. In this study, the role of the qualitative data was secondary to the quantitative data set (Creswell & Plano Clark, 2007). This study included two distinct phases: experimental methods to collect achievement and engagement data, and a post-study interview to get a more in-depth understanding of the research. The same participants were used in both the quantitative and qualitative phases. The experimental phase examined the effects of the IWB on student achievement and engagement followed by the second phase, which through structured interviews, looked at the ASD students' perceptions of IWB integration.

In the first phase, or quantitative part, a single subject design was used. According to Horner et al. (2005), "Because single-subject research documents experimental control, it is an approach, like randomized control-group designs, that may be used to establish evidence-based practices" (p. 166). Interventions or educational strategies must have data that has consistently shown positive patterns of increasing student performances to be considered evidence-based (Kluth & Danaher, 2010; Odom et al., 2003; Tankersley et al., 2008). Additionally, Cardon and Azuma (2011) said that single subject research designs are the most common research design when studying individuals with autism.

This design allowed for a rigorous degree of experimental control that provided additional important information, which could not be gained through a traditional descriptive case study. This design used the person as both the control and experiment, embodied the properties of experimental methods, and suited a range of questions relevant to educational contexts (Tankersley et al., 2008). Single subject research began as a result of Applied Behavior Analysis (ABA), which is a framework for understanding and improving maladaptive human behavior (Marchant, Renshaw, & Young, 2006). Single subject research designs (also termed, single-case experimental designs) are perfect for when the sample size is one subject, or when a sample size is small. These designs are often used to study behavioral changes in individuals as a result of a specific intervention especially with students with low-incidence disabilities (Hitchcock et al., 2016b).

Research related to special education often involves single subject designs (Hitchcock et al., 2016b; Tankersley et al., 2008). They provide a practical methodology for testing educational and behavioral interventions. In single subject designs, each participant serves as her or his own control, similar to a time-series design. A participant is exposed to a non-treatment; then the participant is exposed to a treatment phase, and variables are measured during each phase (Gay, 2003). By measuring target behaviors again and again, researchers can be certain that the data collected are an accurate account of the participant's true performance and random conditions in the environment have minimal impact (Tankersley et al., 2008). Single subject research designs provide a practical research methodology for assessing experimental effects in educational settings.

The two most commonly used types of single subject research designs when studying students with autism are the withdrawal design and the multiple-baseline design (Cardon & Azuma, 2011). Withdrawal designs involve implementation of an intervention (A), and then removal of it, to see how the absence of the intervention affects target behavior (B). Withdrawal designs are useful in identifying a functional or causal relationship between the target behavior and the intervention (Horner et al., 2005), because in A-B-A-B designs the intervention is reinstated (Hitchcock et al., 2016b). According to Tankersley et al. (2008), the design "(ABAB) is one of the most powerful single-subject research designs because it can clearly show the relationship between the implementation of the intervention and changes in the target behavior" (p. 86). This design was suitable to answer the proposed research questions in this study.

Another strong advantage of using a withdrawal design for a study is its straightforwardness (Gast, 2009b). The repeated data collection of performance and behavior required of single subject research is a regular task of most special educators who are required to monitor progress of their students. Special educators often systematically evaluate the effectiveness of their interventions, which requires a basic understanding of the basic principles of single subject research designs: testing a target behavior under both baseline and treatment conditions (Tankersley et al., 2008). Being a special educator for ten years, the researcher had a good base knowledge of the withdrawal model. As a new researcher, a single subject design was easier to implement because it did not require extensive training and required less time than a multiple-baseline design.

The main purpose of this study was to evaluate the impact of the use of an IWB on student achievement and JA for elementary-aged students with high-functioning ASD reading instruction. This research project specifically had an A-B-A-B withdrawal design: a control condition was followed by an experimental condition, which was then followed by an additional control condition, and then an experimental condition. The preference for an A-B-A-B design instead of an A-B-A design was decided based on two main reasons: (a) an A-B-A-B design allowed for two separate instances of replication (Hitchcock et al., 2016b), and the applied nature of educational research made it more dependable (Tankersley et al., 2008); and (b) the internal validity was stronger (Gast, 2009b). Horner et al. (2005) said:

> Traditional case study descriptions, or studies with only a baseline followed by an intervention [A-B-A], may provide useful information for the field, but do not provide adequate experimental control to qualify as single-subject research. (Horner et al., 2005, p. 169)

In this study's design, a student was exposed to two conditions: reading instruction without IWB use (book condition, phase A), followed by instruction of the same curriculum with IWB use (IWB condition, phase B), and then this process was repeated. The research questions assessed differences in student achievement and engagement when a teacher used an IWB in reading instruction for students with high-functioning ASD.

The study was conducted over a six-week period consisting of sessions alternating between the uses of the IWB (B) and withholding the use of the IWB (A). In other words, after one phase, each student moved from the book condition (A) to the IWB condition (B), and then the cycle repeated itself. The only instructional difference between the phases was the integration of the IWB within instruction. The same teacher (the researcher) worked with the same three participants throughout the six weeks, whether they were in the IWB condition (B) or the book condition (A). Each session was systemically introduced and withdrawn for each participant (Tankersley et al., 2008). Each phase included three separate sessions for each participant; however, the length of each session varied slightly based on the unit, student, and reading level of the student. All sessions were approximately 45 minutes of instructional time followed by 15 minutes of free computer time. Most sessions lasted over multiple days. Three participants were used in the study to extend external validity, which was recommended by both Gast (2009b) and Horner et al. (2005).

The researcher was the instructor who implemented the curriculum across all the participants, in both conditions, and the researcher used a procedural checklist to ensure treatment fidelity (see Appendix H). The same instructional procedures for each lesson were followed. Each session began by reading a leveled reader and then completing corresponding worksheets and/or learning tasks related to the book.

The second phase of the study, the qualitative part, measured the perceptions of the participants in semi-structured interviews with each student. The interviews were conducted after the completion of data collection from the first phase of the study. The purpose of the data gained from the interviews was to supplement the experimental data found in the first phase. "Qualitative information can inform understanding of causal mechanisms" (Hitchcock et al., 2016b). Attitudes have been linked to student engagement levels; as a result, there was significance in finding students' attitudes towards the use of IWBs in the classroom (McQuillan et al., 2012).

Priority was given in this design to the single subject design because that phase represented a majority of the data collection and analysis. The qualitative component of this study was to add more descriptive data to the experimental findings.

Setting and Participants

Setting

The study took place in a public elementary school in a suburban area of Northern Colorado. Baseline and intervention sessions were conducted in the school's special education classroom (that serviced students with moderate to severe needs) equipped with an IWB. All sessions were conducted one-on-one. During phase A, the student sat across from the instructor at a rectangular-shaped table. During phase B, the student stood or rode a stationary bike positioned approximately two feet from the front of the IWB. The instructor sat to the right of the IWB in front of the student.

Participants

Reichow et al. (2008) required the following participant characteristics to be described in the study for it to meet quality indicator one: age, gender, and specific diagnostic information for all participants and a detailed description of the characteristics of the interventionist. This section includes these components.

Researcher. The researcher was one of two special education teachers at the school site. She was fully credentialed and highly qualified with more than ten years of teaching experience with ASD students. Five of those years include elementary-aged education. At the district level, the researcher also participated in training teachers and support staff in applied behavior analysis (ABA). She has a master's degree in Special Education, has an Administration licensure, and was pursuing a Doctorate in Education at Colorado State University at the time of the study. She has had an IWB in her classroom for the last eight years, and used it as part of daily instructional routines.

Student participants. The theoretical population for this study was elementary-aged students identified with high-functioning ASD who had a measureable reading ability greater than a first-grade level. The sample for this study was a good representation of this population.

Three students were selected for participation in this study. Students ranged in age from 7 to 12 years old and were selected based on that they: (a) had goals in their individual education plans (IEP) that focused on improving their reading skills; (b) had both a medical and educational diagnosis of ASD; (c) had measurable reading abilities greater than a first-grade level; (d) had a willingness to participant in the study; (e) had prior experience using an IWB; and, (f) had a past teacher-student relationship with the researcher. Participant selection was based upon a sample of convenience. The sampling pool consisted of students receiving intensive support (based on their moderate to severe disabilities) in the district the researcher taught. Children who had multiple diagnoses with autism were excluded from participating in the study to eliminate confounding factors.

The participants were both verbal and ambulatory and also had both a medical diagnosis and an educational determination of ASD. These are two distinct types of assessments for diagnosing ASD: educational verification and medical diagnosis. A medical diagnosis of ASD was determined for each participant by a licensed practitioner or doctor. Each of the participants received an educational diagnosis of ASD by a multidisciplinary evaluation team comprised of various school professionals and parents. The team, based on a variety of evaluation data, determined that each student qualified for special education and related services under the category ASD in the Individuals with Disability Act (IDEA). Significant documentation exists of qualitative impairment for each student in social interactions, communication, and restricted repetitive and stereotyped patterns of behavior, interests, and activities. At the time of participation, some students were enrolled in the specialized educational program. To participate in the specialized program, the students showed a need for intense structure, visual supports, and highly specialized instruction that could not be provided with the general education curriculum alone. Tim, Abby, and Miles are fictional names that were used in this study to protect anonymity, confidentiality, and the privacy of the participants. Table 3.1 summarizes the gender, age, grade level, diagnosis, DRA-2 score, and reading level of each of the participants

Tim. Tim was a twelve-year-old male student. He finished sixth-grade at the start of the study. The researcher has case-managed and has been his special education teacher for six years (kindergarten through 5th grade). The past year, Tim was served by another special education teacher at the middle school. When tested in 2010, Tim's performance on a formal test of cognitive abilities (WISC-IV) suggested that his nonverbal reasoning abilities are much better developed than his verbal reasoning abilities, particularly as evidenced by his performance on an untimed task of nonverbal matrix reasoning. Specific scores include: Composite Scores Summary – (Average range = 90-110), Verbal Comprehension (VCI) 59, Extremely Low Range Perceptual Reasoning (PRI) 79, Borderline Range Working Memory (WMI) 71, Borderline Range Processing Speed (PSI) 78, Borderline Range Full Scale (FSIQ) –not reported due to significant discrepancy (VCI-PRI). These scores suggest that Tim may learn best when provided with the accommodations of repeated verbal instructions and/or visual aides. His reading abilities were at the second-grade level at the start of the study. He was able to participate in the general education curriculum with modifications for non-core subjects and received alternative instruction for reading, writing, and math in a special education classroom.

Abby. Abby was a seven-year-old female student. She finished her second-grade year at the start of the study. The researcher has case-managed her, and has been her special education teacher for the previous three consecutive years (kindergarten, 1st, and 2nd grade). Abby's cognitive abilities measured a full scale of 118, assessed by the Weshcler Preschool and Primary Scale of Intelligence-4th edition WPPSI in September 2014 by a school psychologist. The Full Scale of 118 is considered to be in the high-average range. This information suggests that Abby has the cognitive ability to be successful with most grade-level tasks when she is focused and motivated. Her reading abilities were within grade-level expectations at the start of the study. She was able to participate in the general education curriculum with accommodations.

Miles. Miles was a nine-year-old male student. He finished his third-grade year at the start of the study. The researcher has case-managed him, and has been his special education teacher for three previous years (kindergarten, 1st, and 2nd grade). The past year, Miles was served by the other special education teacher at the school. Miles's cognitive abilities measured a full scale of 97, assessed by the Weshcler Preschool and Primary Scale of Intelligence-Third edition WPPSI in December 2010 by a private licensed psychologist. The Full Scale of 97 is considered to be in the average range. This information suggests that Miles has the cognitive ability to be successful with most grade-level tasks when he is focused and motivated. His reading abilities were within grade-level expectations at the start of the study. He was able to participate in the general education curriculum with accommodations.

Table 3.1

Description of Participants

Student	Gender	Age	Grade	Diagnosis	DRA-2 score	Reading level
Tim	Male	12	5	ASD	20	2nd grade
Abby	Female	7	2	ASD	28	2nd grade
Miles	Male	9	3	ASD	38	3rd grade

Note. DRA-2 = Diagnostic Reading Assessment 2nd Edition

Protection of Human Subjects

The researcher completed the requisite CITI Human Subject's Training during the Spring Semester of 2012 and recertified in October 2015. Documentation of the successful completion of this training was on file in the Office of Research at Colorado State University and is included in Appendix F (see Appendix F).

An application was submitted to the Colorado State University Institutional Review Board for the protection of Human Subjects, and permission was granted for the study (see Appendix F). Also, the school district's director of assessment and professional development and the school principal approved the study.

Parental Consent and Student Assent

Recruitment letters and parental consents were emailed to parents of students that fit the criteria. The recruitment letter and informed consent explained why the student was invited to participate. The letter also included information about the study, such as that sessions would be videotaped (Caldwell & Atwal, 2005), as well as phone numbers and contact information if questions arose. It was communicated to parents that their children would receive free reading intervention during the summer for being in the study. Parents signed and returned the consent form. Parents were encouraged to talk to their children about the study. Then the researcher approached the students to explain the study in terms understandable to the children. All of the students, with parent consent forms already signed, agreed to sign the student assent form (see Appendix B). Every attempt was made to keep the identities of all participants in the study secret. Any information collected, including videotapes, was kept confidential and stored in a secure place. There were no anticipated adverse effects for participants in the study.

Data Collection

Dependent Variables and Measures

Reichow et al. (2008) required the following components related to dependent variables to meet quality indicator three: All dependent variables must have operational definitions, demonstrate an apparent link to the independent variable, and must be collected at appropriate times. This section describes these components related to the study.

In this study, the experimental questions addressed the effects of IWB's on achievement and engagement. The data was collected in the classroom because behavioral change in a person's natural setting is the ultimate goal of educational research. Single subject studies use a variation of direct observation for collecting data on target behaviors. Direct observation of student performance was utilized in areas such as academic (e.g., reading, writing, math) and behavioral skills (e.g., self-regulation, on-task behavior, disruptive behavior) (Tankersley et al., 2008). Four dependent variables were measured during the study. Table 3.2 lists the defined variables included in this research project. Clear behavioral operational definitions of target behavior helped to promote replication of the study, reliability, and overall trustworthiness of the research (Tankersley et al., 2008). The objective criteria for measuring each dependent variable student achievement, student engagement, and students' perceptions in this study are described in detail.

Table 3.2

Description of Variables

Name of Variable	Description of Variable	Type of Variable
Student Achievement	Difference in the number of words read correctly in a minute pre and post intervention	Dependent
Student Achievement	Performance on end unit Comprehension quizzes on non-fiction text	Dependent
Student Engagement	Frequency of child-initiated joint attention during instruction (Eye contact, verbal, gesture)	Dependent
Student Perceptions	Responses from structured interviews after study	Dependent
Phase A (control condition)	Curriculum without use of IWB	Controlled
Phase B (experimental condition)	Curriculum with use of IWB	Controlled
Teacher materials	*Reading A-Z.com* online curriculum–All non-fiction text	Controlled
Instructional Hours	20-40 minutes, 4 mornings a week	Controlled
Students	Elementary-aged students with high functioning ASD	Controlled
Teachers	Special Educator (same in all phases)	Controlled
Pedagogy	Direct instruction	Controlled

Student achievement. This variable was measured by reading accuracy and comprehension. Reading accuracy was measured by the difference in the number of words read correctly in one minute as a pre and post-evaluation. The pre-reading accuracy test was administered at the start of session one and the post-reading accuracy test was administered during session three of each phase of the study. Reading comprehension was measured by the performance on the end-unit comprehension quizzes after each phase. There were four units, one for each phase of the study, for each participant in the study.

Reading comprehension is difficult to operationally define because it involves a number of cognitive abilities that are hard to directly measure; therefore, reading comprehension was defined according to the literature. According to Brown et al. (2013), conducting a meta-analysis of 36 studies on students with ASD, operationally defined reading comprehension "as any task that first required the participant to read sentences or a short text and then to use their understanding of what they read to complete the task" (p. 936). Assessments often require students to read a text and demonstrate their understanding (Kameenui & Simmons, 1999). The comprehension quizzes in this study assessed students on concepts and facts from the book in the unit.

Student engagement. This variable was measured by informal observational measures that involved observation of the frequency of child-initiated joint attention (IJA) topographies during each phase using the Joint Attention Coding Protocol (see Appendix D). In order to make the coding feasible, the number of behaviors was reduced to three (eye contact, gesture, and verbalization). The researcher developed the data collection instrument based on current research of JA. The committee reviewed the data collection instrument before it was utilized in the study. The Joint Attention Coding Protocol was piloted before the study and further refined to minimize measurement error.

