MEASURES FOR COMPARING AN AUGMENTATIVE AND ALTERNATIVE COMMUNICATION APPLICATION FOR USE WITHIN A KINDERGARTEN CURRICULUM

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ABSTRACT

The purpose of this study was to measure the influence of augmentative and alternative communication (AAC) with symbol-supported communication applications (apps) on stimulating kindergarten students to increase expressive language in the general education setting in an elementary school located in Washington, DC. The study sample size was 31 students. The research aimed to identify these tools as an effective strategy to assist kindergarten students in using more verbal language, thereby lowering the risk of communication frustration and increasing the expression of learned knowledge. Language data usage was collected by viewing speech acts as operators in a planning system, then integrating speech acts into plans by comparing the independent variable of the use of the symbol-supported communication app to the dependent variables of knowledge of words and word combinations, knowledge of grammar, supralinguistics (inferencing), pragmatics, and practical use without exposure to the AAC device with a dynamic display and symbolic symbols. The Comprehensive Assessment of Spoken Language tool measured expressive language growth. A quantitative quasi-experimental, pretest-posttest, nonequivalent comparison group design and a multivariate analysis of covariance using the pretests as the covariates measured the outcome. There was a statistically significant difference in the growth of posttest scores in the areas of knowledge of words and word combinations and knowledge of grammar. However, the students’ performance in the areas of supralinguistics and pragmatics did not experience any measurable growth. Future research should continue to validate and build upon the results of this investigation.

Keywords: augmentative and alternative communication (AAC); dynamic display; application (app); language acquisition theory (LAT); speech acts; student, environments, tasks, and tools (SETT).
Dedication

To all those who have something to say … we hear you.
Acknowledgments

First and foremost, I thank my Lord and Savior Jesus Christ for guiding and helping me through this journey. This could not have been possible without His unconditional love, gentle nudges, and devotion. To my husband, Keith, your steadfast love, loyalty, and support never faltered during this process. You are truly my best friend and life partner. It has been a unique and interesting path over the years. To my beautiful children Austin and Alexis, thank you for being the joy in my life. I hope you can use our path through this experience as motivation to push through the difficulties and persevere because anything is possible as long as you do not give up. To my parents, words cannot adequately express my love for you. Mom, your daughter did it! Your constant presence in my life made me who I am today—a mother, wife, sister, friend, and a woman of God. To my Dad, I wish you were here to enjoy this accomplishment with me. While growing up, your constant words of encouragement set me on a constant path of growth and development. To my brothers Walter and Anthony, you always believed in me and my abilities. My love for you has only grown over the years, and I am honored to be your sister. To my friends, Angela, Delores (DeeDee), Joyce, LaVerne, Sabrina, Shiela, Tasya, and Tonja, who have become my sisters in life, thank you for encouraging and motivating me during the challenging moments. I thank my colleagues, family, and friends who helped me and encouraged me during this process. To my committee chair, Dr. Barbara Jordan-White, thank you for your truthfulness, motivation, encouragement, and leadership as you led me through this process. You have truly been a godsend. To my committee members, Dr. Meredith Park and Dr. Rebecca Bowman, thank you for support, guidance, and leadership. I truly appreciate all of your help.
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List of Abbreviations

American Speech-Language-Hearing Association (ASHA)
Augmentative and Alternative Communication (AAC)
Autism Spectrum Disorder (ASD)
Assistive Technology (AT)
Centers for Disease Control and Prevention (CDC)
Developmental Disorder (DD)
Free and Appropriate Public Education (FAPE)
Individuals with Disabilities Education Act (IDEA)
Institutional Review Board (IRB)
Language Acquisition Theory (LAT)
Multivariate Analysis of Covariance (MANCOVA)
No Child Left Behind (NCLB)
Picture Exchange Communication Symbols (PECS)
Specific Language Impairment (SLI)
Student, Environments, Tasks, and Tools (SETT)
CHAPTER ONE: INTRODUCTION

Overview

This chapter presents the current knowledge and specific research questions that are central to the research on the use of augmentative and alternative communication (AAC) with symbol-supported communication applications (apps) to aid kindergarten students in the general education classroom. First, there is a discussion of the relevant background information and the current state of research in this field. Second, the chapter identifies the knowledge gaps. Finally, a presentation of the ways that this study addressed these knowledge gaps and the specific research questions proposed is provided.

Background

In the 1950s and 1960s, AAC emerged as a method of communication for children and adults who had not developed the communication skill of speech (Hourcade, Pilotte, West, & Parette, 2004; Light & McNaughton, 2015). It has experienced significant changes since its initial development. The nature of an assessment for an AAC changed from a candidacy model—in which a person must demonstrate deficiencies to be eligible for an AAC system—to the current model, which is based on the belief that everyone should be able to communicate and that society can benefit from AAC technology (West & Pirtle, 2014). Communication technology is currently abundant in society, and its impact is prevalent (Light & McNaughton, 2014). Technological advancement has impacted the AAC field as well, with the development of a wide variety of devices, such as iPads and other mobile technologies, with AAC apps (Bradshaw, 2013; Lorah et al., 2013; McNaughton & Light, 2013; Shane, Blackstone, Vanderheiden, Williams, & DeRuyter, 2012).
**Historical Perspective**

Historically, it has been assumed that people with communication and learning difficulties are unable to make independent decisions (Light & McNaughton, 2014; Nind, 2008). Indeed, many individuals with developmental disabilities experience significant difficulty in communicating effectively (Hourcade et al., 2004; Light & McNaughton, 2014). They are not adequately able to express their thoughts, needs, or desires, nor can they advocate for themselves due to a lack of communicative competence (Koosha & Yakhabi, 2013). Fortunately, over the past several decades, these difficulties have been addressed through the use of AAC (Romski, Sevcik, Barton-Hulsey, & Whitmore, 2015). Research and clinical practice in the AAC field have focused on replacing speech and enhancing face-to-face communication. Interventions were typically designed to address the expression of needs and wants (Light & McNaughton, 2014).

In 1984, Lori Frost, a certified clinical competence/speech-language pathologist (CCC/SLP), established the Picture Exchange Communication System (PECS; Soomro & Soomro, 2018). The PECS training system is an applied behavior analysis program intended for early nonverbal symbolic communication training (Achmadi et al., 2014). This program was initially designed to teach speech communication using picture symbols to nonverbal children (Frost, 2002; Soomro & Soomro, 2018). In 1991, the first AAC to feature a touch screen with a dynamic display using the PECS was made available to AAC users. Schlosser used this type of AAC device to understand postintervention and intervention efficiency in 1999 (Agius & Vance, 2016).

As technology advanced, the addition of color displays became available in 1996. The next major leap in advancement took place in 1999, when digitized speech was added to AAC
devices with dynamic displays; Blackstone documented research using this device in 2005 (Shane et al., 2012). Visual scene displays were embedded with sounds or speech for the purpose of promoting language via natural contexts (Thistle & Wilkinson 2009 & Light & McNaughton, 2013). Later, Beck, Stoner, Bock, and Parton (2008) adapted the PECS protocol for use with an AAC. Research has shown how typically developing children increase language usage when exposed to PECS (Hartley & Allen, 2014). Finally, the most recent development occurred in 2009. The iPhone was paired with an AAC application (app), which allowed a speech-generated voice to be added to pictures. This technology was then extended to the iPad, a tablet computer, and a PECS app (Kagohara et al., 2013). This development provided significantly cheaper and easier access to AAC.

**Society-at-Large**

The context specific to users of AAC includes the individual, the educational environment, and social settings. The prevalence of voice, speech, and language disorders for children ages 3–6 is 11% (Black, Vahraitian, & Hoffman, 2015). Accordingly, individuals with disorders of speech-language production and expressive language often face educational challenges and limited social participation in their daily lives (Prelock, Hutchins, & Glascoe, 2008; Reschl, 2015).

According to a news report, authored by Baio et al, released in 2018 by the Centers for Disease Control and Prevention (CDC), 1 in 59 U.S. children is diagnosed as having autism spectrum disorder (ASD). This a 15% increase since 2014. Children with ASD often demonstrate delays in expressive communication, impacting their ability to independently function in typical environments, such as at school and home (Lane, Shepley, & Lieberman-Betz, 2016).
AAC devices provide opportunities to balance impairments affecting expressive communication (Beukelman & Mirenda, 1998; Evans, 2016; Glennen & DeCoste, 1997; Lloyd, Fuller, & Arvidson, 1997; Smith, 2004). The areas of most concern when using a symbol-supported communication app on an AAC device are (a) **lexical** and **semantics**, which address knowledge using appropriate words; the ability to use antonyms and synonyms, completing a sentence, and using idiomatic language; (b) **syntactic**, which is knowledge and use of grammar, the ability to use syntax construction, sentence and paragraph comprehension, grammatical morphemes, and grammatical judgment; (c) **supralinguistics**, which is understanding and using nonliteral language, gaining meaning from context, inferencing, and comprehending ambiguous sentences; and (d) **pragmatics**, which is an awareness of appropriate language in a situational context and the ability to modify such language as necessary (Carrow-Woolfolk, 2016; Norbury, Gemmell, & Paul, 2014; Reichow, Salamack, Paul, Volkmar, & Klin, 2008).