Each child-initiated topographic had an operational definition. Eye contact was defined as when a child initiated eye contact with the teacher during an active event. The teacher must also be looking at the child in order for the child to receive this code. A gesture was defined as when a child extends a finger in the direction of an object during an active event in the effort to direct attentional focus of the teacher. A verbalization was defined as when a child commented appropriately, or asked related to the instruction, in an effort to direct the attentional focus of the teacher. Engagement data were coded from videotapes of the live sessions. Occurrences of eye contact, gestures, and verbalizations were recorded for each phase. Engagement data could have been gathered through observation alone; however, videotaping of the sessions allowed for more objective, thorough analysis, and opportunities for repeated reviews of sessions (Caldwell & Atwal, 2005) to establish inter-rater reliability of the coding.

Student perceptions. This variable was measured by students' answers to five questions related to the study (see Appendix E). The questions were adapted from the SMART Board Attitude Scale (SBAS), a standardized instrument developed to evaluate the attitudes of elementary students toward IWB use in education (Şad, 2012). The semi-structured interview with each student was conducted one-on-one at the conclusion of the study.

Control Variables

Reichow et al. (2008) required that the description of the independent variable must be explicit to meet quality indicator two. This section explains how this study meets this requirement.

Validity was managed as closely as possible. Every aspect of the experimental preparation was realistically controlled to establish external validity. External validity was addressed because the intervention was replicated with three different participants. For each student, the curriculum, instructor, behavior expectations, lesson procedures/routine, setting, time of day, and duration of instruction remained consistent (i.e.: *Reading A-Z.com*, same researcher, worked for 45 minutes followed by 15 minutes of free computer time, same varied reinforcers, in a 1:1 ratio in the same special education classroom, four mornings a week during summer break).

The reading program was an online curriculum called *Reading A-Z.com*. It has a range of leveled readers from level AA to Z that correspond with the Developmental Reading Assessment, 2nd Edition (DRA 2) scores. Each of the units included full lesson plans (including instructions for the teacher), printable worksheets, manipulatives (e.g., discussion cards), corresponding readers, and comprehension quizzes at the higher reading levels. The *Reading A-Z.com* curriculum was chosen because it had all the instructional materials (leveled books, benchmark books, comprehension activities, and quizzes) available in printable form and also formatted for digital projectors and IWBs. Each unit in this curriculum had the same format, even though different units were used for different phases of the research project. For this study, the curriculum was administered using direct instruction. The *Reading A-Z.com* curriculum is not normed. However, it includes core elements of scientifically based reading programs including explicit and systematic instruction in phonemic awareness, phonics, fluency, vocabulary, and comprehension. *Reading A-Z.com*'s website stated that the curriculum has earned awards such as the Parents' Choice Recommended Award, the Global Learning Initiative Award, and the Teachers' Choice Award.

The control condition (phase A) was the implementation of the *Reading A-Z.com* curriculum in traditional book and paper form, while the experimental condition (phase B) was the same curriculum, but presented on an IWB (with no print materials). The IWB was a large, touch-sensitive screen connected to a computer and projector. The computer screen was projected onto the whiteboard, which allowed for the teacher the freedom to interact directly with the student.

To ensure validity for achievement data across students, ReadingAtoZ.com unit comprehension quizzes and word accuracy rates of each individual were used as measures. Participants' reading levels were determined by a well-used assessment tool called the Developmental Reading Assessment 2nd Edition (DRA 2) to ensure that the reading instruction was developmentally appropriate for each student. DRA-2 is a tool used by teachers to establish students' reading levels based on accuracy, fluency, and comprehension. The DRA-2 assesses the major components of reading that are essential to an independent reader. It identifies students' reading strengths and needs, in order to help teachers monitor progress of reading growth and guide instruction. The tests are conducted one-on-one with the assessor. Leveled texts that increase in difficultly are used for the assessment.

To ensure validity for engagement data, the Joint Attention Coding Protocol (see Appendix D) included well-defined observable and measurable definitions of the IJA behaviors. The coding tool has been piloted in various educational settings before the study. The researcher was trained in applied behavior analysis (ABA) and had extensive experience with recording observational data.

Procedures

Each baseline phase (book format) consisted of three sessions and each intervention phase (IWB format) consisted of three sessions. The overall study design consisted of the following sequential format: a one-week pilot phase, a one-week baseline phase, a one-week intervention, a one-week baseline phase, and lastly a one-week of intervention. Each session took approximately twenty to forty minutes, depending on each student's reading level and learning abilities.

Pilot Phase

Pilot studies are a crucial part of a good study design and this study included a pilot phase for the first week. The pilot phase was used to increase the probability of success during the actual study. The purpose of the pilot phase was to field test the data collection instruments and procedures, assess whether the research protocols were realistic and workable, provide an opportunity for the beginning researcher authentic practice in the research process, and test the video techniques before taping during the actual study. Many factors are involved when using video recordings in research. The pilot phase allowed the participants and the researcher to become familiar with the equipment, identify logistical problems, and establish camera placements, angles, and lighting for optimum coverage. Based on the findings of the pilot phase, any revisions needed to any procedures were made prior to the beginning of the study.

Baseline and Intervention Phases

The teacher was positioned so that she was able to view the student during the designated reading activities. Students were present and participating in the lesson, and the teacher was delivering varied reinforcement throughout the lesson (e.g., praise, high-fives, and edibles). The video camera was in a fixed location in the room that allowed it to capture the student, the teacher, and the IWB or learning materials. Before each phase began, the teacher offered the student a choice between two non-fiction units at his or her reading level (with books with similar number or words). Within the controlled condition, the student had a level of choice to aid in gaining the student's interest.

During the first session (I), the following procedures were implemented for introduction of vocabulary and building background knowledge. The teacher wrote high frequency and content words on a whiteboard for the student to see. The teacher had the student read through the words with her. The teacher had a conversation about each content word with the student to check for understanding. If the student did not demonstrate a clear understanding of the word, the word was looked up in a dictionary. In phase A, a paper dictionary was used and in phase B an online dictionary was used. The teacher showed the student the front cover of a wordless book about to be read and read the title to him or her. The teacher asked the student what he or she thought the book was going to be about. The teacher completed a picture walk with the student. The teacher and the student discussed aloud what they saw in each picture. While previewing the book, the teacher reinforced the vocabulary words with the student and reminded him or her to look for the words in the pictures. After the picture walk, the teacher asked the student to make a prediction about the story. Then the teacher and student were ready for the first reading of the story.

The teacher showed the student the title page and discussed the information on the page (e.g., title of the book, author's name and illustrator's name). The teacher gave the student a copy of the book in phase A, or had it ready to read on the IWB in phase B. The teacher had the student point to the first word on page three and reminded the student to read words from left to right and to again look for words they had previously reviewed. The teacher set a timer for one minute to record the student's word count in one minute. When the timer stopped, the teacher had the student count the number of words read and the teacher recorded it. The teacher encouraged the student to continue to read the story. During the first reading, the teacher did not focus on comprehension, but assisted the student with decoding words whenever needed. At the end of the first reading, the teacher asked the student to tell her two things he or she remembered from the story. The student completed a corresponding worksheet. In phase A, the worksheet was in paper form, and in phase B, the worksheet was completed on the IWB. The teacher answered any questions the student had and checked for understanding. This concluded the first session (I).

The second session (II) consisted of the second reading of the story. If it was a new day, the teacher asked the student what he or she remembered from the text. The teacher gave the student the option to reread the text silently or aloud with her. The teacher asked the following comprehension questions orally at the end of the book to review the text with the student: Who (characters), what (plot, problem), where and when (setting), and why was the text important. The teacher and the student discussed the comprehension questions on the discussion cards. The student then completed any of the corresponding worksheets. In phase A, the worksheets were in paper form, and in phase B, the worksheets were completed on the IWB. The teacher answered any questions the student had and checked for understanding. This concluded the second session (II).

During the third session (III), the teacher had the student reread the text aloud to her. The teacher set a timer for one minute to record the student's word count again. When the timer buzzed, the teacher counted the number of words the student had read. The teacher recorded the word count. The teacher encouraged the student to continue to read if the student had not read the text the previous day. The student then completed any other corresponding worksheets (if applicable). Lastly, the teacher issued the student the corresponding comprehension quiz to the student. The student was not allowed to use the book for the quiz. The teacher did not help the student answer any of the multiple-choice questions. An independent score was recorded for all multiple choices questions. When the student was finished, the teacher recorded the independent score. Lastly, the teacher had the student complete the extended response question and helped the student when needed. This concluded the third session (III).

Collecting Achievement Data

The baseline and intervention condition were conducted in the following manner: Abby, Miles, and Tim were given an oral reading test for one minute before being introduced to the reading unit lesson. Word accuracy was recorded to establish a baseline. For three different sessions, the students participated in literacy tasks using the traditional book and paper method. The oral reading test was conducted again after the third session. At that time, an end-unit comprehension quiz was also given. The student's independence score on the comprehension quiz and the pre and post reading rates were documented for each of the four phases. Except for the modality of the reading material from paper to IWB, nothing else in the instruction was changed from phase to phase. These same steps were repeated to complete an A-B-A-B design. The researcher, who was also the teacher during the study, conducted and collected the achievement data.

In a spread sheet, the condition (control or IWB), the number of words read correctly in a one minute pre and post-intervention, and the results of the four-unit comprehension quizzes were recorded. See Appendix C for data collection tools for student achievement.

Collecting Engagement Data

Many single subject research designs utilize direct observation for specific identified behaviors (Tankersley et al., 2008). Data on engagement was collected in each baseline and intervention phase for each of the three students. Over the course of the study, there were three sessions in each of the two baselines and intervention phases. This resulted in a total of twelve recorded observations for each student. Each instructional session was videotaped. The video camera was positioned in front of both the participant and the researcher so that both could be viewed at the same time. Camera angles were carefully evaluated to ensure that the instructor and the students were fully observable during a pilot phase. Videotaping allowed for repeated observations of the same event and for the researcher to review the instructional sessions separately and to conduct secondary analysis (Caldwell & Atwal, 2005). Recordings were made using a Sony Digital HD Video Camera Recorder provided by the education department at the university. The data were analyzed to compare the occurrences of the targeted behaviors under the two different conditions.

Observational coding has been used to collect data on JA behaviors in several studies with children with ASD (Kasari et al., 2006; MacDonald et al., 2006; Taylor & Hoch, 2008; Vismara & Lyons, 2007). The frequency of targeted behaviors in each session of each phase was documented on the video coding data collection tool (Appendix E). The data collection tool documented the individual occurrences of the JA behaviors within each observation session. Each time a JA behavior occurred, the instance was recorded with a "+". At the end of each coding session, the number of each JA behaviors were counted and the total number of occurrences reported. By applying the coding system, the researcher was able to closely and precisely examine students' JA actions across the phases. Specific protocols were prescribed for coding in the JA Video Coding Protocol (Appendix D), which stated clear, operational definitions of the targeted behaviors and methods on how to record them (Caldwell & Atwal, 2005). It was developed to ensure the ability to replicate the study and for coding accuracy. The videotaping allowed for the tapes to be played back multiple times (Caldwell & Atwal, 2005). The JA behaviors were coded from the videos by the researcher on two separate occasions with a minimum of two weeks apart. The ratings from the researcher were analyzed and test-retest reliability was determined.

Student Interviews

At the end of the last phase, interviews were conducted individually with the researcher and each student. The interviews took place in the special education classroom. Each interview included five questions for the participant: three open-ended questions and two multiple answer (see Appendix E). Each interview was videotaped for transcription purposes.

Reliability

Procedural Fidelity

Procedural fidelity was assessed through observation by the researcher and the use of a procedural fidelity checklist during each session of each phase (see Appendix H). The checklist served as a reminder of the procedures to follow and the materials required: timer, books, corresponding worksheets, discussion cards, and reinforcers. The procedures were easy to follow, which increased the social validity of the intervention and enhanced treatment integrity. The researcher observed her self-conducting the instructional procedures through video recording.

Reichow et al. (2008) required the following components related to procedural fidelity to meet secondary quality indicators for single subject designs: procedural fidelity must be assessed constantly across all participants, conditions, and interventionists with reliability at or greater than .80. This study meets these requirements. The researcher, who was the same person in the videos, observed the videotaped sessions (five involving each student) from the pilot phase using the procedure checklist (see Appendix H). Compliance with the methods were noted by a “+” or “-”. The checklist was retained until the conclusion of the study. During the pilot phase, procedural integrity was calculated as a percentage, using the number of correct procedures followed by the teacher divided by the number of total prescribed procedure. If the procedural integrity dropped below 95 % during the pilot phase, then the discrepancies were reviewed and modifications were made. The instrument was developed by the researcher and was piloted (field-tested) in her classroom 10 times prior to its use in the pilot phase of the study. It was modified until a pattern of consistency was established to ensure instrument validity and clarity of expectations prior to the actual study.

Reliability of Coding

Threats of instrumentation were controlled through collection of observed reliability data. Multiple coders were considered, however, this procedure requires a significant amount of financial responsibilities and time to train observers before they are able to code with acceptable reliability; therefore, inter-rater reliability was completed with the same coder overtime. The researcher watched each video-recorded session and coded the three IJA behaviors of interest on the JA video coding data collection tool (Appendix E) according to the guidelines prescribed in the Joint Attention Coding Protocol (Appendix D). Then after a two-week interval of time, the researcher re-watched each video-recorded session and recoded the behaviors again blind to the previous coding. This procedure ensured reliability. By doing this, the researcher was able to estimate the degree of coding accuracy of the two separate coding sessions to establish inter-rater reliability. The degrees of accuracy between the two different coding sessions were approximately 78% for Tim, 84% for Abby, and 82% for Miles. When averaged, these degrees of accuracy meet the minimum interobserver agreement standards of 80% that is recommend in the literature for the use of single subject research to identify evidence-based interventions in special education (Horner et al., 2005). The direct observation-coding instrument was developed by the researcher from a variety of sources and was piloted (field-tested) in her classroom several times prior to its use in this study to ensure instrument validity and clarity of the items being described.

Data Analysis

Single subject research data can be evaluated through statistical methods; however, it is more common to examine data through visual inspection (Tankersley et al., 2008). Visual analysis as the sole decision-making method for drawing conclusions has been criticized, though, and the reliability of statements based on visual analysis have been questioned (Gast, 2009b). A combination of both visual and statistical analysis allows for a deeper and comprehensive understanding of the data. Statistical methods allow for the discovery of small, but important effects that possibly could have been overlooked in a simple visual analysis (Tankersley et al., 2008). They assess dependent variables' effects when there is not a stable trend during the baseline phase. Lastly, statistical methods are more objective than visual methods because statistical analysis strengthens and supports visual analysis. Gast (2009b) emphasized, "The ability to quantify intervention effects is important, as several fields now frequently require researchers to report effect sizes in research reports, regardless of the final statistical test results reported" (p. 422).

For this study, data analysis was conducted by examining between-and within-phase patterns for achievement and engagement of each of the three students. It included descriptive statistics on the data, visual analyses of line graphs displaying data from phase by phase, and an analysis of changes from phase to phase for each student.

Visual inspection is a systematic way for evaluating a graphic representation of the continuous data from both baseline and intervention phases. Visual analysis has been used in several single subject designs that have evaluated the effectiveness of reading interventions with students with autism and ASD (Mundy et al., 2003). As suggested by Horner et al. (2005), comparisons were made within participants by level (the amount of magnitude of the target variables), trend (direction in the pattern of the data points as either increasing, decreasing, cyclical or curvilinear), and variability (the degree to which performance fluctuates around a mean or slope) of the changes in achievement and JA across each phase A and B. Graphs that provided evidence of correlations show a stable horizontal baseline, followed by acceleration of the target variable (positive correlation) or a deceleration (negative correlation) during intervention. Changes were examined for increase or decrease, or any qualitative differences in the dependent variables measured at interventions compared to baselines. Achievement and engagement scores were graphed using a simple line graph with phase running on the horizontal axis and each dependent variable running on the vertical axis. Graphing continued from phase to phase. Introduction of each phase was indicated on the graph by a vertical line. In single subject designs, the data should increase or decrease in accordance with active manipulation of the independent variable by the researcher (Horner et al., 2005).

Statistical tests were conducted to refine the observations from the graphic patterns examined through visual inspection. The statistical program, SPSS, was used for analysis of the data. To statistically analyze the data, the researcher ran a paired T-test and Wilcoxon test to look at the mean difference of each dependent variable across each of the A and B conditions.

The data violated the summation of the paired T-test so a non-parametric analysis was also completed. Table 3.3 shows the analysis plan.

Table 3.3

Summaries of Data Analysis Procedures

Research Question	Instrument Content	Variables	Analysis
Effects on achievement	Word Accuracy of Reading A to Z leveled reader	Words read accurate in one minute	Visual inspection of level, trend, slope variability Statistical significance Paired t-test Wilcoxon test
Effects on Achievement	*Reading A-Z.com* Unit Comprehension Quizzes	Percentage of correct answers	Visual inspection of level, trend, and slope variability Statistical significance Paired t-test Wilcoxon test
Effects on Engagement	Observational coding of target behaviors	Frequency of child-initiated joint attention topographies	Visual inspection of level, trend, and slope variability Statistical significance Paired t-test Wilcoxon test
Students' Perceptions	Survey		Descriptive

Conclusion

This chapter described the methodology for this study. The research design was a mixed method design including an A-B-A-B single subject design, with alternating baselines and intervention phases, and a supporting qualitative component. A detailed description of the participants, procedures, instruments, and data collection were included. Data analysis was also described in detail.

Ivers and Pierson (2003) mentioned knowledge of the benefits of technology and how technology can help students learn is important for school staff in supporting all learners, especially those with more needs. The benefits of the appropriate use of technology are very promising in the support of students with special needs and all learners with different learning styles. Using technology with various groups of students can also be cost efficient, as the cost of technology is a serious consideration for all schools.

When the data collected pre and post-intervention are close to baseline, it is difficult to determine whether changes are meaningful or whether they have occurred on a chance basis. The criterion of statistical significance provides evidence to solidify the conclusion of clinical significance. This study attempted to fulfill the conclusion of Higgins et al. (2005):

> To understand the best way for practitioners to use IWB technology in the future as transformational devices, research is needed in order to collect empirical evidence so that the processes of teaching and learning with this new technology are more fully understood and more coherently conceptualized. (p. 99)

This study contributed to the identification of evidence-based practices in the education context for students with ASD. The main purpose of this study was to examine the impact of the use of an IWB on student achievement and JA for elementary-aged students with ASD during reading instruction. Chapter 4 presents the findings of this study.

CHAPTER 4: RESULTS

Chapter 4 gives the results from an analysis and interpretation of the study data. This chapter is organized by: research question, participant, and the type of analysis. This chapter contains the data collected to examine the impact of the use of an interactive whiteboard (IWB) on student achievement, and JA for elementary-aged students with high-functioning Autism Spectrum Disorders (ASD) in reading instruction. These mixed methods included gathering of both quantitative and qualitative data (Creswell & Plano Clark, 2007). The first phase included a single subject design that compared the effects of IWB use on elementary-aged students with high-functioning ASD by examining the students': (a) frequency of IJA during instruction; (b) performance on weekly comprehension quizzes; and, (c) percentage of word accuracy on pre/post reading passages. The second phase of the study played a supplemental role by examining the students' preferred method of curriculum delivery (IWBs or traditional reading instruction) through a structured interview after completion of the last phase.

To evaluate the impact of the use of an IWB on student achievement and reading instruction engagement for elementary-aged students with high-functioning ASD, the first portion of the study used a withdrawal single subject A-B-A-B design. This portion of the study consisted of two baseline phases (A) and two intervention phases (B). Each baseline phase was composed of one data point, and each intervention phase was composed of one data point. The data points plotted represent students' fluency, comprehension, and frequency of IJA behaviors (gesture, verbalizations, and eye contact).

The control condition was followed by an experimental condition, followed by an additional control condition, and lastly, an experimental condition. The second portion of the study included structured interviews with the participants.

The results of the study are presented in the following three sections. The first section reviews the visual analysis results of the single-subject design regarding question one and two (achievement and engagement variables). The second section reviews the results of the statistical analysis of single subject design regarding questions one and two (achievement and engagement). Finally, the third section reviews the results from the post-study interviews with the participants. Triangulation of data collected from both quantitative and qualitative means concludes this section. The main purpose of this study was to examine the impact of the use of an IWB on student achievement and JA for elementary-aged students with ASD in reading instruction.

Visual Analysis of Research Questions One and Two

Research Question One

The first research question asked to what extent are differences found in student achievement when an IWB is integrated into reading instruction compared to a control. Comparisons are for students diagnosed with ASD, as measured by the difference in the number of words read correctly in a minute pre and post intervention (word accuracy), and performance on end unit comprehension quizzes (quiz) of non-fiction text. A single subject A-B-A-B design was implemented, and results were analyzed by a visual comparison of data points across conditions. Results for each participant are reviewed next (see Table 4.1, 4.2, and 4.3).

Tim. Table 4.1 summarizes Tim's achievement through each phase.

Table 4.1

Tim's Achievement Summary Across Each Phase

Date	Phase	Title of unit	Pre # of words p min	Post # of words min	Difference in pre+post	Comprehension quiz score
6/3/15	PB (A)	Monster Truck	104	130	26	70
6/8/15	IWB (B)	Woods of Wonder	112	118	6	80
6/11/15	PB (A)	Colonial Life	108	180	72	80
6/16/15	IWB (B)	World Holidays	118	128	10	80

Note. PB = paper book; IWB = interactive whiteboard

Word count. Tim decreased in word count from the first baseline to the first intervention phase. Secondly, Tim displayed a significant increase in the number of words read when the second baseline phase was implemented. Lastly, Tim responded with a significant decrease when the final intervention phase was reinstated. Based on this pattern of data, Tim's word count was significantly better with the traditional method of reading instruction without technology than on the IWB (see Figure 4.1).

Comprehension. Tim grew in percentage of comprehension from the first baseline to the first intervention phase. Secondly, Tim maintained the same comprehension score from intervention to when the second baseline 2 was implemented, and again when the final intervention phase was reinstated. Based on this pattern of data, Tim's comprehension was not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.2).

Abby. Table 4.2 summarizes Abby's achievement through each phase.

Table 4.2

Abby's Achievement Summary Across Each Phase

Date	Phase	Title of unit	Pre # of words/min	Post # of words/ in	Difference in pre+post	Comprehension quiz score
6/2/15	PB (A)	How Much Is A Trillion?	67	72	5	50
6/8/15	IWB (B)	Wild Horses	66	73	7	50
6/10/15	PB (A)	History of the Bicycle	74	103	29	80
6/16/15	IWB (B)	Wiggly Worms	70	98	28	50

Note. PB = paper book; IWB = interactive whiteboard

Word count. Abby had a slight increase in word count from the first baseline to the first intervention phase. Next, Abby displayed a huge growth in the number of words read when the second baseline was implemented. Abby's number of words read again improved slightly when the final intervention phase was reinstated. Based on this pattern of data, Abby's word count was not significantly better with the reading instruction on the IWB than with the traditional method without technology. Her word count continued to increase across all four phases (see Figure 4.1).

Comprehension. Abby's degree of comprehension remained the same from the first baseline to the first intervention phase. Abby displayed an increase in her comprehension score when the second baseline was implemented, and lastly, the score declined as the final intervention phase was reinstated. Abby's pattern of comprehension may suggest that the baseline could have positively impacted her achievement since there was no difference from baseline to intervention. However, she had an increase in comprehension from intervention to baseline 2, and a decrease from baseline 2 to intervention 2. Based on this pattern of data, Abby's comprehension was not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.1).

Miles. Table 4.3 summarizes Miles's achievement through each phase.

Table 4.3

Miles's Achievement Summary Across Each Phase

Date	Phase	Title of unit	Pre # of words p min	Post # of words p min	Difference in pre+post	Comprehension quiz score
6/1/15	PB (A)	A Landforms Adventure	119	140	21	90
6/8/15	IWB (B)	What Is Water Worth?	127	127	1	70
7/6/15	PB (A)	Albert Einstein	114	138	24	80
7/13/15	IWB (B)	Deserts Dry	118	169	51	88

Note. PB = paper book; IWB = interactive whiteboard

Word count. Miles' pattern of number of words read was different than both Tim and Abby's patterns from phase to phase. Miles decreased in the number of words from the first baseline to the first intervention phase. Then Miles displayed an elevated amount of words read when the second baseline phase was implemented and followed an elevated pattern when the final intervention phase was reinstated. Based on this pattern of data, Miles' word count was not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.1).

Comprehension. Miles initially declined in his comprehension score from the first baseline to the first intervention phase. Secondly, Miles showed a consistent growth pattern in his comprehension scores across the rest of the phases of the study. Based on this pattern of data, Miles's comprehension was not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.2).

Summary Analysis of Achievement Data

If the goal is a sustained increase in behavior, from the information available, the intervention did not cause an increase in number of words for any of the three students. For this to be the case, there would have needed to be amplification in the frequency of number of words from both baseline to intervention and again from baseline 2 to intervention 2. This was not found. Interestingly, the intervention appeared to have a negative correlation on word count for Tim. His achievement was higher during both baseline phases, and then he performed lower than expected during both intervention phases. The IWB actually lowered Tim's word count level. Also, the intervention appeared to have a negative correlation on comprehension for Abby since her baseline 2 increased; however, intervention 1 and 2 both remained the same level.

If the goal is a longstanding increase in behavior, the information available in this study did not show that the intervention caused an increase in comprehension for any of the three students as well. These results are represented in Figures 4.1 and 4.2.

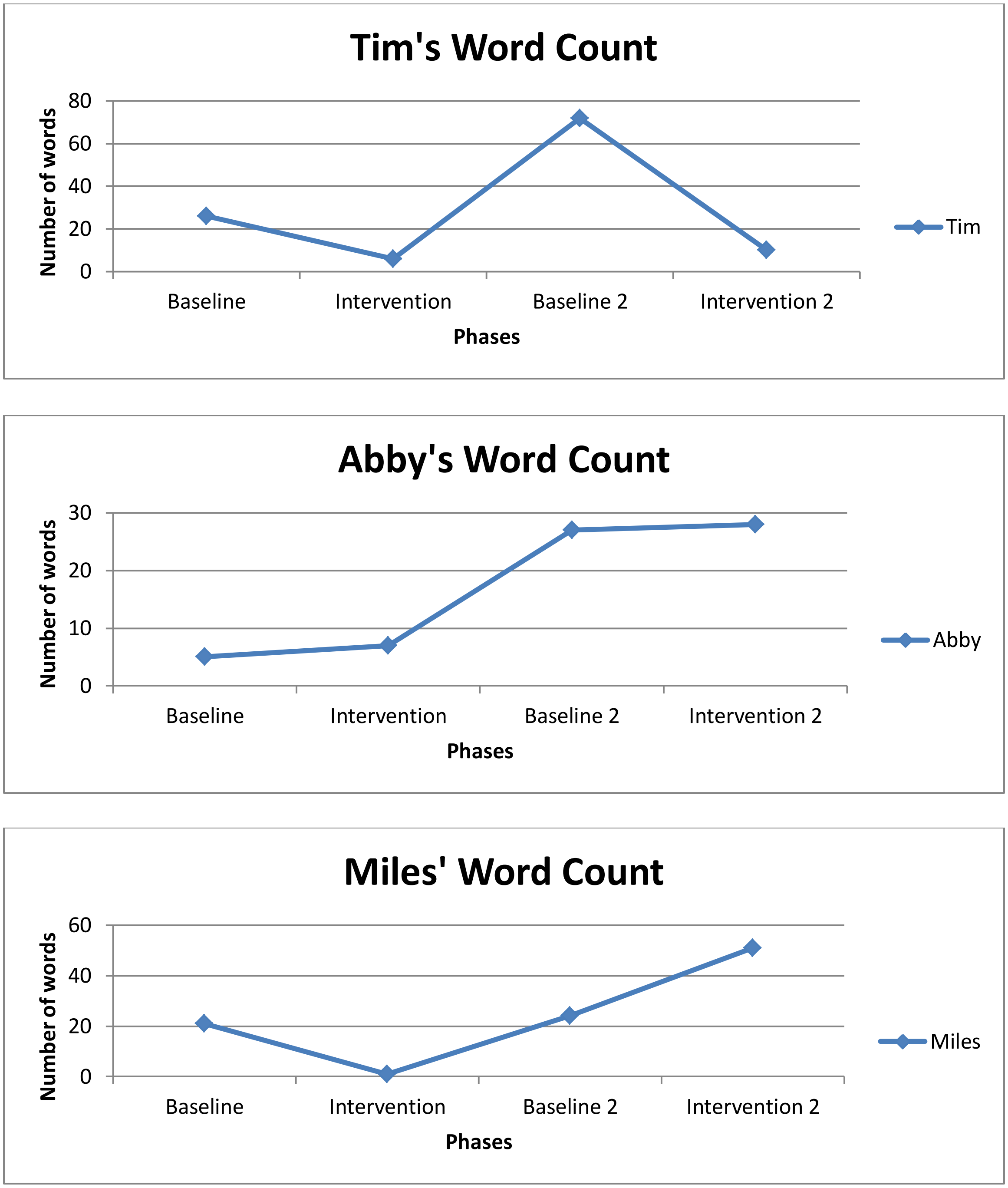


Figure 4.1. Number of words read across phases for each participant. Graphs demonstrate the outcomes of the IWB intervention on word count for Tim, Abby, and Miles. The intervention had a reverse effect for Tim. Also, the intervention did not support intervention efficacy for Abby and Miles since there was a failure to obtain a reversal during the second baseline for both subjects.

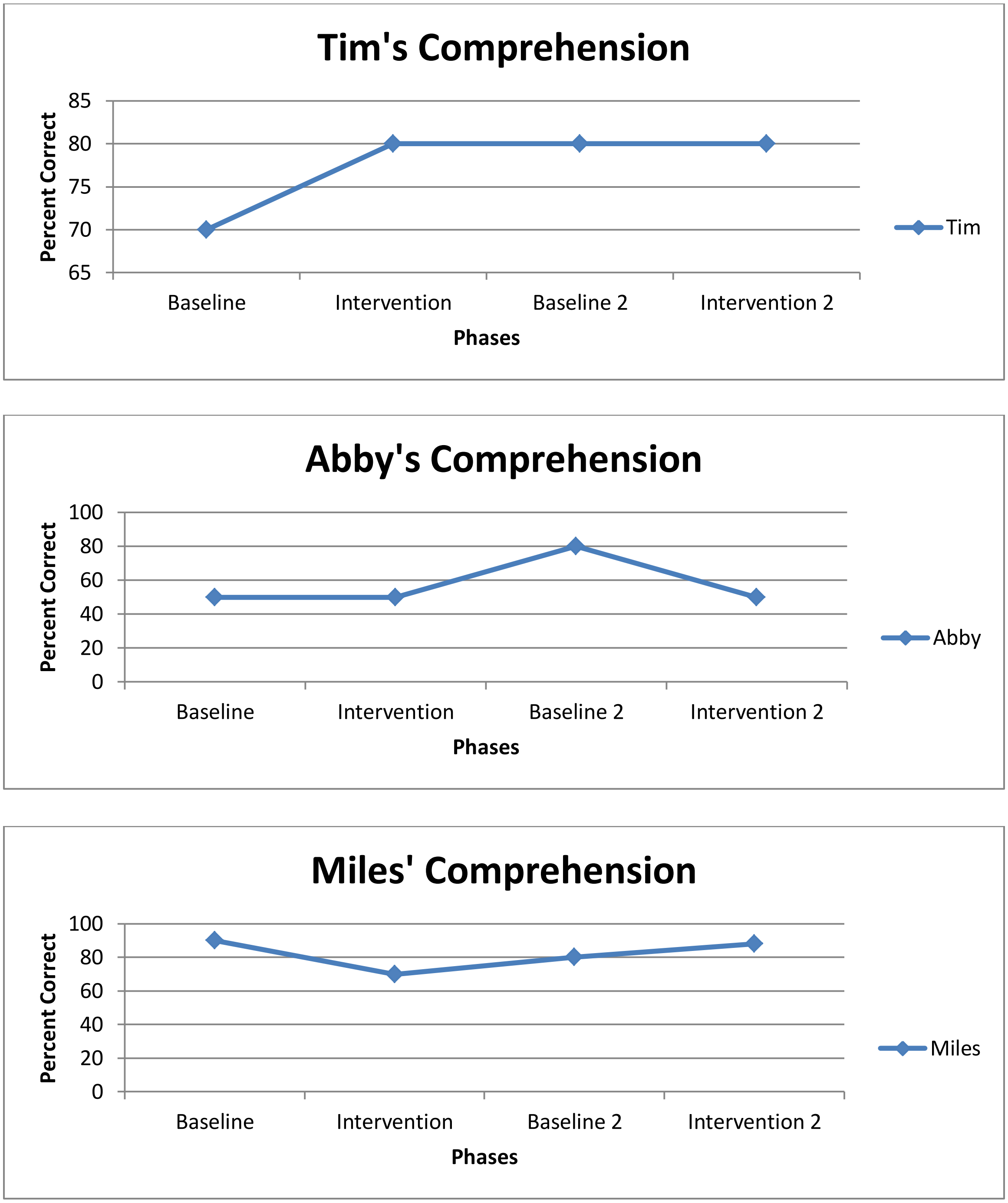


Figure 4.2. Percentage of comprehension across phases for each participant. Graphs demonstrate the outcomes of the IWB intervention on comprehension for Tim, Abby, and Miles. The intervention did not support intervention efficacy for Tim, Abby, and Miles since there was a failure to obtain a reversal during the second baseline for all three subjects. Interestingly, the intervention appeared to possibly have a negative correlation on comprehension for Abby since her baseline 2 increased.