Devices such as tablets, touch screen mobile devices, and computers that can accommodate dynamic display programs are now easily accessible and moderately inexpensive options for classroom communication support (Kagohara et al., 2013; McNaughton & Light, 2013; Rabideau, Stanton-Chapman, & Brown, 2016). The development of symbolic symbol apps intended to be used on these devices has also dramatically increased (Higginbotham & Jacobs, 2011; Reichle, Drager, Caron, & Parker-McGowan, 2016), providing multiple software options and platforms to facilitate the AAC app with a dynamic display and symbolic symbols in the classroom. However, the use of AAC with a dynamic display is not a panacea for communication challenges and student inclusion in the classroom (Bouck & Flanagan, 2014). A fear exists among some educators and parents that dependence on communication devices may interrupt and have a negative impact on verbal language development in children, despite
research that has shown its positive effects (Kagohara et al., 2013; Millar, Light, & Schlosser, 2006; Schlosser & Wendt, 2008; Walker & Snell, 2013). Unfortunately, strategies to promote AAC use during therapy sessions were not analyzed separately from other strategies (Lane, Lieberman-Betz, & Gast, 2016).

Furthermore, limited research exists on expressive language usage after an AAC device with a symbolic symbol app has been used for remediation (Bradshaw, 2013; Calculator, 2009; Kagohara et al., 2013; McNaughton & Light, 2013). As students that require the use of an AAC device are moved into the general education classroom with more frequency, it is imperative to determine if AAC devices with dynamic displays and symbolic software serve to increase expressive language usage. These devices must be beneficial for assisting individual students in expressing their understanding of the curriculum (Jones, 2017).

The rise of the electronic tablet (dynamic display with symbolic symbols) in 2010 has promoted a surge toward technology that may benefit children with expressive language delays due to the device’s portability, easy-to-use touch-screen interface, and the ability to emit a multimodal output (Lofland, 2016). Although countless software apps designed to support language development and communication using digital pictures exist, minimal research has investigated how the use of symbolic symbols presented via tablet technology has affected the ability of kindergarten students with difficulties in the general education setting. Similarly, there is little guidance on how the features of electronic apps can be maximized to specifically facilitate expressive language usage in this population.

Speech-language pathologists are often viewed as the only remediators for language intervention. In actuality, multidisciplinary teams comprised of the speech-language pathologist, special education teacher, general education teacher, and a student’s parent(s) develop and
collaboratively implement behavioral and social supports, communication strategies, and academic modification for a student. Implementation of these plans by the multidisciplinary team can assist with improvements in participation in classroom activities, social interactions with peers, and communication of information and ideas through the use of various types of AAC devices (Gallagher, Malone, & Ladner, 2009; Stewart, 2015).

However, AAC is currently used only by individuals with limited communication. For example, it is often utilized by students who are at risk for limited expressive language, are difficult to understand, or have motor planning difficulties (Fields, 2015). Moreover, research has supported the use of AAC for children with ASD (Fields, 2015; Odom, Collet-Klingenberg, Rogers, & Hatton, 2010; Paul, 1997; Schlosser & Wendt, 2008) as well as for adults with progressive or temporary communication needs (Light & McNaughton, 2015).

The appropriate AAC with symbolic symbol app must be selected together with implementation and execution of strategies to attain global communicative growth for students (Calculator, 2009; Kagohara et al., 2013; McNaughton & Light, 2013). However, it is not achievable without proper assessment of the needs of individual students and an effective AAC with symbolic symbols app for students with different disabilities and ages (Calculator, 2009; Fernandez-Lopez, Rodriguez-Fortiz, Rodriguez-Almendros, & Martinez-Segura, 2013).

The kindergarten-age group located in the general education setting is underrepresented in research studies that focused on knowledge of words and word combinations, and before AAC methods can be applied in the classroom, there are three basic learning analytics that should be considered. First, an AAC is not a one-size-fits-all solution to communication challenges (Gasevic, Dawson, Rogers, & Gasevic, 2016). Second, it must serve as a tool to influence communication (Lane, Lieberman-Betz, & Gast, 2016). It is therefore imperative that an
appropriate AAC system that meets an individual student’s physical, cognitive, and learning needs is identified before that student can rely on an AAC method as his or her primary means of communication (Law et al., 2007).

The Coordinating Committee of Special Interest Group 12, Augmentative and Alternative Communication, has issued statements of concern regarding integration and use of any AAC device without completing a comprehensive assessment to determine which AAC and symbolic symbol app combination best matches a student’s need (American Speech-Language-Hearing Association [ASHA], 2004; Zapf, Scherer, Baxter, & Rinatala, 2015). AAC devices have developed as technology has advanced, but they have only recently been accepted into classrooms. Given these circumstances, limited research literature exists to determine whether new AAC devices with a dynamic display meet student needs or are appropriate for the rigors of the general education curriculum (Light & Naughton, 2014).

Furthermore, there is a lack of knowledge concerning the type and use of AAC to develop language in the kindergarten general education curriculum. Specifically, there is little research to support the effectiveness of assistive technology (AT) devices using AAC methods with babies and children up to 5 years old (Burne, Knafelc, Melonis, & Heyn, 2011; Mistrett, Lane, & Ruffino, 2005; Therrien & Light, 2016). Thus, determining the effectiveness of the use of AAC with a symbolic symbols app within a general education kindergarten curriculum is necessary.

**Theoretical Context**

The theories guiding this study are the language acquisition theory (LAT), conceived by Noam Chomsky (1957) which is documented by Vogt (2000) and later refined by Cantwell and Baker (1987), and Joy Zabala’s (1995) theoretical framework of student, environments, tasks,
and tools (SETT). LAT reveals that language acquisition (originally called the language acquisition device) is a theoretical concept that postulates that the brain is comprised of a device that helps children quickly learn the language and comprehend grammar and syntax. This construct assists in explaining how the processes in the human brain have evolved to assist humans in understanding language acquisition (Chomsky, 1957; Vogt, 2000).

LAT maintains that language occurs in stages (Cantwell & Baker, 1987; Chomsky, 1957). According to LAT, they are (a) Stage 1, ages 6 months to 12 months; (b) Stage 2, ages 1 year to 2 years; (c) Stage 3, ages 2 years to 3 years; (d) Stage 4, ages 3 years to 4 years; (e) Stage 5, ages 4 years to 5 years; (f) Stage 6, ages 5 years to 6 years; (g) Stage 7, ages 6 years to 7 years; and (h) Stage 8, ages 7 years to 8 years. This study is focused on students who are 5 to 6 years old because Chomsky (1957) and Cantwell and Baker (1987) proposed that the most critical stages of language acquisition occur between birth through 5 years of age. By age 5, most students can follow three-step directions, generate understandable language, ask and answer questions, use descriptive words, use compound and complex sentences, know all vowels and consonants, and use correct grammar (Cantwell & Baker, 1987; Saxton, 2017).

Cantwell and Baker (1987) suggested that interventions in language acquisition should be built into a child’s environment. LAT reveals that although language development occurs in stages, learning the language skills that are depressed in development can be learned at any of the language developmental stages (Adi-Japha & Abu-Asba, 2014). LAT also suggests that language development occurs when repetition of information is provided (von Koss Torkildsen et al., 2009). Additionally, language acquisition is attainable when supported by a picture or symbol (Ralph & Rochester, 2016). Therefore, LAT relates to this current study because this study’s participants (kindergarten students) were provided with the repetition of words and word
combinations, use of grammar, and the use of language in which meaning was not directly available. Moreover, participants were provided knowledge of the language that is appropriate across different situational contexts in order to determine if they possessed the ability to modify language according to the social situation—that is, could they retain, comprehend, and express meaning within those segments that were missing (Sundström, Lyxell, & Samuelsson, 2018).

Most studies of students who use AAC with a dynamic display consider the elements of setting, environment, task, and tool. Zabala’s (1995) SETT framework provides a basis for the role of AAC in remediating language acquisition and usage in each of these categories to determine the most appropriate device to support the child in totality. The SETT framework is a useful tool to assist in the decision-making process of selecting a technology tool. Zabala initially developed it as a guide that enables all involved to participate with confidence in assistive technology decision-making through all phases of service delivery (Fonte, Nistal, Rial, & Rodríguez, 2016; Vize, 2013; Zabala, 2005). The SETT framework assists providers (educators, parents, and speech-language pathologists) in selecting the most appropriate AAC technology that will enable a student to communicate and increase expressive language usage (Karlsson, Johnston, & Barker, 2017) because, when needed, early intervention in the area of audiovisual speech processing is an essential aspect of the development of phonological knowledge and expressive language production during subsequent years (Tomalski, 2015).

Deciding which AAC device to use to assist in such interventions of language development is where the SETT framework is used (Achmandi et al., 2014). In a study (Crestani, Clendon, & Hemsley, 2018) in which word knowledge and usage using an AAC device had been vetted using the SETT framework, several words occurred with high frequency when students retold self-generated stories and personal and scripted narratives were analyzed.
The results assisted in the development of a word list for use with personal AAC devices (Crestani, Clendon, & Hemsley, 2018). Other researchers, such as Martínez-Santiago, Montejo-Ráez, García-Cumbereras, and Diaz-Galiamo (2016), studied the task of grammar usage with the pictogrammar (AAC) tool to determine if this tool was capable of generating natural language when responding to teachers, parents, and caregivers. Accordingly, the SETT framework can assist in understanding how AAC with a dynamic display can assist the student with knowledge and use of grammar, meaning, and language modification in the school setting when responding to teachers. The current research assists in filling the gap in the literature by determining if an AAC device with a dynamic display will impact expressive language usage of kindergarten students in the general education setting. This research sought to address the identified gap in the research by focusing on students enrolled in a general education classroom using differentiated instruction that meets the needs of various learning styles and examining whether using AAC with a dynamic display and symbolic software is a strategy that can be used to assist kindergartners in using more expressive language while participating in the kindergarten general education curriculum.