Research Question Two

The second research question asked to what extent are differences found in student engagement when an IWB is integrated into reading instruction, compared to a control, for students diagnosed with ASD. A single subject A-B-A-B design was implemented. Results were analyzed by a visual comparison of data points across conditions. During visual analysis the data were examined for trend, mean shift, and latency of change. In this study, engagement was defined as IJA. The results of the data for the three IJA behaviors measured (eye contact, verbalizations, and gestures) were individually described. The visual analysis of the total number of IJA behaviors for each student is summarized (see Table 4.4, 4.5, and 4.6).

Tim. Table 4.4 summarizes Tim's engagement through each phase.

Table 4.4

Tim's Engagement Summary Across Each Phase

Date	Phase	Title of unit	Eye contact	Gesture	Verbalization	Total IJA
6/3/15	PB (A)	Monster Truck	31	10	56	97
6/8/15	IWB (B)	Woods of Wonder	28	6	51	85
6/11/15	PB (A)	Colonial Life	48	14	88	150
6/16/15	IWB (B)	World Holidays	51	6	83	140

Note. PB = paper book; IWB = interactive whiteboard; IJA = initiated joint attention

Eye contact. Tim decreased in the frequency of eye contact from the first baseline to the first intervention phase. Then Tim displayed a significant increase in eye contacts when the second baseline phase was implemented and then increased again when the final intervention phase was reinstated. Based on this pattern of data, Tim's eye contact was not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.4).

Gesture. Tim decreased in gestures from the first baseline to the first intervention phase. Then Tim displayed another decrease when the second baseline phase was implemented. Lastly, Tim responded with an increase in gestures when the final intervention phase was reinstated. Based on this pattern of data, Tim's gestures were not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.3).

Verbalization. Tim grew in the frequency of verbalizations from the first baseline to the first intervention phase. Then Tim continued to grow in the number of verbalizations exhibited when the second baseline phase was implemented, and increased again when the final intervention phase was reinstated. However, based on this pattern of data, Tim's verbalizations were not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.5).

Total initiated joint attention behaviors. Tim slightly decreased in the amount of total IJA behaviors from the first baseline to the first intervention phase. Then Tim displayed a lengthened degree of total IJA behaviors when the second baseline phase was implemented. Lastly, Tim responded with a slightly diminished amount of total IJA behaviors when the final intervention phase was reinstated. Based on this pattern of data, Tim's total IJA behaviors were better with the traditional method of reading instruction without technology than on the IWB (see Figure 4.6).

Abby. Table 4.5 summarizes Abby's engagement through each phase.

Table 4.5

Abby's Engagement Summary Across Each Phase

Date	Phase	Title of unit	Eye contact	Gesture	Verbalization	Total IJA
6/2/15	PB (A)	How Much Is a Trillion?	50	9	47	106
6/8/15	IWB (B)	Wild Horses	33	5	75	113
6/10/15	PB (A)	History of Bicycle	47	11	57	115
6/16/15	IWB (B)	Wiggly Worms	73	11	93	177

Note. PB = paper book; IWB = interactive whiteboard; IJA = initiated joint attention

Eye contact. Similar to Tim, Abby decreased the number of eye contacts from the first baseline to the first intervention phase. Abby displayed an increase of the number of eye contact as the second baseline was implemented, and again, when the final intervention phase was reinstated. Abby's pattern of output of eye contacts was comparable to Tim's pattern from phase to phase in both growth and decline of the variable. Based on this pattern of data, Abby's eye contact was not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.4).

Gesture. Similar to Tim, Abby decreased in gestures from the first baseline to the first intervention phase; however, Abby displayed an increase as the second baseline was implemented. There was no change in the number of gestures when the final intervention phase was reinstated. Based on this pattern of data, Abby's gestures were not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.3).

Verbalization. Abby's magnitude of verbalizations increased from the first baseline to the first intervention phase. Then Abby displayed a slight decline in the number of verbalizations as the second baseline was implemented. Finally, the degree of verbalizations rose when the last intervention phase was reinstated. Abby's pattern of output of verbalizations may suggest that the intervention did impact her frequency of verbalizations, since there was an increase from the baseline to intervention phases both times. Based on this pattern of data, Abby's verbalizations were slightly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.5).

Total initiated joint attention behaviors. Abby slightly increased in the number of total IJA behaviors from the first baseline to the first intervention phase. Secondly, Abby displayed a continued increase in the number of total IJA behaviors as the second baseline was implemented and again when the final intervention phase was reinstated. Based on this pattern of data, Abby's total IJA behaviors were not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.6).

Miles. Table 4.6 summarizes Miles's engagement through each phase.

Table 4.6

Miles's Engagement Summary Across Each Phase

Date	Phase	Title of unit	Eye contact	Gesture	Verbalization	Total IJA
6/1/15	PB (A)	A Landforms Adventure	21	11	26	58
6/8/15	IWB (B)	What is Water Worth?	10	6	38	54
7/6/15	PB (A)	Albert Einstein	20	3	41	64
7/13/15	IWB (B)	Deserts Dry	16	10	47	73

Note. PB = paper book; IWB = interactive whiteboard; IJA = initiated joint attention

Eye contact. Miles' data pattern for eye contact was different than the other two subjects. Miles initially decreased in the amount of eye contact from the first baseline to the first intervention phase, which was similar to the other two students, but then Miles displayed a lengthened degree of eye contact when the second baseline phase was implemented. Finally, Miles responded with a slightly diminished amount of eye contact when the final intervention phase was reinstated. Based on this pattern of data, Miles' eye contact was significantly better with the traditional method of reading instruction without technology than on the IWB (see Figure 4.4).

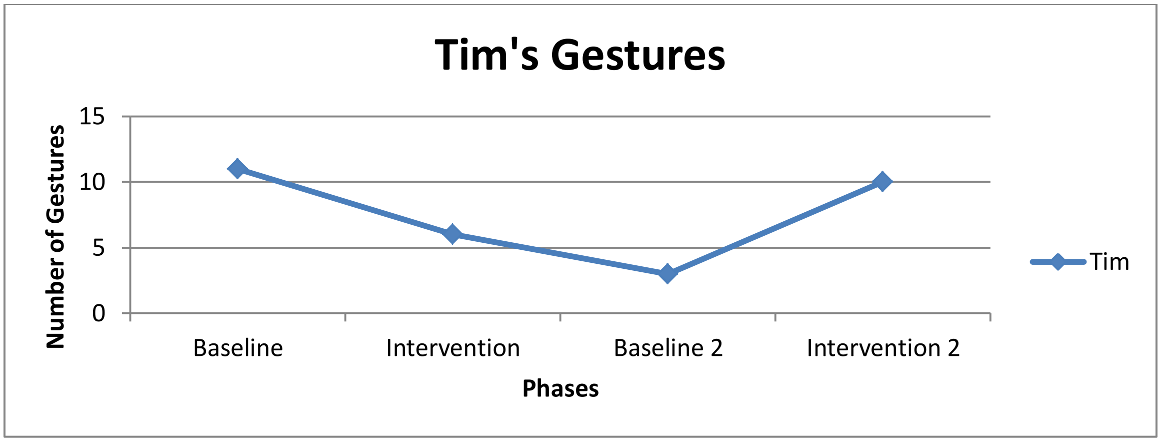
Gesture. Miless pattern of output of gestures was comparable to Tim's pattern from phase to phase. Miles decreased in gestures from the first baseline to the first intervention phase. Miles then displayed another regression when the second baseline phase was implemented. Lastly, Miles responded with an increase in gestures when the final intervention phase was reinstated. Based on this pattern of data, Miles' gestures were not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.3).

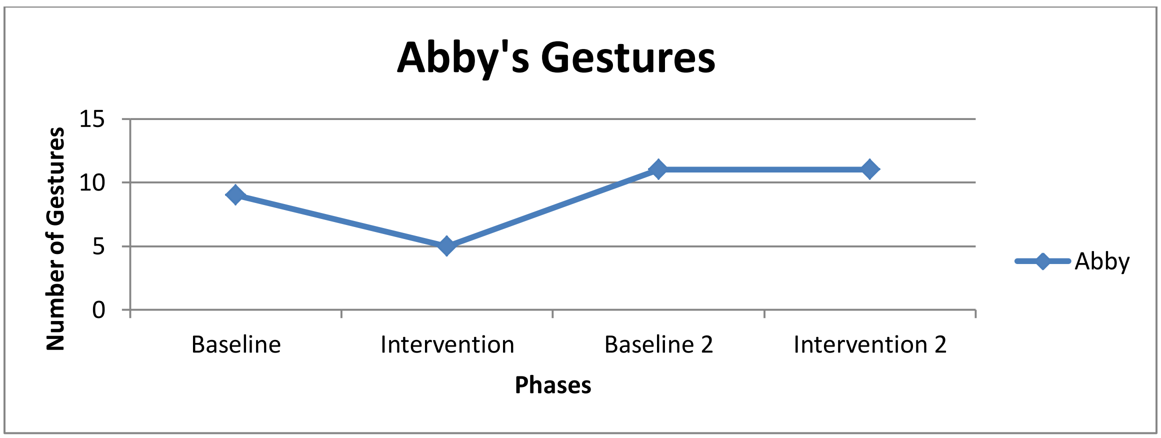
Verbalization. Miles' data pattern for verbalizations was similar to Tim's data pattern. Miles initially increased in the amount of verbalizations from the first baseline to the first intervention phase. This growth pattern continued across the other phases of the study. There was no decline in verbalizations for Miles. Based on this pattern of data, Miles' verbalizations were not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.5).

Total initiated joint attention behaviors. Similar to Tim, Miles slightly decreased in the frequency of total IJA behaviors from the first baseline to the first intervention phase. Miles displayed a slight increase in total number of total IJA behaviors when the second baseline phase was implemented, and then increased again as the final intervention phase was reintroduced. Based on this pattern of data, Miles's total IJA behaviors were not significantly better with the reading instruction on the IWB than with the traditional method without technology (see Figure 4.6).

Summary Analysis of Engagement Data

If the goal is a longstanding increase in behavior, the information in the study did not show that the intervention caused an increase in eye contact for any of the three students. For the study to demonstrate this, an increase in the frequency of eye contacts from baseline to intervention would need to be found both times. This must also be said for gestures, but the intervention did not lead to an increase in gestures for any of the three participants. The intervention did support intervention efficacy for Abby on verbalizations because there was a reversal during the second baseline. The intervention did not support intervention efficacy for Tim and Miles because there was a failure to obtain a reversal during the second baseline; however, there was an increase in verbalizations for all three subjects from the beginning data point to the end data point. This increase in verbalizations over the fours phases was not dependent on the intervention but some other construct. Furthermore, the data shows that intervention did not support intervention efficacy for all three students on total-IJA given that there was a failure to obtain a reversal during the second baseline. However, there was an increase in total-IJA for all three subjects from the beginning data point to the end data point. The increase in engagement over the four phases was not dependent on the intervention but some other variable. These results are summarized in the following four tables.





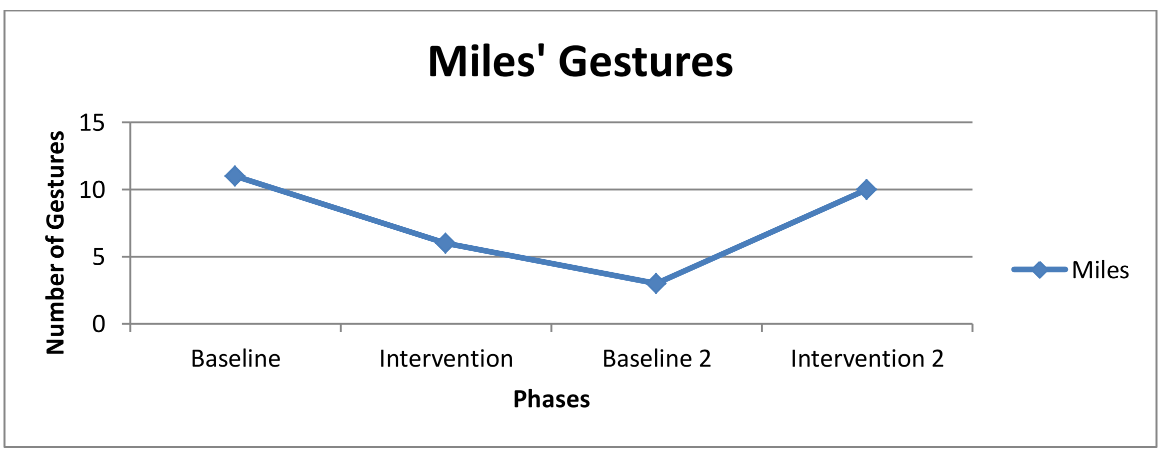


Figure 4.3. Frequency of gestures across phases for each participant. Graphs demonstrate the outcomes of the IWB intervention on gestures for Tim, Abby, and Miles. The intervention did not support intervention efficacy for Tim, Abby, and Miles since there was a failure to obtain a reversal during the second baseline for all three subjects.

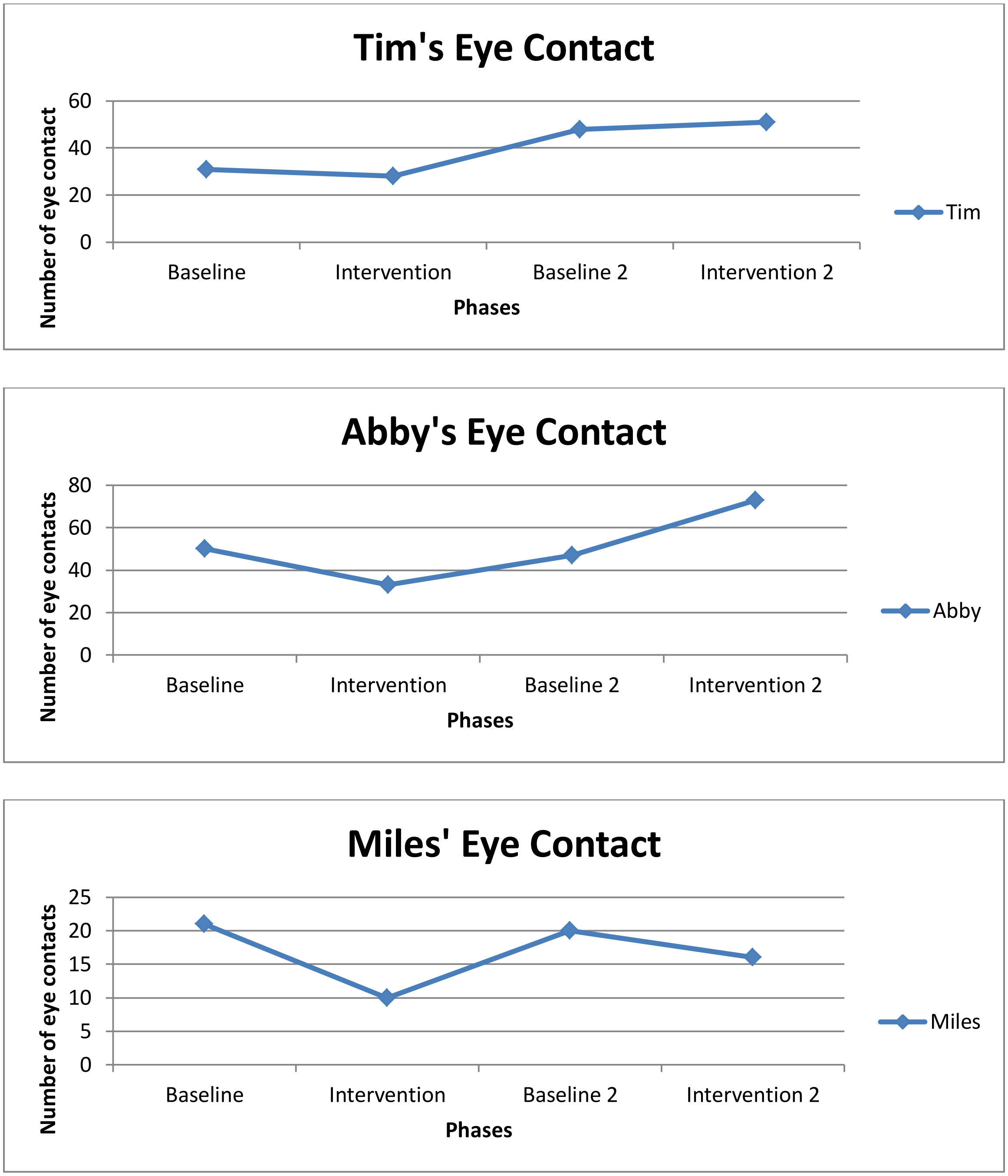
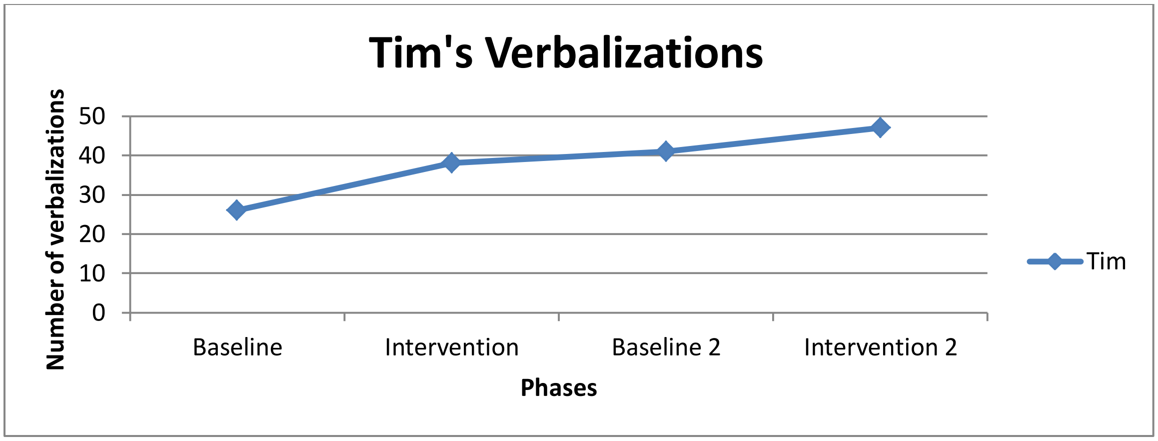
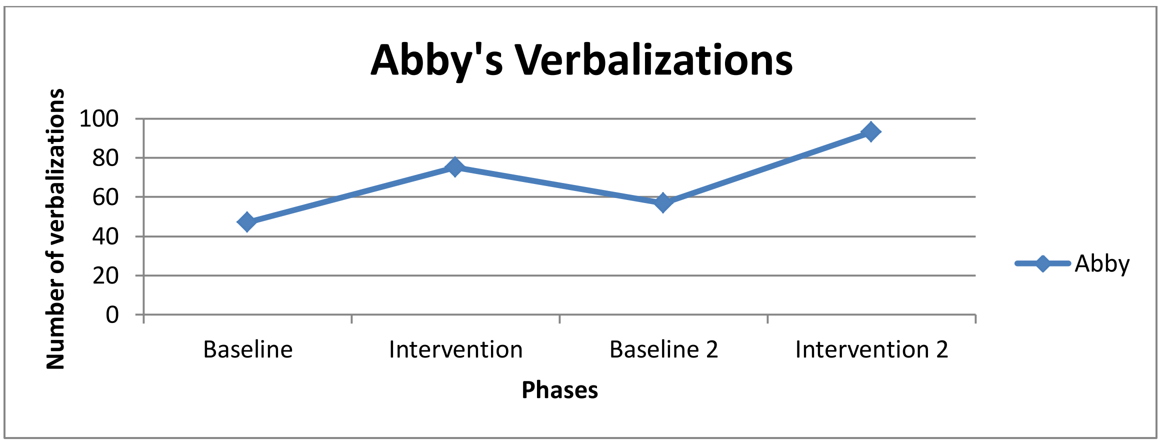


Figure 4.4. Frequency of eye contacts across phases for each participant. Graphs demonstrate the outcomes of the IWB intervention on eye contact for Tim, Abby, and Miles. The intervention did not support intervention efficacy for Tim and Abby since there was a failure to obtain a reversal during the second baseline for both subjects. The intervention had a reverse effect for Miles.





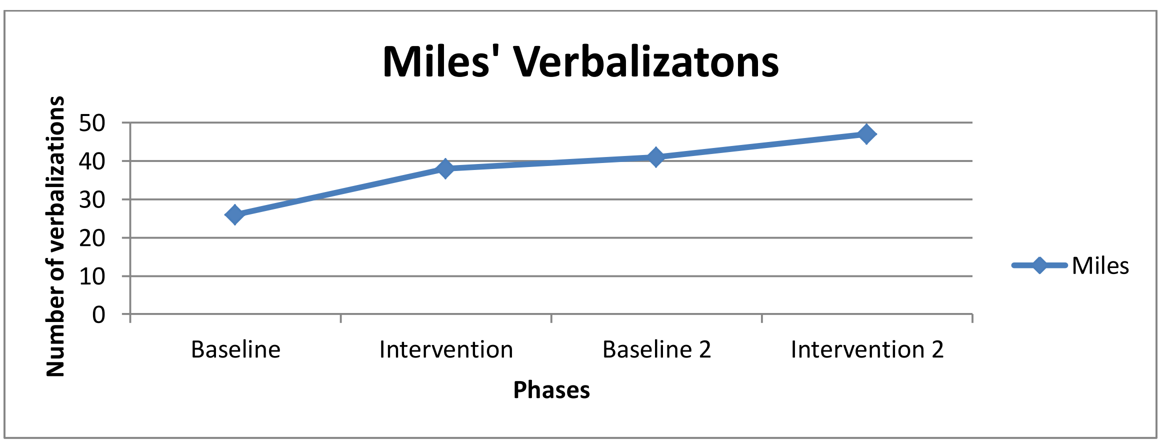
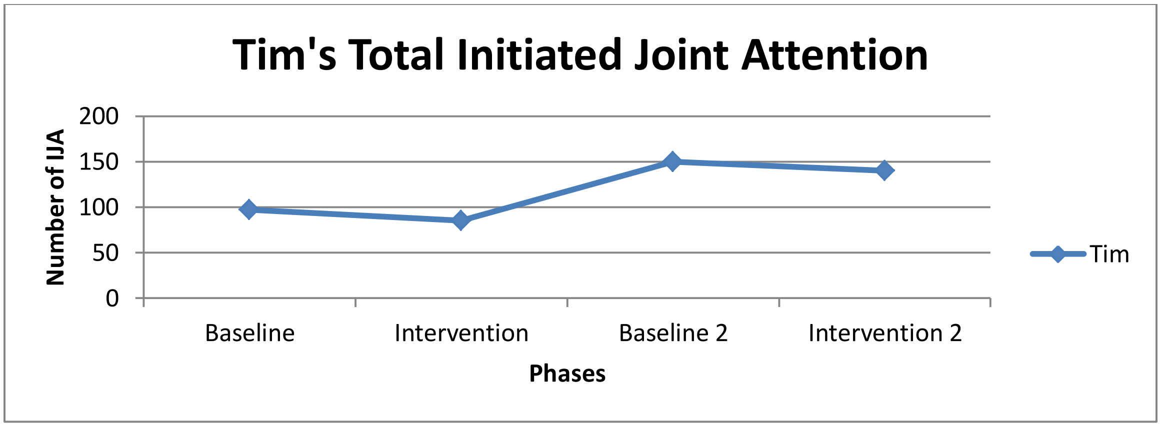
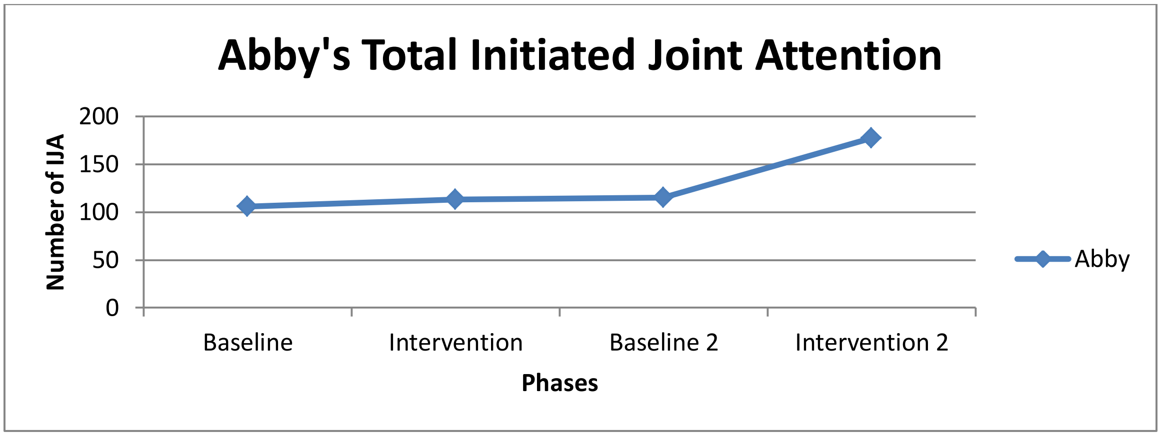


Figure 4.5. Frequency of verbalizations across phases for each participant. Graphs demonstrate the outcomes of the IWB intervention on verbalizations for Tim, Abby, and Miles. The intervention did support intervention efficacy for Abby since there was a reversal during the second baseline. However, the intervention did not support intervention efficacy for Tim and Miles because there was a failure to obtain a reversal during the second baseline for both subjects.





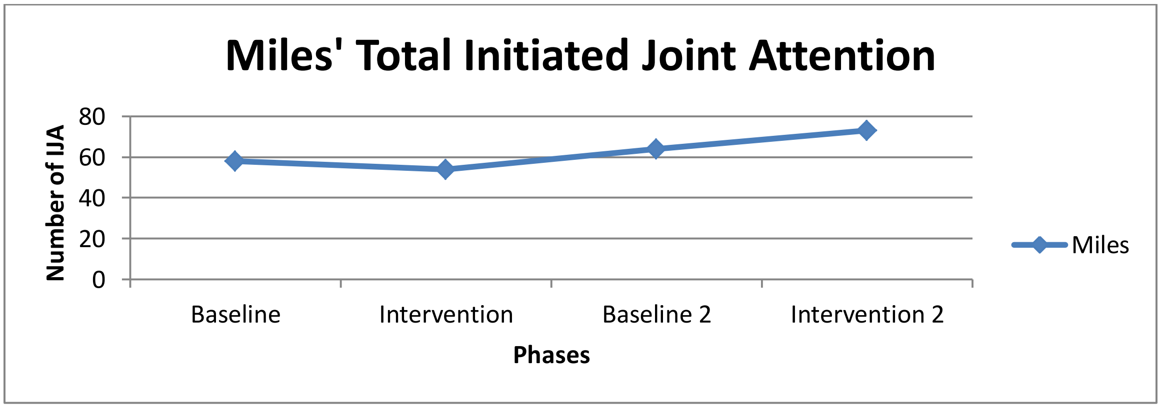


Figure 4.6. Frequency of total initiated joint attention across phases for each participant. Graphs demonstrate the outcomes of the IWB intervention on word count for Tim, Abby, and Miles. The intervention had a reverse effect for Tim. Also, the intervention did not support intervention efficacy for Abby and Miles because there was a failure to obtain a reversal during the second baseline for both subjects.

Statistical Analysis of Research Questions One and Two

Statistical measures were employed to support the visual interpretation of the results of research questions one and two. This was conducted to ensure objectivity and minimize bias. SPSS was used to determine if any statistical significance could be found when comparing conditions A-B across all variables. The statistical data supports the findings of the visual analysis.

Table 4.7

Descriptive Statistics

						Skewness	
Conditions	N	Minimum	Maximum	M	SD	Statistic	Std. error
PrenumberA	6	67	119	97.67	21.768	-.776	.845
PostnumberA	6	72	180	127.17	36.630	-.190	.845
PrenumberB	6	66	126	101.67	26.485	-.854	.845
PostnumberB	6	73	169	118.83	32.258	.199	.845
GainA	6	5	72	29.50	22.457	1.622	.845
GainB	6	1	51	17.17	18.989	1.444	.845
CompQuizA	6	50	90	75.00	13.784	-1.375	.845
CompQuizB	6	50	88	69.67	16.269	-.477	.845
GestureA	6	3	14	9.67	3.670	-1.278	.845
GestureB	6	5	11	7.33	2.503	.926	.845
VerbalA	6	26	88	52.50	20.773	.823	.845
VerbalB	6	38	93	64.50	22.161	.116	.845
EyecontactA	6	20	73	37.67	20.057	1.289	.845
EyecontactB	6	10	73	35.17	23.404	.813	.845
JtattentionA	6	58	150	98.33	34.098	.279	.845
JattentionB	6	54	177	107.00	45.769	.564	.845

Table 4.7 shows the number of participants, minimum and maximum values for each of the six variables for condition A and condition B, and the skewness of the values. Note the large standard deviation for each of the size variables, and also note that five variables were skewed greater than the absolute value 1, which is according to Huck (2008) skewed.

Table 4.8

Paired t-Test

Conditions	M	SD	SEM	95% CI		T	df	Sig. (2-tailed)
				Lower	Upper			
APrenumber – Bprenumber	-4.000	5.477	2.236	-9.748	1.748	-1.789	5	.134
APostnumber – Bpostnumber	8.333	26.786	10.935	-19.776	36.443	.762	5	.480
GainA – GainB	12.333	29.884	12.200	-19.028	43.695	1.011	5	.358
CompQuizA – CompQuizB	5.333	16.083	6.566	-11.545	22.212	.812	5	.454
EyecontactA – eyecontactB	2.500	4.848	1.979	-2.587	7.587	1.263	5	.262
GestureA – GestureB	2.333	5.241	2.140	-3.167	7.833	1.091	5	.325
VerbalA – VerbalB	-12.000	17.006	6.943	-29.847	5.847	-1.728	5	.144
JtattentionA – JattentionB	-8.667	27.508	11.230	-37.534	20.201	-.772	5	.475

Note. CI = confidence interval of the difference

Table 4.8 shows the correlations for each of the A and B conditions. There was no measurable growth in achievement across the conditions. There was an increase in both verbalizations (M = -12.0) and total initiated joint attention (M = -8.667) across the conditions. However, the data violated the summation of the paired t-test. The paired t-test did not work well for this data; therefore, both the Wilcoxon and the paired t-test were run to examine the mean difference of each variable across A-B condition.

Table 4.9

Paired Samples Statistics

Condition	Mean	N	SD	Std. Error Mean
GainA	29.50	6	22.457	9.168
GainB	17.17	6	18.989	7.752
CompQuizA	75.00	6	13.784	5.627
CompQuizB	69.67	6	16.269	6.642
EyecontactA	37.67	6	20.057	8.188
EyecontactB	35.17	6	23.404	9.555
GestureA	9.67	6	3.670	1.498
GestureB	7.33	6	2.503	1.022
VerbalA	52.50	6	20.773	8.480
VerbalB	64.50	6	22.161	9.047
JtattentionA	98.33	6	34.098	13.920
JattentionB	107.00	6	45.769	18.685

Table 4.9 shows the paired t-test results and note that there are no comparisons that are statistically significant. There was no significant difference between the pre and post comparisons on any of the six variables examined; however, five of the comparisons were in the positive direction, and two of the comparisons were in the negative direction (verbal and total JA).