**Problem Statement**

Current research has confirmed most kindergarten students can follow three-step directions, generate understandable language, ask and answer questions, use descriptive words, use compound and complex sentences, know all vowels and consonants, and use correct grammar (Cantwell & Baker, 1987; Saxton, 2017; Thistle & Wilkinson, 2015). However, some kindergarten students who have not met some or all of these developmental language milestones and do not qualify for special education services remain in the general education setting with minimal support (Kover, Edmunds, & Ellis Weismer, 2016). Additionally, limited research has
taken place to identify interventions for kindergarten students in the general education setting who might benefit by using current AAC with a symbol-supported communication app (Shanley, Strand Cary, Clarke, Guerreiro, & Thier, 2017). Peters (2016) found the developmental delay may cause students to have difficulties verbally expressing thoughts, ideas, and learned knowledge using appropriate words and word combinations; learning grammar, supralinguistics, and pragmatics. However, the latest research has not addressed using current AAC technology with a symbol-supported communication app intervention to assist the general education kindergarten population and remediate this issue. Therefore, this current study sought to fill this research gap and extend the knowledge provided by the work of Jennische and Zetterlund (2015).

Current research has confirmed delivering AAC with symbolic symbol intervention to kindergarten students with identified language delays and autism while in the special education classroom can strengthen language skills (Schlosser et al., 2016). A review of the current research revealed that there is a need for expressive language intervention for kindergarten students in the general education setting (Soto & Clarke, 2017). Therefore, this study sought to identify further practical apps for increasing expressive language usage—identified as knowledge of words, knowledge of grammar, knowledge of supralinguistics, and knowledge of pragmatics by using AAC with a symbolic symbols communication app (Jennische & Zetterlund, 2015; Lane et al., 2016; Naguib Bedwani, Bruck, & Costley, 2015; Soto & Clarke, 2017).

Current research-based interventions at the general education kindergarten level are designed to increase expressive language vocabulary usage using a variety of modalities, including AAC with symbolic symbols (Bowne, Yoshikawa, & Snow, 2017; Neuman, Newman, & Dwyer, 2011). Many educators recognize the need for developmentally appropriate
classroom-based intervention. However, the demands of an already overburdened classroom schedule should be supported by strategies that can be easily implemented within the classroom setting and curriculum and that are designed for adapting interventions across the curriculum (Farmer et al., 2016). Current researchers confirm that AAC devices are tools that can enhance learning and may have a practical impact on instruction (Herron, Kiger, & Owens, 2013). When personalized, AAC learning advances a global trend of logical next steps in school districts and higher education that include embracing pedagogical shifts and supporting distinct devices and personal learning (McKnight, 2014). Therefore, this current study sought to identify further practical applications for increasing expressive language usage.

A view of the most recent literature called for AAC with symbolic symbols intervention that is easy to use and naturally fits into the general education kindergarten curriculum. Additionally, a review of the current literature reveals a need for practical interventions to meet this demand (Reichow et al., 2008). Therefore, the current study sought to fill this research gap by evaluating the use and extending the current research by using AAC with symbolic symbols to increase knowledge of word and word combinations, knowledge of grammar, knowledge of supralinguistics, and knowledge of pragmatics (Thistle & Wilkinson, 2015). The latest version of AAC with symbolic symbols created by AAC researchers was used and empirically tested in the current study to contribute to the expressive language enhancement using AAC with symbolic symbols (Lorah & Parnell, 2017). This study responds to an identified need for research in the area of expressive language remediation in the general education kindergarten classroom using AAC with a symbolic symbol app (Chen & Liang, 2017; Jennische & Zetterlund, 2015; Kapalkova, Polisenska, & Sussova, 2016; Kasari et al., 2014; Olson & Astington, 2013; Peters, 2016; Sonbul & Schmitt, 2013). Kindergarten students with expressive
language delays, although being educated in the general education setting, need a practical solution to help them increase expressive language usage; current literature supports the necessity for such a solution.

**Purpose Statement**

The purpose of this proposed quasi-experimental, nonequivalent control group, pretest-posttest design was to test Chomsky’s (1956) LAT and Zabala’s (1995) SETT theoretical framework as they relate to students’ ability to increase expressive language using an AAC device with symbolic symbols. The independent variable is the *symbol-supported communication app*, which is defined as symbolic symbol software (Pei-Lin & Tabor-Doughty, 2015). The independent variable is the symbol-supported communication app acting on two levels: use and non-use. The dependent variables are defined as knowledge and use of words and word combinations, knowledge and use of grammar, knowledge and use of supralinguistics, knowledge of pragmatics (Carrow-Woolfolk, 2016; Vörös, Rabi, Pinter, & Sarkany, 2014). The Comprehensive Assessment of Spoken Language (CASL-2), administered as a pretest, was used as a covariate during the analysis to measure lexical use and semantics (knowledge and use of grammar), syntax (knowledge and use of the words and word combinations), supralinguistics (knowledge and the use of language in which meaning is not directly available), and pragmatics (knowledge of language that is appropriate across different situational contexts and the ability to modify language according to the social situation).

The LAT was the leading theory being tested. This theory examines language acquisition and usage among children ages 0–8 years old (Cantwell & Baker, 1987; Chomsky, 1956). The theory indicates that language milestones can best be met by age 8 (Zwisterlood, Wijnen, Weerenburg, & Verhoeven, 2015).
In regard to this study, LAT created expectations that the independent variable, a symbol-supported communication app, would influence the dependent variables of knowledge and use of the words and word combinations, knowledge and use of grammar, knowledge and use of supralinguistics, and knowledge of pragmatics (Carrow-Woolfolk, 2016; Vörös et al., 2014). Children are innately equipped to acquire language (Chomsky, 1956). However, when that acquisition is interrupted, it affects not only verbal communication abilities, but also comprehension and writing abilities (Cantwell & Baker, 1987; Kasari et al., 2014; Romski et al., 2015). Consequently, it is imperative that language is remediated at a point when a child can experience the most success, which is ages 5–6, when children first enter kindergarten (Cantwell & Baker, 1997), the first level of mandatory education in the United States (Wallner, 2012). Additionally, the SETT theoretical framework by Zabala (1995) was considered in regard to how the data were gathered and organized, the student’s abilities, the environment where the device was used, the task needed for active participation, and finally, the tools needed for the student to address the task.

**Significance of the Study**

Educators should have access to a set of scientifically evaluated AAC devices and symbolic symbol apps to assist them in meeting the mandates of the Assistive Technology Act (AT Act 2004) and the Individuals with Disabilities Education Act (IDEA 2004), which make provisions for free and appropriate public education (FAPE) within the least restrictive environment (Baxter, Enderby, Evans, & Judge, 2012). As more students in kindergarten general education classrooms require specific devices and apps to assist with communication, it is crucial to determine which AAC devices and symbolic symbol apps are most useful in
enhancing these students’ language and literacy development for their global academic development (Aldabas, 2017; Hourcade et al., 2004; Kent-Walsh & Light, 2003).

Without a research-based assessment of AAC devices with symbolic symbol apps, inappropriate or ineffective AAC systems might be used in classrooms, resulting in minimal or no improvements for students with a language acquisition disability (Calculator, 2009; Kagohara et al., 2013; McNaughton & Light, 2013). AAC devices with a dynamic display and symbolic software are relatively inexpensive and socially acceptable, so school districts are increasingly adopting these devices for their AAC platforms in the classroom. However, they are neglecting to research both their effectiveness for use in such a capacity and their influence on students’ use of the device as designed (Kouroupitroglou, Pino, & Riga, 2017). A systematic review focusing on children who are expressive users of AAC revealed that the findings are not applicable to other groups of children and adults who use AAC (e.g., those who use AAC to support comprehension and expression) or on other outcomes (e.g., the impact of AAC on speech development; Lynch, McCleary, & Smith, 2018).

Children who use AAC are a heterogeneous population facing a broad range of challenges related to expressive language usage. Therefore, valid and reliable assessment tools are critical in order to improve their language usage outcomes (King, Binger, & Kent-Walsh, 2015). This study addressed the current knowledge gap in AAC, with symbolic symbols specifically used to influence an increase in expressive language for kindergarten students. Although research has demonstrated that language development occurs up to 8 years of age (Cantwell & Baker, 1987; Nippold, 2016), few studies have investigated the potential of AAC devices with symbol-supported communication apps to improve classroom communication and influence kindergarten students to use more expressive language (Burne et al., 2011; Mistrett et
al., 2005, Therrien & Light, 2016). By targeting students ages 5–6 using AAC with a symbol-supported communication app, this study not only informs guidelines about the use of AAC with a symbol communication app in classrooms, it also sheds light on whether or not this age group can benefit from the use of AAC with a symbol-supported communication apps as an intervention tool.

**Research Questions**

The following questions guided this research:

**RQ1:** Is there a significant difference between the knowledge and use of words and word combinations scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

**RQ2:** Is there a significant difference between the knowledge and use of grammar scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

**RQ3:** Is there a significant difference between the supralinguistic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

**RQ4:** Is there a significant difference between the pragmatic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

**Definitions**

The following definitions of key terms are provided to encourage understanding and consistency throughout this research:
1. *Augmentative and alternative communication (AAC)*—This type of communication attempts to assist individuals with severe expressive communication disorders by creating another system to deliver a communicative message in natural speech and writing using aided or unaided symbols (ASHA, 2013).

2. *AAC theory*—This theory states that appropriate measures must be taken to identify an appropriate AAC system that meets an individual’s physical, cognitive, and learning needs (Law et al., 2007).

3. *Assistive technology (AT)*—Assistive technology devices are identified as any item, piece of equipment, or product system—whether acquired commercially or off the shelf, modified, or customized—that is used to increase, maintain, or improve the functional capabilities of children with disabilities (Wilmshurst & Brue, 2018).

4. *Co-construction*—A grammatical or semantic entity that has been uttered by more than one speaker. It is a technical term for the concept of one person finishing another person’s thought (Ono & Yoshida, 1996).

5. *Cognitive impairment*—A problem with thought processes (CDC, 2011). It can include loss of higher reasoning, memory lapses, learning disabilities, focusing difficulties, reduced intelligence, and other decreases or limitations in mental functions. Cognitive impairment may be present at birth or can occur at any point in a person’s lifespan.