Table 4.10

Wilcoxon Signed Ranks Test

Conditions		N	Mean Rank	Sum of Ranks
	Total	6		
GainB – GainA	Negative Ranks	4[g]	3.50	14.00
	Positive Ranks	2[h]	3.50	7.00
	Ties	0[i]		
	Total	6		
CompQuizB – CompQuizA	Negative Ranks	2[j]	3.50	7.00
	Positive Ranks	2[k]	1.50	3.00
	Ties	2[l]		
	Total	6		
EyecontactB – EyecontactA	Negative Ranks	3[m]	2.83	8.50
	Positive Ranks	1[n]	1.50	1.50
	Ties	2[o]		
	Total	6		
GestureB – GestureA	Negative Ranks	4[p]	2.75	11.00
	Positive Ranks	1[q]	4.00	4.00
	Ties	1[r]		
	Total	6		
VerbalB – VerbalA	Negative Ranks	2[s]	1.50	3.00
	Positive Ranks	4[t]	4.50	18.00
	Ties	0[u]		
	Total	6		
JattentionB – JtattentionA	Negative Ranks	3[v]	3.33	10.00
	Positive Ranks	3[w]	3.67	11.00
	Ties	0[x]		
	Total	6		

Table 4.10 shows the Z-scores and significant values for each for the six comparisons. Similar to the parametric analysis, there was no significant difference in the non-parametric analysis.

Analysis Related to Research Question Three

The third research question asked what are the perceptions of students with ASD towards the integration of IWB into reading instruction? Each student was interviewed following the end of the study and asked the same five questions to address the research question. The five questions were the following: (a) Do you prefer to read books during reading at the table or on the IWB?

(b) What do you like about using the paper books? (c) What do you like about using books on the IWB? (d) Which way helps you read better: reading on the IWB or reading at the table? Why is that? (e) Is there anything else you want to tell me about your reading learning? The data from the interviews were informative and are described below.

Both Abby and Miles related that they preferred to read the books on the IWB. Tim, on the other hand, stated he preferred to read at the table because he could just “sit there” and “didn’t have to get up.” When asked about what they liked about using the paper books, Abby noted that she could see black and white. Tim said “nothing,” and Miles said you can pick them up, but he didn’t like them because you could get paper cuts.

When asked about what they liked about using the books on the IWB, Abby answered because the books have color and the paper books don’t, which also has been reported in previous research (Beeland, 2002a; Şad, 2012; Şad & Özhan, 2012; Wall et al., 2005). Tim declared that it was easier to read on the IWB; however, the only problem was that he had to move. Miles stated that he liked to use the pen on the IWB just like students reported in Levy (2002); however, he said at times it was difficult to write well.

When asked which way helped them read better all three students responded with the IWB. Abby said the IWB because she could point with the pen instead of her finger, Tim stated the IWB because the words were bigger, which was also reported by students in Shenton and Pagett (2007), and Miles replied that the IWB was easier to go from page to page, which was also reported by students in Shenton and Pagett (2007).

When asked the last question, if there was anything else he or she wanted to talk about their reading learning, Abby stated she liked to learn new words, Tim said “no,” and Miles said he liked to play on computers. Student perspectives were positive and negative for both conditions; however, a preference was given to the IWB.

This chapter presented the findings, which were presented in different sections related to the research questions and the type of analysis. Visual analysis of the data for research questions one and two were discussed; then the statistical analysis of the data for research questions one and two were discussed, and lastly, the analysis of the data for research question three was summarized. The main purpose of this study was to examine the impact of the use of an IWB on student achievement and JA for elementary-aged students with ASD in reading instruction. There were no significant results from the study; however, from the qualitative portion, the students said they preferred the IWB.

CHAPTER 5: DISCUSSION

The summary section provides an overview of the study, including the rationale, purpose, research questions, methodology, and summarization of the findings. The second section includes a discussion of the findings and the implications of the research and results. The third section presents the limitations of the study and suggestions for future research.

Summary of Study

Educators are mandated by law to implement educational practices for all learners that are supported by rigorous evidence-based research including students with Autism Spectrum Disorders (ASD). Children are being diagnosed with ASD at an alarming rate (Rice et al., 2015). It is estimated that 1 in 68 children have some form of ASD (Centers for Disease Control and Prevention, 2014). Appropriately integrated technologies have shown promising interventions for this subgroup. Previous research supports the use of computer-assisted instruction (CAI) as an effective intervention for students with ASD (Coleman-Martin et al., 2005; M. Heimann & K. E. Nelson, 1995; Knight et al., 2013; Pennington, 2010; Rice et al., 2015; Whitcomb et al., 2011; Williams et al., 2002). Currently, literature is emerging on the use of new technologies as interventions for students with ASD such as iPads, (Lee et al., 2015; Neely et al., 2013) and iPods (Carlile et al., 2013).

Despite the growing literature on the use of other technologies as interventions for students with ASD, few studies have investigated the use of interactive whiteboards (IWB) with this subgroup, but a substantial amount of research supports the use of IWBs with typical-developing students (Ashfield & Wood, 2007; Digregorio & Sobel-Lojeski, 2010; Higgins et al., 2007; Yáñez & Coyle, 2011). The majority of this research is anecdotal, however (Beauchamp & Parkinson, 2005; Kennewell et al., 2007; Torff & Tirotta, 2010). Given this gap in the literature and the need for evidence-based interventions for students with ASD, investigating the use of IWBs as an educational intervention for students with ASD from a quantitative lens had value.

The main purpose of this study was to examine the impact of the use of an IWB for three elementary-aged students' with ASD reading during achievement and JA. This study was a quantitative-dominant mixed methods approach and included two distinct phases. The first phase evaluated the effect of the IWB in an A-B-A-B design. An alternating treatment design was used to compare two conditions (i.e., reading instruction without IWB use and reading instruction with IWB use). The only distinction between the book condition and the IWB condition was the form in which the book was presented. The second phase served as a supporting qualitative component. At the conclusion of the experimental phase, structured interviews were conducted individually with each participant. The interview sought to find the perceptions of the students on the integration of the IWB into their reading instruction.

This study investigated three research questions:

1. To what extent are differences found in student achievement when an IWB is integrated into reading instruction, compared to a control, for students diagnosed with ASD?
2. To what extent are differences found in student engagement when an IWB is integrated into reading instruction, compared to a control, for students diagnosed with ASD?
3. What are the perceptions of students with ASD towards the integration of IWB into reading instruction?

Summary of Findings

The findings summary is arranged in three sections related to each research question. No statistically significant results were found from either the quantitative and qualitative portion of the study. The first section synthesizes the impact of the intervention on student achievement. The second section synthesizes the impact of the intervention on student engagement. The third section synthesizes the interviews with the participants after the conclusion of the study. Table 5.1 presents the summary of the findings from the quantitative phase.

Table 5.1

Summary of Findings For Each Variable

Participants	Word Count	Comprehension	Eye Contact	Gesture	Verbalization	Total IJA
Tim	Negative correlation	No correlation	No correlation	No correlation	No correlation	Slight negative correlation
Abby	No correlation	Negative correlation	No correlation	No correlation	Positive correlation	No correlation
Miles	No correlation	No correlation	Negative correlation	No correlation	No correlation	No correlation

Note. IJA = initiated joint attention

Research Question One

The first research question examined the effects of an IWB intervention on student achievement. Torff and Tirotta (2010) noted a strong need for research on the impact of IWB on academic achievement. Student achievement was measured by difference in the number of words read correctly in a minute pre and post intervention and performance on end unit comprehension quizzes of non-fiction text. Achievement variables were tested across all four phases of the study for the three students. Data were analyzed visually, and then sequentially followed by statistical analysis that supported the initial visual analysis.

Tim had a reverse correlation for word count. Word count was lower during the intervention phase (IWB method), than during the baseline phase (book method) for both phase A and B. This could indicate that achievement was actually better during the traditional book method than compared with the IWB; however, this same reverse correlation was not found for the achievement variable comprehension. Both Miles and Abby had no correlations for achievement for either measurable variable of word count or comprehension. No noticeable differences in reading achievement were found between the two methods of intervention for the students with ASD; furthermore, there was no growth in achievement for all three subjects from the beginning data point to the end data point.

Research Question Two

The second research question examined the effects of an IWB on engagement, as measured by frequency of IJA during instruction (eye contact, verbalization, gesture). Engagement variables were measured across all four phases of the study for each of the three students using observational coding.

Tim showed no correlations for the variables eye contact, gesture, and verbalization, but he showed a slight negative correlation for total-initiated joint attentions. TJA were lower during both intervention phases (IWB method) compared to both baseline phases (book method). This could indicate that TJA was actually better during the traditional book method than compared to the IWB for Tim; however, this same reverse correlation was not found when the variables were measured separately.

Abby showed no correlations for the variables eye contact, gesture, or TJA, yet she showed a positive correlation for verbalizations. Verbalizations were higher during both intervention phases (IWB method) compared to both baseline phases (book method). This could indicate that verbalizations were actually better during the intervention phase (IWB) compared to the baseline phase (book method) for Abby.

Miles had a reverse correlation for eye contact. Eye contact was lower during the intervention phase (IWB method) than during the baseline phase (book method) for both phase A and B. This could indicate that eye contact was actually better during the traditional book method, than the IWB for Miles; however, this same reverse correlation was not found for the other engagement variables. Miles showed no correlations for gesture, verbalizations, or TJA.

Despite finding a few correlations, overall, no noticeable differences in engagement between the two methods of intervention for the students with ASD were found. However, interestingly, there was an increase in both verbalizations and TJA for all three participants from the beginning data point to the end data point.

In total, no noticeable differences or statistical significance were found in achievement or engagement between the two methods of intervention for the students with ASD. While a few correlations were found, they existed in only one variable in each category of achievement and engagement. For instance, none of the participants had correlations for both measurable variables for achievement, and none of the participants had correlations for more than one of the four measured variables for engagement.

Research Question Three

The third research question examined the perceptions of the students toward the two different interventions after their participation in the study. Students expressed both positive and negative aspects of both conditions, but a preference was given to the IWB. Mechling et al.

(2009) stated, "Motivational and engaging features of technology may further support students' preference to use such an interactive medium over traditional formats for delivering instruction" (p. 45).

Discussion of Findings

This study sought to extend previous research on the effects of technology-based interventions on students with ASD in which the technology condition was associated with more student engagement and higher achievement than with traditional methods (Neely et al., 2013; Williams et al., 2002). The findings did not find consistent differences between conditions (technology-based vs. traditional methods) for any of the three participants. The IWB was statistically the same as the book method on both student achievement and engagement for all three students

On both achievement variables (word count and comprehension), based on the visual analysis of the data, the intervention did not result in increased number of words or comprehension for any of the three students. The intervention, however, appeared to have a negative correlation on word count for Tim and comprehension for Abby. The IWB actually lowered Tim's word count level.

The visual analysis intervention also did not cause an increase in eye contacts or gestures for any of the three students. The intervention could not be connected to an increase in verbalizations for Tim or Miles because both boys increased their number of verbalizations in each of the four phases. Compared to the other two subjects, Abby did increase in the frequency of verbalizations in both sets of baseline to intervention; therefore, the intervention may have had a positive impact on Abby for number of verbalizations. The intervention did not cause an increase in engagement for any of the three students, and these visual analyses were supported by the statistical analyses, as well.

The results were not in the direction predicted when the study was first designed. Since there were no significant differences found in skill acquisition of the students, this study does not support the case that using IWB technology will yield higher achievement or engagement levels for students with ASD (Knight et al., 2013). However, there was an increase in total verbalizations and TJA from the beginning of the study to the end for all three students. The difference in increased engagement was not the intervention but by other unknown variables that were not measured in this study. When data is analyzed from beginning to end, it suggests that even though there was no growth in achievement, there was growth in expressive language. Due to the small sample size, findings are only suggestive that eye contact did not increase during the IWB intervention because the social load was reduced, and while looking at the board, they were verbalizing more. The absence of significant findings exhibits important theoretical, methodological, and applied implications. Student learning is multifaceted and there is a complex interface of constituents that impact this.

Theoretical Implications

The results of this study illustrate the importance of idiographic or individual level of analysis in research, because "the idiographic level of analysis is what we can see operating at the level of a particular individual. It is studied in special education through single case designs" (Hitchcock et al., 2016b). The idiographic approach focuses on the individual. This method of thinking advises that everyone is unique and different, and should be researched and analyzed individually. This also aligns with the dialectical pluralism (DP) theoretical approach to research. According to Hitchcock et al. (2016a), "DP is a metaparadigm for research . . . that researchers should interact with differences" (p. 2). In other words, researchers should seek to understand across differences because learning is not confined to one variable. It is especially critical in special education inquiry that differences are thoroughly examined. When applied to conducting research, DP supports the mixing of paradigms and types of analysis. DP can guide the fusion of qualitative and quantitative efforts in special education research.

Methodological Implications

By law school districts are required to address the specific and increasing needs of students with disabilities, including students diagnosed with ASD, with evidence-based interventions. A critical need exists for research in special education seeking out causal inferences to guide decision-making of instruction and interventions. Students in special education often have low-incidence disabilities, and single subject designs provide an avenue for finding causal inferences when working with small samples sizes (Hitchcock et al., 2016b). A major limitation of idiographic methods, such as single subject designs, is around generalization; therefore, replication of findings from a number of similar single subject studies can help to establish evidence-based interventions. Until the use of IWB technology, as an intervention for students with ASD in school settings, is researched more, this study's findings can only be described within its context. As this study suggests, quantitative measures alone will not always answer research questions. According to Hitchcock et al. (2016b), "quantitative inquiry needs qualitative inquiry" (p. 16). Using multiple sources of data helps illustrate a more holistic picture of circumstances, and "qualitative information can inform understanding of causal mechanisms" (Hitchcock et al., 2016b). When conducting educational research, research questions guide the methods chosen, and when used in combination, quantitative and qualitative methods complement each other and allow for more complete analysis. Conducting research in the school setting can have many difficulties; however, relevance is significant to address the need to establish evidence-based practices for students with ASD. Quantitative research aids in generalization to large populations and replication and qualitative research aids in getting a deep understanding of the context and participants involved. Like this study, mixed method designs can bridge research with everyday experiences in special education research.

Applied Implications

Findings from this study have implications for special educators, classroom teachers, and school administrators. The results of this study suggest that interventions for students with ASD must be based on a generic understanding of common characteristics of the disability and must also be determined based on the individuality of the specific student. It is imperative that educators and service providers working with students with ASD take the time to really get to know their students as learners and children first.

Children with ASD should always be referenced as children first. A disability is part of their identity; however, it doesn't define them. One established way of communicating that puts people before their disability is called People First Language. For instance, this type of communication would use the phrase "a child with Autism Spectrum Disorder" instead of "an autistic child." People First Language is much more than how we communicate, but an important mindset that emphasizes the humanity of individuals. It is critical that educators use People First Language when communicating about students with disabilities.

As the data in this study supports, an evidence-based intervention alone, such as IWB technology, is not the only variable that influences student learning. The influence of other factors such as cultural, emotional, social, and students' interests and learning styles make learning multi-dimensional. Students come from different backgrounds and have different life experiences. All of these different factors must be considered when planning instruction and interventions for students. In the school environment, educators must always be mindful of context when working with students because behavior, such as learning, is inseparable from its context.

Educators' knowledge of their students' needs begins with an understanding of Maslow's Hierarchy of Needs. Maslow developed a leveled system of needs that include basic and growth needs essential to all mankind. He believed that humans have specified needs that must be met and if lower level needs go unmet, humans cannot strive for higher level needs. Once physiological needs (e.g., food and safety) are fulfilled, individuals become motived by other constraints (e.g., social). For example, a student who does not have a good night sleep the evening before may not be focused on his or her learning. Therefore, teachers must educate the whole child, keeping in consideration physical, social, emotional, cognitive, language, and academic needs.

It is also essential for educators to have knowledge about modality preferences, or the preferred modes that students take in information. Four main modalities exist: visual, auditory, kinesthetic, and tactual. Children with ASD often have difficulties processing complete verbal information and need visual cues to help facilitate understanding and comprehension. Students with ASD are often better visual learners than auditory learners. Visual supports may help eliminate language difficulties for children with ASD and allow them to gain communication through an alternative way (Mundy et al., 2003; Tissott & Evans, 2003). Visual materials and supports are effective interventions because visual perception skills are often strengths of students with ASD (C. Carnahan, 2006; Lanter et al., 2012). Many students that prefer visual learning may benefit from IWB technology because they like material to be displayed. Bouck et al. (2014) suggested that as a result of these visual needs, students with ASD might show higher levels of engagement using high-tech devices compared to lower-tech options. Teachers must pick a variety of materials including technologies that focus on children's different visual, tactile, and auditory needs (Stockall et al., 2012).

If there is not an educator available to incorporating evidence-based practices when implementing technology-based interventions, then the design of the technology itself must include learning strategies that have been scientifically proven to work with students with ASD. For instance, the iPad may not be the perfect fit for all children with ASD; however, well-developed apps that incorporate learning strategies, such as visual schedules, social stories, reward systems, and errorless learning (the learner never fails) that are sensitive to the unique learning needs of students with ASD. The importance of structure and routines also can be effective. An app that utilizes errorless teaching strategies to learn a skill can highly benefit students with ASD where most children learn skills by trial and error.

Children are being diagnosed with ASD, a lifetime developmental disorder, at an alarmingly increasing rate. It occurs in all cultures, social classes, and age groups (Crosland & Dunlap, 2012). ASD is a very complex disability and impacts students in different ways. Students on the spectrum have a wide variety of strengths and deficits. Students with ASD exhibit marked variability in characteristics (Tissott & Evans, 2003) and cognitive abilities (Randi, 2010), especially in reading. Brown et al. (2013) stated that reading comprehension in students with ASD could vary tremendously from extreme impairments to within the normal range. Because of the range of diversity in ASD, one type of reading intervention that works for some students with ASD may not be suitable to all others (M. Bono et al., 2004; Koegel et al., 2012).

When working with students with ASD, it is also critical to involve them in the learning process and to understand the students' perspectives (Hitchcock et al., 2016a). Educators must take into account their students' individual preferences and diverse learning styles. Students need to understand the importance of their learning in order to be engaged and to make progress. Attitudes have been linked to student engagement levels; as a result, student attitudes towards the use of IWBs in the classroom were sought in this study (McQuillan et al., 2012). Research shows that when motivational components such as choice are included in academic tasks for students with ASD, there is an increase in work completion, a decrease in problem or off-task behavior, and a positive effect on overall interest in learning (Koegel et al., 2010). Even in this study's small sample size, students' preferences varied. In scenarios where two approaches to intervention yield equal results in effectiveness and efficiency, it might be empowering to allow a child to choose between the available intervention options. However, as this study shows, high engagement does not necessarily correlate to high achievement. This study further highlights that many educational complexities exist with students with ASD, as well as the research into how to best educate them.

It remains unclear why some children with ASD may benefit more from technology-based interventions than others. The outcomes presented in Lee et al. (2015) also showed mixed results when comparing a therapist-implemented intervention verses a technology-based (iPad-assisted) intervention. In their study, one student showed increases in on-task behavior and a reduction in challenging behavior, and the other student demonstrated no notable differences in behavior between interventions. Child-specific characteristics and other variables are likely to influence differences in results among children with ASD. Knowledge of students as learners enables educators to maximize learning opportunities by matching appropriate interventions with student strengths and preferences.

Teachers also must have the fundamental technical skills to use technology effectively. When teachers have a lack of required skills to use a device it can actually cause classroom management difficulties (Ozerbas, 2012). Becoming technically capable takes considerable time, experience, and trial and error. Teachers cannot expect a student to be adequate with technology if they do not have familiarity of the technology themselves. An educational climate that does not increase access means that technology will not be utilized to its full potential. Technology alone will not bring about change, and teachers need to feel confident and competent in technological matters before introducing it to students.

The necessary training and development for teachers is essential for successful implementation of technology (López, 2010; McQuillan et al., 2012). Formal training on specific devices is extremely important. Most teachers learn how to use devices on the job, and as a result, they spend a large amount of time preparing materials. Professional development with technology appears to be a major factor in teachers' competence with technology. It is important to have continuous support for staff and teachers, not just initial training. Teachers need adequate time to learn how to use technology, and if that time is not allocated, teachers will not use them effectively.

In addition to lack of knowledge on how to utilize technology, teachers must have access to basic technical support. Technology can waste instructional time and cause problem behavior as a result of unforeseen breakdowns, simple equipment troubles or needed software updates.

These simple technology problems frustrate teachers and decrease their willingness to try technology integration altogether. There are many cost-related issues of technology in schools. In addition to the cost of initial training and equipment, ongoing technical support, upgrades in software, and ongoing teacher training must also be considered. If the technology is not dependable and teachers are not trained properly to use the devices or programs, what is their use in classrooms?

Furthermore, considering the UK's example of buying before studying, it seems important to study the effects of IWBs amid the rapid increase in purchases and use of this technology in American classrooms. The small amount of evidence gathered so far looks promising, but studying IWBs effectiveness in various settings is useful to academics and educators, regardless of positive or negative outcomes. Essentially, if IWBs are shown to be effective and useful, then it is evidence of money well spent and evidence of where future money should be allocated. If IWBs show no aid in classroom learning, then it is evidence that large quantities of money should not be put into this particular piece of classroom technology and should go to more effective tools. This study was inconclusive regarding this larger question.

As Knight et al. (2013) suggested, decisions regarding the implementation of technology-based interventions with students with ASD to teach academic learning should be on an individual basis, carefully assessed, used with evidence-based practices, and changed when students are not making desired measurable achievement growth. All instructional strategies need to be designed to incorporate a student's strengths, interests, and individual needs (C. Carnahan, 2006; Greenwood et al., 2002; Hume & Reynolds, 2010; Iovannone et al., 2003; Koegel et al., 2012). Lastly, technology in the school setting needs to be facilitated by technically capable and knowledgeable staff.

Limitations

This study has a number of limitations: sample size, time constraints, reliability, and research design. These limitations are discussed in relation to both single subject design and validity of the results.

Sample Size

The first limitation this study exhibited was the small sample size. The single subject design included three students with high functioning ASD. As a result of the small number of participants, it is difficult to know whether the participants are comparable to other members of the students with high-functioning ASD population and whether the results would generalize to them as well. Due to the sample size, this study alone cannot be used to establish whether IWB technology is an effective evidence-based practice for students with ASD. Students with ASD exhibit marked variability in characteristics (Brown et al., 2013; Tissott & Evans, 2003); therefore, interventions that work for some students with ASD may not work as well for others (M. Bono et al., 2004). However, this study does add to the limited current literature. Multiple single subject studies are needed to determine if an educational practice is evidence-based with varied disabilities (Horner et al., 2005; Tankersley et al., 2008). The study could be easily replicated for future research projects but on its own, it cannot establish evidence-based practices.

To address the small sample size limitation, single subject research designs include detailed descriptions of participants so that future researchers can replicate the study with a similar sample. In alignment with recommendations for quality single subject design (Horner et al., 2005), participants with ASD were described in detail in the methodology section of the study. In a single subject research design, each participant acts as his or her own control, which makes it possible to assess intervention effectiveness with only a few participants (Horner et al., 2005). An A-B-A-B design was utilized, which allowed for two separate instances of replication and the applied nature of educational research. This allowed more dependability (Tankersley et al., 2008) and stronger internal validity (Gast, 2009a) with a small sample size. Lastly, three participants were used in the study to extend external validity, which was recommended by both Gast (2009b) and Horner et al. (2005). Even though only a small number of participants with ASD participated in this study, recommendations from the literature for use of single subject research design were followed to support the validly of the findings. The sample size also limits the results of the generalizability of the qualitative results section of the study as well. To further extend validity of the results of the survey, additional studies should include the perceptions of students with ASD when asking about the use of IWBs, because a majority of the literature only included interviews from students with typical development (Digregorio & Sobel-Lojeski, 2010; Hall & Higgins, 2005; Levy, 2002; McQuillan et al., 2012; Shenton & Pagett, 2007).

Time Constraints

The second limitation regarding this study involved time constraints. Even though a single subject design was used, the duration of the study could have been extended so that measurements were further repeated to analyze the variables, such as an AB-AB-AB-AB design. Also, a more comprehensive qualitative section would have provided a better understanding of the context and could also address and acknowledge differences in the study. This was not feasible because this study was conducted during the summer months of June through the end of July during summer break. Additionally, this study suffered from a lack of maintenance data, which was again not feasible due to the time constraints.

Reliability

A third limitation of the study was related to reliability. Reliability of the engagement data was assessed through inter-observer agreement with the same coder over time instead of the use of multiple coders. Multiple coders were considered and attempted. However, this procedure requires a significant amount of financial responsibilities and time to recruit and train observers to ensure coding has acceptable reliability. It is important to note that this does not meet Horner et al. (2005) quality indicators for single subject studies regarding reliability of data collected. Horner et al. (2005) advocated that reliability data should be collected with inter-observer agreement (IOA) with more than one coder, and with IOA levels meeting minimal standards of 80%. The researcher watched each video-recorded session and coded the behaviors of interest on the JA video coding data collection tool (Appendix E) according to the guidelines prescribed in the JA video coding protocol (Appendix D). After a two-week interval of time, the researcher re-watched each video-recorded session and recoded the behaviors again blindly to the previous coding. By doing this, the researcher was able to estimate the degree of accuracy of coding of the two separate coding sessions to establish inter-observer reliability. Results of the inter-observer reliability showed some variability in agreement with agreement percentages approximately 79%. The variability was expected due to the complexity of data collection despite use of a pilot phase. Also, this was the first time the researcher completed observational coding of JA for research purposes. Another limitation regarding reliability was around the assessing of procedural fidelity. The same person in the videotapes was also the same person that assessed procedural fidelity instead of using someone that was blind to the study.

Research Design

Among the most limiting factors in this study was the design of the qualitative portion of the study. Even though the study included both quantitative and qualitative data, in this study, the role of the qualitative data was secondary to the quantitative data set (Creswell & Plano Clark, 2007). A more in-depth qualitative inquiry could have provided a better understanding of the context. According to Hitchcock et al. (2016b):

> We do not have a full understanding of causality until we understand why the mechanism works for some people and some circumstances and not for others. We not only have to understand the mechanism, but also its context and scope. (p. 17)

Learning is complex, and mixed methods in special education may help answer questions about why certain evidence-based interventions work for some students but not for others.

Suggestions for Future Research

The findings of this study present an interesting picture because there was no statistical significance for any of the three students with ASD as a result of the intervention for both achievement and engagement. The results provide little answers but plenty more questions to be furthered investigated. According to Godsmith and LeBlanc (2004), preliminary research findings have yielded promising results on the impact of technology-based interventions for children with ASD; however, these authors recommended that further research is needed to determine that these interventions are really more efficient, cost-effective, and engaging than traditional counterpart interventions for children with ASD (Bouck et al., 2014). The research in this study contributed to this literature, and suggestions can be made for similar future research.

Given the small sample size, multiple replicated single subject studies would be needed to determine whether IWB technology has a positive effect on student engagement and achievement with students with ASD or to make any generalizations. Horner et al. (2005)

recommended that multiple replications of an intervention are needed to name it as an evidence-based intervention. Further studies could involve the replication of this study with a larger number of participants with ASD, which include different aged students across different disciplines and across different technologies such as Ipads. Research could evaluate effects across other school settings to assess generalization and to better understand how IWBs support UDL principles. This will only be more relevant in the future. "With the explosion of development on new technologies, continued research is essential" (Y. Lee & Vail, 2005, p. 17). Technology is not going away and will continue to be an important part of life. It will continue to evolve and it is important that classrooms stay relevant with its practices. Research has shown that technology can be an effective tool in teaching academics to students with ASD. This study could serve as a catalyst for other researchers to evaluate technology-based interventions with children with ASD. It is important that research continues to investigate technology with children with ASD to ensure that the most influential interventions are utilized (Knight et al., 2013). Equally important is finding effective interventions that also promote inclusive practices such as UDL principles.

A following question could be explored in future research: Do IWBs provide too much stimulation for some children? Some children with development disabilities have sensory issues and may not benefit from the procedures used in this study, or students that are highly distracted may not need extra animations, graphics, or sounds (Y. Lee & Vail, 2005). Regardless of the results of this study, the IWB should continue to be explored as a tool to teach skills to children with ASD because the current research is limited. When completing future research, it is essential that both quantitative and qualitative data be gathered. The integration of this data would assist researchers in gaining a better understanding of the complexities within special education.

Summary

The researcher anticipated that the IWB would have a positive impact on both student achievement and engagement for students with ASD during reading instruction based on her informal observations in the classroom. Specifically, the researcher posited that the research would positively support the use of IWBs as an instructional tool to enhance student achievement and engagement in reading. After a thorough review of the literature, Ormanci et al. (2015) established, “that interactive whiteboards contribute positively both to the affective and the cognitive domains” (p. 545). These conclusions were consistent with the results of another study conducted by Ozerbas (2012). However, the data in this study was unable to support the initial hypothesis. This study adds a fascinating element to the literature regarding the use of IWBs for students with ASD. The graphs for achievement and engagement would have needed to show a stable horizontal baseline, followed by acceleration of the targeted behavior (positive correlation) during intervention to provide evidence of correlation. The statistical analysis also supports these findings. Qualitatively, students expressed both positive and negative aspects of both conditions; however, they had a preference to use the IWB. As the numbers of children diagnosed with ASD increase, and as the need for evidence-based interventions that best meet the learning needs of these students increases, research such as this study begin to address these necessities.

All students come to school with a wide range of abilities and experiences and “Ipads, Ipods, Iphones, and Smartboards are becoming standard instructional tools in classrooms across the country” (Knight et al., 2013, p. 2646). Perhaps classrooms that embrace UDL environments and curricula may help provide an inclusive environment for all learners (Stockall et al., 2012). Through the integration of UDL and technology, teachers might have an avenue to create multiple and flexible ways of instruction that supports all types of learners. A specific technology, such as an IWB, will not be miraculously effective on students' achievement and engagement, but rather how educators effectively use and integrate these technologies with evidence-based strategies to the specific needs of the individual students (Kagohara et al., 2013; Knight et al., 2013). There is no "one-size-fits-all" intervention for students with ASD and technology cannot replace good teaching, but when used properly, it has the potential to make good teaching even more effective.

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APPENDIX A: PARENT CONSENT FOR STUDENT PARTICIPATION IN STUDY

Colorado State University

PARENT CONSENT FOR STUDENT PARTICIPATION IN STUDY

TITLE OF STUDY: Engagement and achievement in students with developmental disabilities in the content of reading: using interactive whiteboard technology

PRINCIPAL INVESTIGATOR: Gene Gloeckner, Ph.D, Professor, School of Education; gene.gloeckner@colostate.edu

CO-PRINCIPAL INVESTIGATOR: Nicole Stanley, Doctoral Candidate, School of Education; CRES Intensive Learning Center 970-371-4170, nickilstanley@gmail.com

WHAT IS THE PURPOSE OF THIS STUDY?
The purpose of this research study will be to examine the effects of using interactive whiteboards on academic achievement and engagement in elementary-aged students autism spectrum disorders. Your child was selected as a potential participant because (child's name) is on an IEP with reading objectives and has a diagnosis of autism spectrum disorder.

HOW MANY PEOPLE WILL PARTICIPATE?
Approximately 3-5 children will take part in this study.

HOW LONG IS THE STUDY?
Your child's participation in the study will last 4-6 weeks during the summer of 2015. The study will take place at Coyote Ridge Elementary School. Your child will come four mornings a week (Mon-Thurs) for approximately one-hour sessions. Set times will be individually scheduled between the research and parents to accommodate.

WHAT WILL HAPPEN DURING THIS STUDY?
The research project will consist of two methods of delivery of a reading intervention-traditional book and paper and on an interactive whiteboard. During the traditional delivery, students received books and corresponding worksheets in paper form. During the interactive whiteboard condition, each student reads the books and completed corresponding activities on the interactive whiteboard. For the purpose of the study, data will be collected on engagement and achievement of the participants. Observations of the students' engagement and their performance on regular quizzes will be recorded. These literacy sessions will be videotaped. Videotapes from all sessions will be kept in a locked cabinet accessible only by the lead researcher and will be destroyed by shredding after she successfully completes the dissertation process. At the

conclusion of the study, students will be interviews regarding their thoughts on which method of delivery they preferred.

WHAT ARE THE RISKS OF THE STUDY?
There are no known risks to participating in this study. It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known or potential, but unknown, risks.

WHAT ARE THE BENEFITS OF THIS STUDY?
Although your child may not benefit directly from this research, your child will get free reading intervention for being in this study. Also, we hope that in the future, other children might benefit from this study because we are looking to establish sound evidence-based interventions in special education.

WILL IT COST ANYTHING TO BE IN THIS STUDY?
Your child will not have any costs for being in this research study.

WILL THERE BE PAYMENT FOR PARTICIPATING?
Your child will not be paid for being in this research study. However, s/he will receive 4-6 weeks of free individualized reading intervention from a district certified special education teachers.

ARE MY RECORDS CONFIDENTIAL?
The records of this study will be kept private to the extent permitted by law. In any report about this study that might be published, you or your child will not be identified. The Colorado State University-Institutional Review Board ethics committee may audit your child's study record. Any information that is obtained in relation to this study that can be identified with your child will remain confidential and will be released only with your permission or as required by law. Confidentiality will be maintained by means of securing all videotapes and documentation of behaviors in a locked cabinet (e.g., filing cabinet) that is only accessible by the lead researcher and advisor. The videotapes will only be accessible by the researchers, and will be destroyed after the researcher successfully defends her dissertation. If a report or article is written about this study, the study results will be described in a summarized manner so that your child cannot be identified.