6. *Common ground*—The basic unit of grounding is the collaborative process in which a signal (e.g., gesture, word, or utterance) is successfully understood (Cornish & Higginbotham, 2008).

7. *District of Columbia Public Schools Common Core State Curriculum Framework English Language Arts—Grades Kindergartners through Grade 2*—These are the educational
standards that identify the essential skills and knowledge that a student needs to master (Office of State Superintendent of Education, 2019).

8. **Duration ratio**—The time necessary to complete a communicative message (Ratcliff, Sutton, & Lehman, 2009).

9. **Free and appropriate public education (FAPE)**—FAPE mandates that school districts provide access to general education and specialized educational services. It also requires that children with disabilities receive support free of charge, as is provided to nondisabled students. Furthermore, it provides access to general education services for children with disabilities by encouraging that support and related services be provided to children in their general classrooms as much as possible (National Center for Learning Disabilities, 2014).

10. **General education curriculum**—The general education curriculum is a program of study in the arts and sciences that provides students with broad educational experience. Courses teach students fundamental skills and knowledge in mathematics, English, arts, humanities, and physical, biological, and social sciences (Bergen Community College, n.d.).

11. **iPad**—The iPad is a line of tablet computers designed, developed, and marketed by Apple Inc., primarily as a platform for audiovisual media including books, periodicals, movies, music, games, apps, and web content (Apple, 2016).

12. **Item search**—Generating answers, both one word and complete answers.

13. **Language acquisition theory (LAT)**—The process by which humans perceive and comprehend language, as well as use words and sentences to communicate (Chomsky, 1957).
14. **Least restrictive environment (LRE)**—Schools are required by law and to the extent possible to provide FAPE in an educational setting that is appropriate to the individual student’s needs together with their nondisabled peers (Alfonso & Flanagan, 2018).

15. **Lexical**—Knowledge and use of the words and word combinations (Carrow-Woolfolk, 2016).

16. **Linguistic system**—Human language, which has three categories: language form, language meaning, and language context (Akmajian, 1995).

17. **Metrics**—Parameters or measures of quantitative assessment used for measurement, comparison, or to track performance or production (Ratcliff et al., 2009).

18. **Modeling**—Using a slow speech rate, clear patterns of speech, precise words, vocabulary that is age and cognitively appropriate, and repetition of language, which is given as a standard of performance (Bowen, 2006).

19. **No Child Left Behind (NCLB) Act**—A 2001 federal education act that instituted nationwide requirements for students’ yearly progress and mandated yearly assessment of students’ basic skills (Husband & Hunt, 2015).

20. **Pragmatics**—Use of appropriate language (Lin, Chen, Justice, & Sawyer, 2019).

21. **Recasting**—The corrective reformulation of a student’s utterance in such a way that it does not interfere with communication (Ye, 2008).

22. **Semantics**—Knowledge and meaning of words (Carrow-Woolfolk, 2016).

23. **Statistical Package for the Social Sciences (SPSS)**—A software package used for the analysis of statistical data (Cronk, 2019).

24. **Student, environments, tasks, and tools (SETT) theory**—A four-part model intended to promote collaborative decision-making in all phases of AT service design and delivery,
from consideration through implementation and evaluation of effectiveness (Zabala, 1995).

25. *Supralinguistics*—Comprehension of complex language whose meaning is not directly known from lexical or grammatical information (Carrow-Woolfolk, 2016).

26. *Syntax*—Knowledge and use of grammar and the ability to use word construction, paragraph comprehension, grammatical morphemes, sentence comprehension, and grammaticality judgment (Carrow-Woolfolk, 2016).
CHAPTER TWO: LITERATURE REVIEW

Overview

The purpose of this quasi-experimental, pretest/posttest factorial design study was to determine the effects of a symbol-supported communication app on the expressive language skills of knowledge and use of words and word combinations, knowledge of grammar, supralinguistics, and pragmatics. A review of the most recent literature called for AAC with symbol-supported communication app intervention that is easy to use and naturally fits into the general education kindergarten curriculum (Reichow et al., 2008). Additionally, a review of the current literature revealed a need for practical interventions to meet this need. This literature review synthesizes a series of articles, books, and research publications. These items were selected with the intent to examine the research methods used to change expressive language behavior. Children who use AAC systems have unique needs relative to their abilities that teachers should individually manage for students to communicate as effectively as possible in the classroom (Light & McNaughton 2014). Moreover, these students’ ability to express learned knowledge has a direct impact on their ability to make adequate progress in the general education setting (Marcinowski, 2017).

This chapter discusses the theoretical framework for the current study, including relevant theories and concepts from the body of literature concerning expressive language usage with AAC combined with a symbol-supported communication app. In addition, a review of the literature supports the need for continued research on the topic because it demonstrates that a gap determining if a symbol-supported communication app is an appropriate intervention tool for general education kindergarten students still remains.
The theoretical framework for this study included LAT (Cantwell & Baker, 1987; Chomsky 1957) and Zabala’s (1995) SETT theoretical framework—comprised of student, environments, tasks, and tools. Students acquire information when the concept they are learning is paired with an associated task (Chomsky, 1957; Marzouk et al., 2016; Piaget, 1964). AAC devices and associated symbolic symbol apps provide the opportunity to perform a language task associated with a concept in the classroom setting (Ganz, Rispoli, Mason, & Hong, 2014; Zabala, 1995). Combined with Cantwell and Baker’s (1987) identification of the approximate age of the critical language acquisition stage for children, the incorporation of the AAC system with a symbol-supported communication app in the classroom assists in supporting students’ knowledge of words and word combinations, knowledge of grammar, supralinguistics, and pragmatics (Vigilante & Hoile, 2018).

Vygotsky (1962) hypothesized that language is learned during interactions with communicative partners who are experienced in the exchange of language (Iskandar & Baird, 2014). Verbal guidance and adult modeling are of particular importance in these social interactions (Donaldson, 2009). Actions such as participating in the demonstration of the knowledge of words, grammar usage, comprehension tasks (supralinguistics), or pragmatics while engaging in joint attention to an object or task encourage language operations and internalization of the symbolic functions of language (Roberts & Lyons, 2017). Language must be used fluently, accurately, and appropriately in a social context to achieve effective language acquisition and usage (Pond & Siega, 2008).

Furthermore, language acquisition competence grows from a structural knowledge of the language, allowing people to generate and create an infinite variety of sentences (Wen, 2012).
Thus, an AAC device with symbol-supported communication software provides for insertion of a tool to teach parts of the language, model usage, and allow for a response to complete a task. It demonstrates knowledge of words, knowledge of grammar, comprehension (supralinguistics), and pragmatics combined with language acquisition and the SETT theoretical framework (Gevarter et al., 2014). Moreover, it allows full participation in a task by using language that is being acquired in a setting in which the environment is conducive to task completion (Rosen, Nussbaum, Alario-Hoyos, Readi, & Hernandez, 2014).

**Language Acquisition Theory**

Language acquisition theory holds that abstract information must be learned before the onset of the expressive production of words, phrases, or sentences (Chilton & Ehri, 2015; Chomsky, 1956). Once conceptual knowledge has been acquired, the next step in the process is the development of language usage (Kamsu-Foguem, Tchuenté-Foguem, & Foguem, 2014). As a child progresses through these stages of development, he or she can master progressively advanced levels of language development—specifically expressive language (Norbury et al., 2014). The developers theorized that language acquisition occurs in stages (Cantwell & Baker, 1987; Chomsky, 1956).

Cantwell and Baker (1987) proposed that the most critical stage of language acquisition occurs before age 5. Therefore, they suggested that interventions in language acquisition should be built into a child’s environment during that stage of their development. If language acquisition has not developed after this critical stage, intervention is needed to support growth (Scheibman et al., 2015). Of importance, as Wallner (2012) noted, is that mandatory schooling does not start until age 5 in the United States.
Language production involves a conceptualizer that generates the message, a lexicon, and a formulator, which contains a grammatical and a phonological encoder (Indefrey, 2014). During the early stages of language learning, a child or adult must rely on his or her lexicon and grammatical abilities to create even a simple message (Mackey & Sachs, 2012; Pienemann, 1998; von Schilling, 2000). The learner slowly obtains more information; however, the lack of appropriate processing procedures makes it difficult to express language (Phillips & Ehrenhofer, 2015).

The fact that people use a variety of nonverbal and verbal behaviors to express themselves highlights the importance of social interactions for effective communication. This fact is predominantly true for face-to-face communicative interactions. Nonverbal communicative interactions include eye gaze, facial expressions, gestures, body orientation, and proximity (Straube, Green, Jansen, Chatterjee, & Kircher, 2010). Verbal communicative interactions usually begin as an utterance before the creation of an inner sequence of words and structure (Ramsdell-Hudock, Stuart, & Parham, 2018). During the creation and processing of an inner message, the form and content of the message are monitored through feedback from communicative partners, resulting in the further development of communication cues (Loncke, Campbell, England, & Haley, 2006; van Berkel-van Hoof, Hermans, Knoors, & Verhoeven, 2016). Thus, the process of developing language proficiency is learned from ordinary communication interactions (Cantwell & Baker, 1987; Hooper, Hynd, & Mattison, 2013).

AAC with language acquisition and symbol-supported communication app programs provide an understanding of the stages of LAT. Naguib Bedwani et al. (2015) explained this process in their study, which focused on children with autism. The results of their research showed that most of the children improved their functional communication and length of
utterances using either the symbolic symbol communication app or spoken language, and all the children, ages 4 to 12, increased their knowledge and use of the words and word combinations (lexical) and meaning (semantics). Accordingly, the current study sought to fill this research gap and extend the knowledge of Naguib Bedwani et al. by evaluating knowledge of grammar (lexical/semantics), using appropriate words and word combinations (syntax), comprehending and expressing meaning (supralinguistics), and use of appropriate language (pragmatics) by using a symbol-supported communication app of kindergarten students in the general education setting.

Another study that provides clarity regarding LAT was done by Soto and Clarke (2017). The researchers conducted a study to evaluate the effects of a conversation-based intervention concerning the knowledge and use of grammatical skills of children with severe motor speech disorders and expressive language delay who used AAC. An intervention was provided for the children in which they were supported in learning and using linguistic structures that are essential for the formation of clauses and the grammaticalization of their utterances, such as pronouns, verbs, and bound morphemes. The results showed that participants presented improvements in their use of spontaneous clauses and greater use of pronouns, verbs, and bound morphemes.

Jennische and Zetterlund (2015) also provided a deeper understanding of LAT. The researchers examined supralinguistics, the comprehension of complex language whose meaning is not directly known from lexical or grammatical information. Their research explored how children with typical development using an AAC device interpreted symbolic characters and compound symbolic symbols. Their research also explored the children’s interpretation of symbolic characters and their ability to construct new symbolic words. Results from this study
revealed that children aged 5 years and older appeared to realize the logic of the structure of the symbolic words, and children of all ages used the symbolic characters to represent new ideas. Overall, children learned many of the symbolic symbols after a brief exposure and demonstrated semantic creativity in the interpretation and construction of symbolic symbols.

Moreover, LAT provides insight into the awareness of language used within context and the speaker’s ability to change the language as needed. This insight, known as pragmatics, was explored in research conducted by Olson and Astington (2013). Their study examined the ability of children in late preschool and primary school years to assign belief to speech acts that they generated, as well as to assign belief of a speaker’s intention when producing an utterance containing an assertion of some kind. The results suggest that statements that are agreeable to judgments of truth and falsity are not essential components of ordinary language. Instead, they are irregular structures primarily associated with quoted speech and writing in which the content has been arbitrarily cut off from the speaker’s intention when speaking an utterance in which the meaning is usually embedded.

**Student, Environments, Tasks, and Tools Theoretical Framework**

Children with language disorders, delays, or impairments often do not follow normal developmental paths concerning pragmatic, semantic, or syntactic acquisition (Cantwell & Baker, 1987). The sociolinguistic aspect of language is significant in the classroom because a student must develop the ability to express his or her learned knowledge to succeed. However, this skill takes time to develop. To take full advantage of the language acquisition window, a child needs the opportunity to demonstrate his or her acquired language skills. The SETT theory suggests that the use of AAC systems might give more students in the classroom the ability to
participate and communicate academic knowledge and interact socially (Fonte et al., 2016; Zabala, 1995).

A conventional method of traditional software companies is to provide a time- or feature-restricted trial version that can be obtained and tested before purchasing to determine if an app is appropriate. This process is beneficial for educators because it provides before making a financial commitment a method in which software features can be tested for ease of use by the student; to determine that it is not a distraction in the classroom environment; and to determine if it aligns with instructional goals, pedagogical approach, and other criteria (Schmidt, Lin, Paek, MacSuga-Gage, & Gage, 2017).

Once educators have selected an app, they tend to use Zabala’s (1995) SETT framework. SETT is an AT selection framework and does not prescribe but aids teachers in using data to best match a device or software with the needs of an individual to decrease the chance that an AT will be abandoned (Zabala, 2005). To reduce the likelihood that this will happen, stakeholders require information about the students’ environment, the tasks the teachers expect the students to perform, and the tools to support those tasks (Schmidt et al., 2017). A team approach is typically used to obtain information using a variety of tools and processes, including group discussions, prescribed questions, worksheet-style forms and questionnaires, and collecting data on the AT’s effectiveness and revising the plan, if necessary, based on the data (Zabala, 2010).

Related Literature

**Historical Background of AAC Technology Research**

AAC technology use in the educational setting is a relatively recent development compared to other assistive devices (such as wheelchairs). Since the introduction of AAC in the classroom setting, the qualifications to gain access to a device or app has significantly changed.
The primary qualifications to receive an AAC system has evolved from a candidacy model—in which a student had to demonstrate prerequisite skills—to a universal model, which is based on the belief that students at large can benefit from the use of AAC systems, devices, and services (Hourcade et al., 2004; Mehr, 2017). This progression of change is similar to the philosophical evolution of special education services. Initially, teachers focused on teaching skills to special education students in an isolated setting outside of the general classroom, whereas today’s educators focus on an all-inclusive approach that assimilates the special education student into a general education classroom when at all possible. Similarly, AAC systems can be utilized within a student’s natural general education classroom environment if appropriate (Mehr, 2017).

Legislation has led to increased demands on programs and school districts to adequately provide for students with disabilities (Edyburn, Higgins, & Boone, 2005; Ornstein, Levine, Gutek, & Vocke, 2014). In 1975, the Education for All Handicapped Children Act (P.L. 94-142) was passed, requiring that students be given a free, appropriate public education and be educated in the least restrictive environment possible (Kaufman et al., 2018). The Education of the Handicapped Act Amendments of 1986 (P.L. 99-457) provided the legislation necessary for the implementation of technological services for students with disabilities.

Additionally, Congress passed the Technology-Related Assistance for Individuals with Disabilities Act (P.L. 100-407) in 1989. It mandated that states must make reasonable attempts to offer assistive technology to citizens with disabilities, regardless of age, disability, or location of residence (Beukelman & Mirenda, 1998; Romski et al., 2015; Zangari, Lloyd, & Vicker, 1994). In 1997, IDEA mandated that students with disabilities should have access to the general education curriculum and participate in assessments. IDEA extended the meaning of access for students with disabilities beyond mere physical access to schools and classrooms to the actual
general education curriculum (Young, 2017). Under IDEA is the FAPE provision, which guarantees that no one can discriminate against a person because of a disability; as a result, schools applied educational provisions for students with disabilities to all classroom settings (IDEA, 2004). Finally, the amended NCLB Act of 2001 required that disabled students reach high academic standards (P.L. 107-110). Together, these legislative measures have paved the way for the use of AAC technologies in classrooms, (Hourcade et al. 2004). These laws assisted the growth of, and access to, assistive technologies, including AAC devices (Mourlam, Strouse, Newland, & Lin, 2019).

Legislation was passed that further supported AAC advancement by specifically endorsing its use. This new legislation demonstrated a heightened level of acceptance to the full range of communication needs of students and yielded a stronger understanding of how AAC systems enhance the lives of individuals with communication needs. The Assistive Technology Act (AT Act 2004) upheld access to AT equipment and services for children and adults. The AT Act fully supported projects that focused on achieving progress in five goal areas: employment, health care, community living, education, and telecommunications/information technology. Moreover, that act “seeks to increase the capacity of organizations to provide AT equipment and services” (P.L. 105-395, 112 Stat. 3627). It fully supported the idea that teachers must increase their effectiveness with all students in the general education classroom by using innovative practices, techniques, and technologies (Edyburn et al., 2005; Hughes & Talbott, 2017). AAC technology has allowed for further integration of the inclusion model, which has allowed multiple opportunities for children with severe disabilities to participate broadly and successfully in more inclusive environments (Mahoney & Hall, 2017).
Unfortunately, many children who could have benefited from AAC devices at school have often faced difficulties obtaining those devices. Many states have established programs intended to assist in acquiring AT devices for students with a demonstrated need in an attempt to remedy this issue. One such program created to accomplish this was the State Assistive Technology Act of 1998, as amended by P.L. 018-364. These state programs act as a bargaining and purchasing agent for state educational entities who need to purchase assistive technology for students, and the programs have helped school districts save millions of dollars (Gale Group, 2013). Currently, the proper uses of AAC devices within public schools now comply with the AT Act.

**Communication and educational outcomes for children with disabilities.** Children who have learning disabilities can use AAC devices to assist with expressing wants, needs, assistance, and demonstration of knowledge in the classroom (Lloyd et al., 1997; Texas Statewide Leadership for Autism, 2013). However, finding the most effective AAC device for an individual student can be difficult. Full understanding of the three key bodies of knowledge needed for child literacy development can help facilitate this process. They are “(a) development of literacy skills, including prerequisite skills students need to become successful readers; (b) the research base on effective literacy instruction; and (c) the unique needs of students with physical and developmental disabilities who use AAC” (Machalicek et al., 2010, p. 220).

Students first must have the literacy skills of phonemic awareness, phonics, fluency, vocabulary, and comprehension to develop into successful readers. Upon being commissioned by the National Institute for Child Health and Human Development (2000), the National Reading Panel found that phonemic awareness, which is the ability to hear and manipulate the individual sounds in words, was among the strongest predictors of later reading performance (August &
Moreover, teaching phonemic awareness to students resulted in strong positive outcomes for word reading and reading comprehension (Machalicek et al., 2010).

Further research on reading interventions revealed that a focus on phonics instruction, or instruction using sound-symbol association to sound out and read words, along with text reading, had the most significant effect on reading outcomes. This instruction included the dynamics of phonemic awareness, word identification, word attack, spelling, reading fluency, vocabulary, and comprehension (Wanzek & Vaughn, 2007). Such reading interventions were categorized by the delivery of explicit instructions in phonological awareness and phonics (Gunn, Biglan, Smolkowski, & Ary, 2000; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997), text reading (Jenkins, Peyton, Sanders, & Vadas, 2004; Morris et al., 2000; Santa & Høien, 1999), and comprehension strategies (Vadas, Sanders, Peyton, & Jenkins, 2002). These interventions have been well researched, peer-reviewed, and proven effective for beginning or struggling readers; however, students who require AAC devices may present unique challenges and require different strategies. The current study sought to fill the gap in the research by evaluating the use of a symbol-supported communication app that supports the knowledge of words and word combinations, knowledge of grammar, supralinguistics, and pragmatics of kindergarten students in the general education setting.