IS THIS STUDY VOLUNTARY?
Your child's participation is voluntary. Your child may choose not to participate or may discontinue participation at any time without penalty or loss of benefits to which your child is otherwise entitled. The decision whether a child participants or not will not affect his or her relationship with the teacher/researcher or school. Furthermore, the decision whether or not to participate will not affect you or your child's current or future relations with Colorado State University.

WHOM MAY I CONTACTS IF I HAVE QUESTIONS?
Please contact NICOLE STANLEY if interested in getting more information regarding this study or participating. #970-371-4170 or nickilstanley@gmail.com

You may call this number or email if you have any questions, concerns or complaints about the research. If you have any questions about your rights as a volunteer in this research, contact CSU IRB at RICRO_IRB@mail.colostate.edu; 970-491-1553.

IRB is a group of people who review the research to protect your rights and welfare. You may also call this number about any problems, complaints, or concerns you have about this research study. You may also call this number if you cannot reach research staff, or you wish to talk with someone who is independent of the research team. General information about being a research subject and the IRB committee can be found on their website at: http://ricro.colostate.edu/IRB/IRB.htm

Please initial: ____ Yes ____ No
I give consent for my child to be videotaped during this study.

Please initial: ____ Yes ____ No
I give consent for my child's quotes to be used in the research; however, my child will not be identified.

Your signature indicates that you have read and understand the information provided above, that your questions have been answered, and that you voluntarily agree to permit your child to take part in this study. You will receive a copy of this form.

Child's Name:

____

Signature of Person Authorized to Provide Permission for the Child and Date

____

I have discussed the above points with the parent or, when appropriate, with the subject's legally authorized representative. It is my opinion that the parent adequately understands the risks, benefits, and procedures involved with participation in this study.

Signature of Person Who Obtained Consent and Date

____

APPENDIX B: STUDENT ASSENT

Verbal Assent (Form will be read to the students and they will fill in the bottom)

Dear student:

You are invited to be in a research study. This research is being conducted by me, Nicole Stanley, doctorate student in the School of Education at CSU under the guidance of Dr. Gloeckner, Professor in the School of Education. I would like to work with you using the interactive whiteboard and a reading program called *Reading A–Z.com*. If you agree, you will be working with me on your reading and you will be videotaped. You have the right to decide not to participate. Even if you start working with me, you can still decide you don't want participate at anytime. You can ask me any questions about why I am taking notes, and/or the activities I am doing with you. If you agree to be part of this study put a check mark in the "Yes" box. If you do not want to participate, put a check mark in the "No" box. Put your name at the bottom of the paper. If you chose to participate, thank you so much for helping other teachers learn how they may help other students just like you! For your help, at the end of the study you will get a free lunch from a place of your choosing.

Sincerely,
Nicole Stanley
Colorado State University
Doctorate Student

Check on box

___________YES
I want to be in the study and I understand that I don't have to do any extra work to be in the study. I understand that even if I check yes now, I can change my mind later.

__________NO
I do not want to be in the study. I understand I must still do the work in class like everyone else.

My name is ____

Date ____

APPENDIX C: JOINT ATTENTION VIDEO CODING PROTOCOL

General Coding Purpose and Guidelines

The overall purpose of this study was to examine student achievement and engagement when a teacher integrates an IWB into reading instruction, compared to when they do not in students with identified Autism Spectrum Disorder (ASD). This protocol was developed to systematically observe individual student's engagement levels. The dependent measures for student engagement in this study are *child-initiated joint attention (IJA) actions*. These include: a) *child-eye contact*, b) *child-gesture,* c) *child-verbalization*. The frequency of occurrences of IJA behaviors are coded via video record observations.

The conceptual definition of JA that was used is shared attention between two individuals (student and teacher) to an exterior object or event (in the classroom) using conventional gestures and eye contact, with the intention of positive shared interest or social experience (Kasari et al., 2006; MacDonald et al., 2006; Mundy et al., 2003; Taylor & Hoch, 2008; Vismara & Lyons, 2007). Eye contact, gesture, and verbalization are discrete forms of behaviors associated with JA and are often described as conventional JA gestures. These behaviors are objectively defined and examples and non-examples of each behavior are provided below.

Initiated Joint Attention

1. Record IJA not teacher JA.
2. Code all actions in order of onset of occurrence.
3. For multiple instances or repetitions of behaviors, code as separate any instances separated by 1 or more seconds (one-one-thousandth).
   a) Example: child initiates eye contact, pauses (one-one-thousandth) and then initiates eye contact again (code as two separate instances of eye contact).
   b) Example: child points to a pictures on the IWB; then lifts finger and points to a different pictures on the IWB (code as two instances of child-gesture).
   c) Non-example: Student taps index finger repeatedly in same location with less than one second pause on IWB (code as one instance of student-gesture).
4. If eye contact occurs simultaneously with a gesture or verbalization-code the behavior as eye contact; however, if they occur at separate points in time code in order of onset of occurrence.
5. Actions must be coded based on visual data. While head orientation can be used an as indicator of eye contact, do not code instances in which there is insufficient visual data to make a reasonable assumption about eye contact.
6. For all actions: *In an attempt to direct attentional focus* is defined as any action that is intentional (the individual initiates the action in a purposeful manner), focused (target is clear to observer), social (intended to share with social partner), and communicative (intended to communicate with social partner).

7. An *active event* is defined as any activity involving the child and teacher that is the current focus of attention (e.g., book).
8. Coding of child actions is not contingent (example: an interaction does not have to occur in order to code an action). Instead, each child's actions meeting the definitions are coded whether or not the teacher socially responds as anticipated.
9. Target objects are stimuli to which child is attempting to draw the attention of the teacher. Child and teacher's body part (feet, hands) can be considered object if they are clearly the focus of attention and both social partners are capable of viewing them.
10. Behavior must be related to positive affect such as smiling and laughing. If the behavior is related to negative affect then it is not coded (Mundy et al., 2003; Vismara & Lyons, 2007)
11. If a qualifying action is directed at a third person, do not code.
12. A JA interaction ends when the JA criteria are no longer met: 5 seconds has elapsed and there has been no qualifying response in the form of a gaze alternation, affect is no longer positive, the target object/event changes.
13. If a JA sequence continues, but one social partner responds two times in a row, only code the first response.

Child Eye Contact. The child initiated eye contact with the teacher during an active event. The teacher the child is looking at must also be looking at the child in order for the child to receive this code.

Eye Contact may occur subtle and relatively rapid (MacDonald et al., 2006; Mundy et al., 2003; Vismara & Lyons, 2007); therefore, vigilance and an alert state are required for reliable coding. Also, code eye contact even if it occurs in combination with another JA behavior.

Examples:

1. Child looks at teacher's face, looks at book, and looks back at teacher's face smiling
2. Child looks at IWB, then looks pointedly at teacher's face
3. Child looks at teacher's face, then looks at picture of a cat and says "cat"
4. Child looks at picture on IWB of an animal, and then orients face and eyes towards teacher.

Non-examples:

1. Child looks at teacher's back, then looks at IWB (shift did not occur between object and social partner's face)
2. Child looks at teacher's face, then glances away (unclear what the target of the gaze shift is)
3. Child looks at book, then scans the room, gaze passing across the teacher without recognition (not intentional, social, or communicative)

Child-gesture. Child gesture is when the child extends finger in direction of object during active event in an effort to direct attentional focus of the teacher. Finger may touch object or not (Kasari et al., 2006; MacDonald et al., 2006). A gesture to objects beyond the frame of views of the camera should be coded

Examples:

1. Child extends finger towards a pictures on the IWB.
2. Child extends finger, the tip of which intentionally touches the book.
3. Child extends finger toward the IWB after something rings.
4. Child extends finger towards own ear and says “ee” while looking at teacher.

Non-examples:

1. Child puts finger in his or her ear (not intended to be social or communicative).
2. Child unintentionally touches book while shifting position to go from sitting to standing (not intentional, social, or communicative).

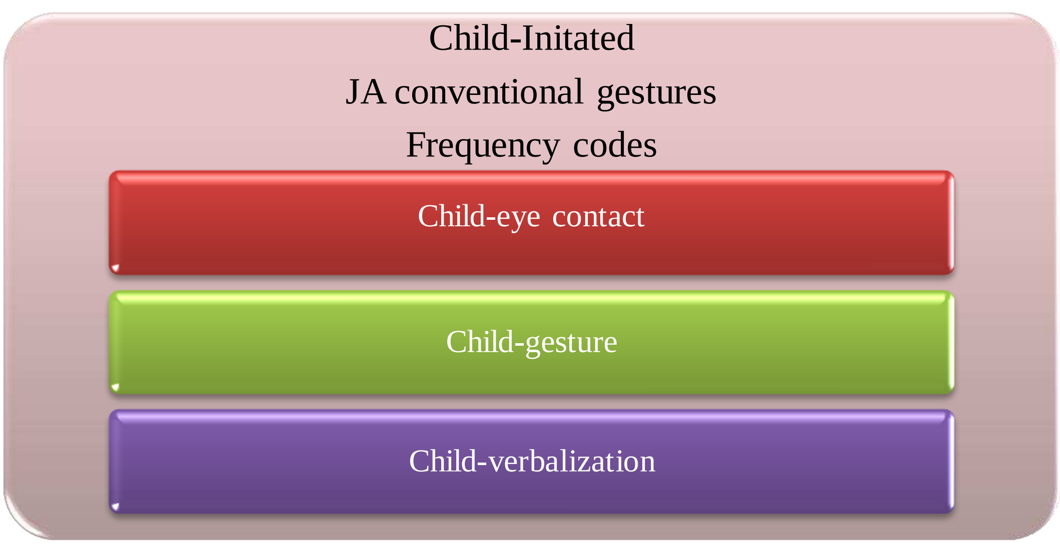
Child-verbalization. Child comments appropriately or asks a question about the object in an effort to direct the attentional focus of the teacher (MacDonald et al., 2006; Taylor & Hoch, 2008). NOTE: If comment is not related to lesson or comment associated with a negative affect (whining, crying) is not coded.

Examples:

1. Child vocalizes a comment about a cat in a picture in the book the teacher and the child are reading together (Vismara & Lyons, 2007).
2. Child asks a question regarding the text the teacher and child read on the IWB.
3. Child makes a personal connection regarding the text the teacher and child are reading.

Non-examples:

1. Child shouts, “I’m bored!”
2. Child vocalizes he or she needs to go to the bathroom.



APPENDIX D: JOINT ATTENTION VIDEO CODING DATA COLLECTION TOOL

Date Videotape: __________
Condition (circle one): Phase A (paper/pencil) Phase B (IWB)
Session #_______
Student:__________
Coder:____________
Date Coded:____________

Use "+" marks for each occurrence of joint attention (JA) behavior

Eye Contact (IJA)

Total:__________

Gesture (IJA)

Total:__________

Verbalization (IJA)

Total:__________

Total JA (Eye contact + Gesture + Verbalizations:_________________
Notes:

APPENDIX E: STUDENT INTERVIEW QUESTIONS

Student Satisfaction Questions
(Student)________________________________

I am going to ask some questions about reading ….

1. Do you prefer to read books during reading at the table or on the IWB?

2. What do you like about using the paper books?

3. What do you like about using books on the IWB?

4. Which way helps you read better: reading on the IWB or reading at the table? Why is that?

5. Is there anything else you want to tell me about your reading learning?

APPENDIX F: PROCEDURAL FIDELITY CHECKLIST

Session #____________________ Dates and times of sessions: I _______________
Level of Unit ___________ II______________
Name of Unit ____________ III_____________

Condition (circle one): Phase A (paper/pencil) or Phase B (IWB)

Person Conducting Procedural Integrity Probe: ___________________________

"+"= The statement reads true and procedures were followed. The procedures do not need to follow the exact sequence listed
"O"= The statement reads false and procedures have not been followed or are out of sequence
"N/A" if the step doesn't apply or necessary

_____The teacher is positioned and she is able to view the students during designated activity
_____Student is present and is participating in lesson
_____Teacher delivers varied reinforcement (e.g., praise, high-fives, edibles, stickers)
_____Teacher uses non-fiction texts /units in curriculum

Session I
Introduction of Vocabulary to build background knowledge and first reading of text:
_____Teacher offers the student the choice between two non-fiction units (books with similar number of words).
_____Based on student's unit preference, teacher has the student read the unit's content words with her. If there is a glossary at the back of the book, the words and definitions are read aloud.
_____Teacher shows student the front of the cover of the book and reads the title to them.
_____Teacher asks the student what he/she thinks he/she might read about in the book.
_____Teacher completes a picture walk with the student. The teacher and student discuss aloud about what they see in each picture.
______After the picture walk, teacher asks the student to make any other predictions about the story after the picture walk.
_____Teacher shows the student the title page and may discuss the information on the page (title of the book, author's name).
_____Teacher gives the student a copy of the book (in phase A). Teacher has student open book to page 3. The student reads table of contents (if applicable).
_____Teacher sets a timer for one minute to record student's word count for a one minute.
_____When the timer stops, the teacher records where the student stopped reading in the book.

_____Teacher does not focus on comprehension during the first time reading, but assists student with decoding whenever needed.
_____At the end of the story, the teacher ask the student to tell her any two details he or she remembers from the story.
______Student completes corresponding phonics worksheet. The teacher answers any questions the student has and checks for understanding.
______Teacher counts the number of words read until timer buzzed and records number next to Pretest Word Count.

Session II
Second Reading-Comprehension:
_____Teacher asks the student what he remembers about the text (if it is a new day).
_____Teacher gives the student the option to reread the text silently or aloud with her.
_____Teacher asks comprehension questions at the end of the book to facilitate review/retell of the text. Questions can include: who (characters), what (plot, problem), where and when (setting), why is text important?
_____Teacher has the student cut out the discussion comprehension cards (phase A).
_____The teacher places the cards upside down on the table (phase A). The student chooses which card he/she wants to answer. Student answers all the discussion cards questions.
_____The student completes corresponding worksheets

Session III
Third Reading-Comprehension:
_____Teacher asks the student to reread the text aloud to her.
_____ Teacher sets a timer for one minute to record student's word count.
_____When the timer stops, the teacher records where the student stopped reading at buzzer.
_____Teacher encourages the student to continue to read aloud or silently.
_____Have student complete any other corresponding worksheets (if applicable).
_____Teacher issues the Comprehension Quiz to the student. Teacher does not help student answer multiple choices questions. Independence score is needed for all questions except extended response.
_____Teacher records independent score.
_____Teacher has the student complete the extended response and helps as needed. The teacher may scribe the student's answer.

Total # marked with an "+"=__________ divided by total # of spaces marked with X and O, multiplied by 100= the _________% of steps followed correctly. Do not include spaces marked with N/A.

Pretest Word Count______
Posttest Word Count______
Comprehension Quiz Score______

APPENDIX G: APPROVAL LETTER FROM CO. STATE UNIVERSITY IRB BOARD

Colorado State University
Knowledge to Go Places

Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011 Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	August 26, 2014	
TO:	Gloeckner, Gene, School of Education	
	Robinson, Danny, School of Education, Stanley, Nicole, 1588 School of Education	
FROM:	Swiss, Evelyn, Coordinator, CSU IRB 2	
PROTOCOL TITLE:	Effects of using interactive whiteboards on academic achievement and behavior in students with autism spectrum disorders	
FUNDING SOURCE:	NONE	
PROTOCOL NUMBER:	11-3040H	
APPROVAL PERIOD:	Approval Date: July 26, 2014	Expiration Date: July 25, 2015

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Effects of using interactive whiteboards on academic achievement and behavior in students with autism spectrum disorders . The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

IRB Office - (970) 491-1553; RICRO_IRB@mail.Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381; Evelyn.Swiss@Colostate.edu

Swiss, Evelyn

Evelyn Swiss

Swiss, Evelyn

Approval is to recruit the remaining 5 elementary-aged students identified with autism spectrum disorders with the approved parent cover letter, parent consent, and child assent. The above-referenced project was approved by the Institutional Review Board with the condition that the attached consent form is signed by the subjects and each subject is given a copy of the form. NO changes may be made to this document without first obtaining the approval of the Committee. Subjects under the age of 18 years old must obtain parental permission.

Approval Period:	July 26, 2014 through July 25, 2015
Review Type:	EXPEDITED
IRB Number:	00000202

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