Light, Collier, and Parnes (1985), Light (1997), and Romski, Sevcik, and Adamson (1997) each found evidence to support the null hypothesis that impaired language development could be caused by cognitive and motor speech disorders and by external factors such as a lack of opportunity to generate communication (Binger, 2004). Furthermore, even students with average IQ levels demonstrated below grade-level reading abilities (Berninger & Gans, 1986;
Koppenhaver & Yoder, 1992) and “such students often have limited communication skills . . . and may use AAC to communicate” (Beukelman & Mirenda, 2012, p. 13).

Calculator (2009) noted that, according to educators, positive results of AAC use in the classroom go beyond just academic success within the general education curriculum. When AAC devices are used within inclusive classrooms, teachers report increased participation from those students in class and more social interactions with their classmates (Calculator, 2009). Given that social interactions are essential to further language acquisition (Vygotsky, 1962), increased social interactions with other classmates through the use of AAC devices is highly beneficial for students with disabilities.

Other studies have recognized the link between self-regulation and other behavioral challenges with underdeveloped communicative abilities (Walker & Snell, 2013). One study revealed that “problem behavior functions as a primitive form of communication for those individuals who do not yet possess or use more sophisticated forms of communication” (Carr et al., 1997, p. 22). Thus, positive communication outcomes may help address behavioral challenges that could otherwise impede educational success in a classroom setting, which highlights the broadly positive benefits that the app of AAC systems may have on the lives of children with disabilities.

Finally, the timing during which AAC devices are added to a child’s life was also found to be integral to positive communication and educational outcomes. Researchers have observed that if a child with an identified expressive language delay is provided instruction and the opportunity to use an AAC device with symbolic symbols around age 5, it increases the probability that their language development skills progress at a similar rate of a normally developing child of the same age during this crucial period (Light & McNaughton, 2009).
The current study, which was supported by LAT, sought to extend this research by evaluating the expressive language skills of 5- and 6-year-old kindergarten students in the general education setting. Walker and Snell’s (2013) review of 54 studies of AAC interventions also determined that they were much more effective when used with younger children, specifically those under 12 years old. The effectiveness of AAC interventions after the age of 18 had no significant effect, possibly since participants’ communication patterns were already well established (Walker & Snell, 2013). However, AACs do give an individual a mode of communication (Machalicek et al., 2010). Thus, to achieve positive educational and communication outcomes, AAC interventions need to be incorporated into a child’s life at an early age.

**Development of AAC technologies.** In AAC research, normally developing children are generally used to determine cognitive processing demands and to limit confounding factors associated with physical and intellectual disabilities (Faragher & Clarke, 2014; Higginbotham, 1995). Research studies have found the optimal time to introduce AAC instruction is before the age of 5 (Barton-Hulsey, Wegner, Brady, Bunce, & Sevcik, 2017; Drager, Light, Speltz, Fallon, & Jeffries, 2003; Light et al., 2004). Currently, there is no explanation for why 4-year-olds have better performance outcomes than 5-year-olds, but some researchers have suggested that “when individuals are not systematically introduced to language instruction in the form of aided AAC, they are less receptive to new communication skills” (Ganz et al., 2011, p. 1507). Although researchers do not fully understand the reason, documenting this difference in performance outcomes with age could have a significant impact on the design and programming of AAC devices (Thistle & Wilkinson, 2009).
Previous research also found that normally developing children provide important group data that describe their learning strategies and challenges. For instance, many AAC devices have been designed to work on a sentence construction model in which the goal of the interface is to create sentence-level messages for the user (Higginbotham, Kim, & Scally, 2007). Such functionality is important in a classroom setting in which constructing complete sentences is critical for certain writing and speech activities. However, such sentence-level interfaces have been found to have high communication costs, and faster mixed methods (i.e., whole words and spelled words) of communication were found to support more interactive social communication in the classroom (Higginbotham et al., 2007).

As AAC development has increased, an understanding of how nonspeech signals are stored, accessed, and processed by the sender of the message has gained more importance (van Berkel-van Hoof et al., 2016). The benefits of augmentative signs in word learning are evidenced by children who are deaf/hard of hearing and children with specific language impairment. Loncke et al. (2006) stated that AAC is built on the theory of multimodality, which means that most communication occurs in more than one mode at a time, such as auditory (i.e., speech) and visual (i.e., hand gestures or facial expression) modes. They further noted that in AAC systems, multimodality typically refers to the use of both speech and graphic symbols or manual signs. Because of this firm reliance on the visual mode when using AAC systems, researchers have found that visual information processing is more developed than auditory processing in individuals with communication issues (Laws, 2002).

Fristoe and Lloyd (1979) found that visual representations provided by some AAC symbol systems assisted with memory and learning an object reference. This result stems from the iconicity hypothesis, which reveals that symbols that have a greater resemblance to their
object of reference are simpler to remember and learn than symbols with a weaker visual relationship (Lloyd et al., 1997; Shane et al., 2012). Individuals with specific types of disabilities, such as those with autism spectrum disorders, may be more suited to understanding visual content through AAC systems because of their natural strengths at certain types of processing (Shane et al., 2012).

Recent advancements in hand-held technology have led to an upsurge in the availability and quantity of AAC devices and apps. Instead of custom-built AAC platforms and specially designed software, AAC devices now include a variety of easily accessible technology, such as tablets, smartphones, and other apps (Bradshaw, 2013; Higginbotham & Jacobs, 2011; Kagohara et al., 2013). Currently, AAC system apps are available on Apple and Android products and perform a variety of functions, including text to speech, symbols to speech, word predictors, set phrases, limited eye pointing apps, photo stories, and picture exchange communication systems (Bradshaw, 2013; Higginbotham & Jacobs, 2011). These apps brought the use of AAC systems to a broader audience by making them more accessible and acceptable in the social environment (Johnston, McDonnell, Nelson, & Magnavito, 2003). However, with the onset of so many choices on the market, it has become incredibly challenging for parents and educators to choose which platform and system are most appropriate for an individual student’s needs.

**AAC and Language**

People deliberately contemplate what they say to affect a listener’s belief, goals, and emotional states; thus, language use can be viewed as speech acts (Cohen & Perrault, 2005). These speech acts are operators in a planning system that allows for both physical and verbal acts (e.g., speech can be treated in the same way as physical action). The ability to process language first develops at the lexical level, then at the phrase level, and finally at the interphrase level. In
and of itself, each level is not difficult. However, each level is dependent on the full development of each previous level for a thoroughly planned speech act to occur (von Schilling, 2000). Understanding communication through both speech and physical acts is essential to the use of specific AAC systems, which rely on physical actions to operate the devices.

AAC devices are intended to help minimize the communication barrier that individuals with speech and language disabilities experience when trying to express themselves to other people. An AAC system is an “integrated group of components, including the symbols, aids, strategies, and techniques used by individuals to enhance communication” (ASHA, 2004, p. 6). In general, AAC systems are divided into two categories: unaided and aided (Beukelman & Mirenda, 1998; Bradshaw, 2013; O’Neill, Light, & Pope, 2018; Romski, Sevcik, Hyatt, & Cheslock, 2002). Unaided AAC communication does not require props or devices and includes nonsymbolic vocalizations, gestures, facial expressions, body language, and sign language (Beukelman & Mirenda, 1998; Bradshaw, 2013; Miller & Allaire, 1987; O’Neill et al., 2018). Aided AAC systems assist individuals through the use of props or devices, including communication boards, speech-generating devices, or a combination of the two (Beukelman & Mirenda, 1998; Miller & Allaire, 1987). AAC technologies range from relatively low-tech systems, such as communication boards and conversation books, to high-tech computer-driven devices, such as iPads, Toughbooks, the Dynavox series, and the Accent series.

In the only study of its kind, Yoder and Stone (2006) discovered that participants who used a PECS with a high-object exploration acquired a variety of new vocabulary after treatment in comparison to those who were trained with Responsive Education and Prelinguistic Milieu Teaching (RPMT). However, the success of the children in either program depended on their retention abilities. Thus, children with high-item retention abilities may have better success
using PECS, while those with low-item retention abilities may have better outcomes with RPMT (Angermeier, Schlosser, Luiselli, Harrington, & Carter, 2008). It is therefore likely that the graphical, iconicity-inspired approach of PECS and the physical, act-based RPMT training may have differential benefits for individuals, which should directly influence the form of AAC system chosen for a student.

**Choice and Integration of AAC Systems**

As technologies have advanced and changed, the options for AAC devices have increased and provided new communication options for prospective users. However, these advances have made choosing a specific AAC system for a potential user a challenging task for AAC professionals, users, and their families (Huer & Threats, 2016; O’Keefe, Brown, & Schuller, 1998; Quist & Blischak, 1992). An appropriate device must be suited to an individual’s cognitive abilities, fine and gross motor skills, and processing time for an AAC device to be most useful to an individual (Ratcliff et al., 2009).

Currently, the features of several AAC devices are categorized in a variety of online databases (Ratcliff et al., 2009). These databases are useful in that they organize the different AAC features of the various platforms and make these features searchable so that clinicians can find a device that matches the needs of their patients. However, such databases have some significant limitations as well. When searching the lists of features, they are all treated equally. It is therefore not possible to weigh particular features against other features when searching for a device for a particular child. It is entirely possible that an AAC device with fewer features might be a better match for an AAC user if those features are best suited to that user’s specific needs (Ratcliff et al., 2009). Additionally, the database is only useful as long as it is updated and maintained with the latest software and device options. Many clinicians struggle to select the
most appropriate AAC device because none of the features listed consider what is necessary to communicate life functions (Higginbotham & Bedrosian, 1995; McCarthy & Boster, 2018).

A better system to rank the performance of AAC devices and features is needed to help facilitate the choice of appropriate AAC devices for individuals. In Yu-kyong, Azuma, and Mathy’s (2010) study, the authors found that significant outcomes in satisfying knowledge gaps depended on which device was most effective for an individual student. Their study compared a home computer with a high-tech AAC device by having participants with chronic, nonfluent aphasia practice 10 words on a home computer and 10 words on an AAC device (Choe, Azuma, & Mathy, 2010). The conditions for both operating systems were home practice programs. The computer practice significantly improved verbal naming for all participants, while the AAC devices did not produce significant improvement in the users (Choe et al., 2010).

It should be noted that different program abilities between the AAC device and computer, procedures used for each device, and participant motivation could all have influenced the higher outcome by computer users. However, the results are a prime example of why a one-device-fits-all approach does not meet the needs of individual users. Developing a system that matches the skill, mobility, cognition, and motivation of the users to AAC device features can greatly assist clinicians and teachers in selecting the most appropriate AAC device to meet a student’s needs. Ganz et al. (2014) determined that an AAC system must meet the needs of the student by being easily programmable and appropriate for academic, social, and functional communication needs. They also said that the system must meet the child’s processing speed requirements to allow him or her to express and answer questions, give commands, and readily participate in conversations.

Wolf, Vembu, and Miller (2006) stated that predictive tools such as AAC devices could prevent spelling errors, assist in developing writing skills, and accelerate message delivery.
Moreover, saving keystrokes is an essential benefit for users with physical and cognitive disabilities. Fewer keystrokes save the user time and effort, which better prepares the user for rapid communication in social settings. Further, some concerns must be resolved for the device to be used consistently by an individual. The first aspect to consider is the ease of use of the device (Bradshaw, 2013).

Parents have described some devices as challenging to use and time consuming to program (Marshall & Goldbart, 2008). Because parents might become frustrated trying to incorporate them into their child’s daily life, such devices are less desirable. A second important aspect is that parents need reliable technical support for the AAC device (Bradshaw, 2013). If an AAC device breaks regularly, it is not a dependable communication device for the individual (Kent-Walsh & Light, 2003; Smith, 2015). Furthermore, if there is an issue with the AAC device, parents and educators need easy access to technical support to address the problem quickly (Smith & Connolly, 2008).

The benefits of using new AAC platforms are many. Platforms such as iPad tablets have larger displays that accommodate more items and symbols on the display for users (Bradshaw, 2013). Such high-tech devices are socially acceptable, making users more willing to use them in the classroom and daily life (Bradshaw, 2013; Higginbotham & Jacobs, 2011; Kagohara et al., 2013). The newer AAC devices are also cheaper and more portable than traditional AAC devices (Bradshaw, 2013; Kagohara et al., 2013), which is particularly vital because the researchers found that cost was identified as a barrier to AAC incorporation in the past (McNaughton & Bryen, 2007). Touchscreen devices are easy to use, reliable, and widely liked by people, so they are more likely to be used consistently by people in their daily lives (Bradshaw, 2013).
AAC Selection

It is important to choose an appropriate AAC device with symbolic symbols that will adequately support incorporating the device into the daily life of the user to achieve positive outcomes (Calculator, 2009). Individuals who use an AAC device in the classroom but receive little to no support for its use in daily life will have limited positive results (Starble, Hutchins, Favro, Prelock, & Bitner, 2005).

Starble et al. (2005) suggested that comprehensive family-centered intervention techniques are a method to increase the societal use of AAC devices outside of the therapy environment. They suggested that family-centered interventions involve multiple face-to-face training sessions with the entire family in the home environment to help them incorporate the use of the AAC device in their daily lives as much as possible. Parental satisfaction with the family-centered training is related to the individualized nature of the support and the fact that they become full, active participants in the intervention along with the specialists, as opposed to merely passive receivers of information (Starble et al., 2005).

Moreover, individual users may have a personal preference for a specific AAC device (van der Meer, Sigafoos, O’Reilly, & Lancioni, 2011). In a study that examined 12 participants, van der Meer et al. (2011) found that individuals given many options had clear preferences for particular types of AAC systems. Schlosser and Lee (2009) did not determine if the use of a preferred AAC method increases the positive outcomes for individuals; however, they said that maintenance of AAC use decreases over time for individuals using AAC devices. Although more research needs to be done regarding whether or not the use of a preferred AAC device promotes more positive outcomes or long-term use, the user’s preference should likely be considered when choosing an AAC method to encourage its use. Furthermore, user preferences
often change over time, so frequent check-ins and adjustments to the AAC device being used may be required to maintain the user’s interest and motivation to continue using the aid (Kagohara et al., 2013).

A specific area of concern for parents of AAC device users is that the use of these aids will limit their language and communication abilities. The primary concern of these parents is that their child will see the AAC device as an excuse for not communicating verbally (Millar et al., 2006). However, research has shown that AAC devices do not negatively affect a child’s language and communication skills, and moreover, may increase their communication abilities (Millar et al., 2006; Schlosser & Wendt, 2008). It is imperative to communicate this information to parents and clinicians who often adopt a wait-and-see approach when, in reality, earlier AAC interventions are the most beneficial for a child (Schlosser & Wendt, 2008; Walker & Snell, 2013). Although children who often use AAC systems have limited vocabulary and grammar usage, that deficiency is not attributable to the use of the AAC system itself.

There are multiple techniques designed to address issues associated with the limited grammatical usage of many children who use AAC systems. Intervention techniques such as modeling and recasting can be used to assist students with a developmental disorder (DD) and specific language impairment (SLI). The use of models and recasts can help children with an SLI or DD, as well as those individuals who have difficulty processing information and use an AAC device. Using concentrated models and recasts should make morphological markers more salient to a child, including when these grammatical markers are shown on speech-generating devices (Binger, Maguire-Marshall, & Kent-Walsh, 2011).

Moreover, Binger et al. (2011) asserted that these same techniques have the potential for aiding children who utilize AAC. It has additionally been found that children with no
demonstrated intellectual impairment who use AAC systems are prone to many types of expressive language errors. Research participants tended to use telegraphic speech that could also benefit from modeling and recasting techniques to generate more salient grammatical markers when using a speech-generating device (Binger, Kent-Walsh, Berens, Del Campo, & Rivera, 2008; Binger, Kent-Walsh, Ewing, & Taylor, 2010; Binger & Light, 2007; Smith & Grove, 1999).

Limited experimental data exist that have focused on grammatical structures beyond the two-symbol stage for children who require the use of AAC devices (Binger et al., 2011). Moving from a single-symbol to a multisymbol production is a critical stage of development for AAC users that is equivalent to verbal language development in normally developing children because it signals the move from semantics to syntax (Finke et al., 2017). At this point, a child can produce utterances of increased length and exhibits more complex communication. This stage is the first step in the child’s ability to generate unique symbol combinations to express him or herself (Binger, 2004). Unfortunately, the majority of AAC users experience difficulties transitioning from single-symbol production to multisymbol production (Light & McNaughton, 2014; Smith & Grove, 2003).

In a study of children ages 5–8 who had primary motor and speech disorders, it was found that they used eye gazes, facial expressions, gestures, and vocalization more readily than a single graphic symbol to communicate even though they had access to AAC devices with multiple symbols (von Tetzchner & Martinsen, 1996). Moreover, there was only one recorded instance of a child using a multisymbol combination during that study. The lack of opportunities to communicate and the types of opportunities that are provided may contribute to the low rates of multisymbol messages observed in children who rely on AAC systems (Binger, 2004).
Individuals who often use AAC devices have difficulty expressing multiword messages for a variety of reasons, which include the longer time required to compose multisymbol messages, the fact that a single symbol can hold multiple meanings for a user, the fact that communicators often ask yes or no questions of AAC users, and the fact that responding with an AAC device is a single mode of communication that does not encourage multisymbol messaging (Binger & Light, 2007). Binger and Light (2007) evaluated the impact of aided AAC modeling on the multisymbol message productions of five preschoolers who used AAC devices. Four of the children had a DD, and one had no cognitive delays. The instruction was provided using AAC modeling as a catalyst to present the recast method during play routines. The four preschoolers who received the instruction were successfully able to use their AAC devices to produce the correct multisymbol combinations. Moreover, the children continued to use those symbol combinations over two months after the instruction, suggesting that direct instruction and modeling of multisymbol messages on AAC devices could be integral to long-term increases in a child’s grammar abilities.

Another example of the benefit of direct instruction for advanced, multisymbol communication with AAC devices is a study by Lund and Light (2003). In this study, the researchers instructed two adults who used AAC devices for communication on how to create various grammatical targets. The program consisted of explaining grammatical rules, identifying correct and incorrect forms, and fixing incorrect forms. Both participants were successful at learning the complex grammar forms taught in the study and maintained the skills for up to two months following the instruction (Lund & Light, 2003). Further studies are required to determine precisely how often such direct instruction should be given to support the ability for multisymbol usage long-term and increase grammar usage over time.
Group-item scanning and directed scanning accuracy are two other concerns regarding the limited use of multisymbol messages by children using AAC devices. For a small portion of AAC device users, a scanning technique compensates for motor challenges that impede the use of a direct selection of symbols (White, Carney, & Reichle, 2010). The time needed to select a symbol using scanning selection techniques places excessive demands on the user of the AAC device. When testing AAC devices on normally developing 4-year-olds, there was decreased symbol selection speed with higher accuracy and increased symbol selection speed with lower accuracy when using directed or group-item scanning (White et al., 2010). Thus, improved accuracy with directed scanning was associated with a slower response time when compared to group-item scanning. Group scanning appeared to be faster, but the quicker process rate caused a lower number of accurate responses. Such limitations may be addressed as technology advances, but solutions that allow rapid scanning and precise answers are needed (Scheibman et al., 2015).

An often overlooked but integral part of successful AAC device integration is familial integration. Choosing an appropriate AAC device to fit an individual’s abilities requires adequate support for the family to incorporate the device into the daily life of the user (Calculator, 2009). Based on the responses of 165 AAC devices users, family members are the most significant communication partners of young children (Caron, Light, & Drager, 2016; Huer & Lloyd, 1990). What is more, caregivers were reported to say, “We never use the device at home” or “I don’t know how to program the device” when asked about their child’s AAC device use (Angelo, Jones, & Kokoska, 1995, p. 194). This desire to understand their family member’s AAC device functionality to facilitate better communication highlights why the use of consumer technologies, such as tablets, is beneficial to users and their families. Many individuals are
already familiar with these technologies and may feel more comfortable using them to communicate with their children.

Between 1990 and 2002, a variety of strategies were used to teach children between the ages of 3 and 8 how to incorporate the use of AAC devices into their school and home environments. These strategies, which consisted of arranging the environment to create communicative opportunities; modeling; verbal, physical, or gestural cues; and time delay, were then incorporated into a student’s daily routine (Johnston et al., 2003; Romski et al., 2015). The use of these strategies produced expected consequences, such as receiving requested items, social interactions with a communication partner, the continuation of an activity, or avoidance of an undesirable object or event (Giangrasso, 2015). Other research determined that the successful development of reading skills in children was related to having positive reading experiences both at home and at school (Light & Smith, 1993; Sennott & Mason, 2016), emphasizing the need for AAC use at home while parents read to their children.

Kapalkova et al. (2016) recommended comprehensive family-centered intervention techniques as a method to increase the use of AAC devices outside of the therapy environment. Furthermore, Mullican (2012) found that family training in the use of the AAC device was so vital that often AAC devices were abandoned solely because the parents did not receive enough training to encourage and teach their child to use the device. Lane, Lieberman-Betz, & Gast, (2016) concurred, finding that if a family does not use a child’s AAC device at home, the child’s ability to generalize those communication skills to other environments is minimal.

Lal (2010) posited that a significant concern when developing AAC interventions is ensuring that the AAC device is socially valid. Social validity represents the level to which an intervention tactic achieves the goals, uses procedures, and has outcomes that are valuable to the
children, the teachers, and the parents and thus will most likely be adopted (Giangrasso, 2015; Schlosser & Sigafoos, 2002). Social validity is difficult to assess, but some studies have attempted it. For instance, Schlosser and Sigafoos (2002) proposed a social validity framework to identify the stakeholders of AAC devices, methods of AAC systems, and goals for AAC use in an attempt to quantify the social validity of different devices. Regardless of successful assessment, now that mainstream platforms such as tablets, computers, and phones are being used as AAC devices, there is increasing public acceptance and social validity of AAC devices (Bradshaw, 2013; Kagohara et al., 2013).

Current AAC technologies have reached a minimal level of spontaneous co-construction during social interactions due to slow input caused by communication breakdowns during face-to-face communication (Fiannaca, Paradiso, Shah, & Morris, 2017). The use of communication co-construction as a common communication strategy is an essential aspect of social communication in daily activity settings (Cornish & Higginbotham, 2008). The following is an example of co-construction:

Person A: Excuse me, could you direct me to the, um...

Person B: Front Office?

Person A: Yes, thank you.

This process is relevant to the classroom when a student transmits a response to a teacher via an AAC device. First, that message must be effectively prepared. Then, the teacher must develop an understanding within the context of the language and subject to effectively respond to the student using co-construction, if necessary. This communication exchange between teacher and student is essential for communication in the academic setting. Educators must support the effective communication of students so that they can participate and regularly contribute to the
educational experience. For this reason, AAC devices must progress with the demands of communication in the classroom (Ball, Bilyeu, Prentice, & Beukelman, 2008).

For children who have severe speech and language delays, the primary goal of intervention is to increase their functional communication. Although their expressive language is limited even with the use of AAC devices, these students’ functional communication skills can be stimulated by selecting words relevant to their environment and the context of the subject. Thus, teaching a child to use the words and symbols practically within a specific context and preparing people in that environment to respond to words used in a functional context will facilitate effective communication despite the limits of AAC devices (Lal, 2010).

Notwithstanding the research that has been done regarding the positive outcomes of AAC devices on communication among different age groups, there is still a severe knowledge gap in the effectiveness of AAC devices with students ages 5–6 in the kindergarten general education curriculum (Burne et al., 2011; Mistrett et al., 2005). No studies have specifically looked at this demographic, which is the entry level to the general education curriculum, to see how AAC devices might enhance participation and communication of children with disabilities in the kindergarten classroom.

**Summary**

Communication pervades all aspects of the general education curriculum. Whether engaged in math, science, reading, or writing, information is exchanged through various methods of communication. If administered properly, an AAC program should not only enhance a child’s communication skills but all skills that depend on effective communication (Calculator, 2009).

According to the current knowledge and available data, it is evident that students can greatly benefit from the improved communication abilities available to them through the use of
an appropriate AAC device. Furthermore, that positive impact is most apparent when AAC intervention is integrated while a child is still young, preferably around the age of 5. Although new AAC devices and software have made these aids available to users more than ever before, no easy method exists to determine which AAC device is most appropriate for an individual user. If AAC devices are not appropriately matched to a student’s specific communication needs, they will have little to no positive effect on their academic success (Bradshaw, 2013; Calculator, 2009).

Finally, since no previous research has addressed the effectiveness of AAC devices with students ages 5–6 in the kindergarten educational curriculum, it is unclear how useful AAC devices might be in the kindergarten classroom. Consequently, there is a need for research into the potential for AAC methods to support the student population at the kindergarten level. The next chapter will present the methodology and research design for the present study.
CHAPTER THREE: METHODOLOGY

Overview

This chapter provides a detailed description and justification of the methods that were used to test the hypotheses of this study. The first section outlines the design of the research, which entailed a quantitative quasi-experimental pretest-posttest, nonequivalent comparison group design using a multivariate analysis of covariance (MANCOVA) with the pretests as the covariates. The researcher restates the research questions and hypotheses before presenting details about the setting, participants, instruments, and procedures for the study. The next section of this chapter provides information on the methods that were used to ensure that ethical requirements for protection of human subjects were met. The final section of the chapter details the methods that were employed to analyze the data generated from the study.

Design

The research used a quasi-experimental, nonequivalent control group design with convenience sampling for students already placed in two kindergarten classrooms. This design was selected because of nonrandom assignments in the experiment that were performed using pre-established, nonrandom groups that occur in the school setting. The purpose of this research study was to determine the effect of an intervention on an experimental group while withholding the intervention from a control group. The groups were nonrandomized, and a pretest-posttest evaluation was used to measure the effects.

Evidence-based data provided an important method to evaluate the effectiveness of symbol-supported communication app intervention in the educational setting. As such, the research design adopted in this study was a quasi-experimental, nonequivalent control group, pretest-posttest design used to test Chomsky’s (1956) LAT, Cantwell and Baker’s (1987) stages.
of language development theory, and Zabala’s (1995) SETT framework as they relate to the influence of a symbol-supported communication app on the expressive language usage of kindergarten students in the general education setting.

The independent variable was a symbol-supported communication app. Both the comparison and treatment groups were enrolled in the kindergarten general education classroom. The independent variable for the investigation was used during individual, small group, and whole group lessons. The dependent variables were knowledge and use of grammar, knowledge and use of the words and word combinations, knowledge and use of supralinguistics, and knowledge and use of pragmatics.

As shown in Figure 1, the study involved a series of steps consistent with a quasi-experimental, nonequivalent control group, pretest/posttest design. In the first stage, treatment and comparison group participants completed a CASL-2 pretest. Then, the treatment group received instruction via the symbol-supported communication app, while the comparison group did not. After the treatment, both groups of participants completed a CASL-2 posttest to determine effective use during maintenance. This quasi-experimental, nonequivalent control group, pretest/posttest design provided an opportunity to compare whether those skill sets taught using the symbol-supported communication app made a difference in the level of expressive language usage—specifically knowledge and use of words and word combinations, knowledge and use of grammar, supralinguistics, and pragmatics—used by kindergarten students. Therefore, this study aimed to contribute to knowledge regarding remediation of expressive language skills and to contribute to the research on the efficacy of AAC with symbol-supported communication app use in the classroom.
One alternative research design was considered but was evaluated as not suitable for addressing the aims of this study. The rejected design was a correlational research, or a nonexperimental design, which investigates if there is a relationship between two or more variables with no manipulation of variables (Ary, Jacobs, Razavieh, & Sorensen, 2009). The major drawback of this design is that it investigates how the variables are related but does not provide a causal path of relationships (Ary et al., 2009).

The selected research design was chosen because it offered the opportunity to gain a baseline on students’ knowledge and use of words and word combinations, knowledge of grammar, knowledge of supralinguistics, and knowledge of pragmatics. The posttest then measured for those same skills to determine the effectiveness of the symbol-supported communication app. According to Cook, Shadish, and Wong (2008), quasi-experimental designs

Figure 1. Sequence of pretest-posttest comparison group design.
analyze descriptive hypotheses about manipulated causes to determine what would happen in the absence of treatment before the effect is measured. A quasi-experimental design tests whether a program or treatment impacts treatment outcomes and is thus consistent with the focus of this study and its research questions. The data generated from this quasi-experimental study was expected to enable comparisons in the use of symbol-supported communication app usage in a kindergarten classroom (treatment/program group) to a contrast group that was taught using traditional curriculum strategies with no symbol-supported communication app to determine whether there was a significant difference in knowledge and use of words and word combinations, knowledge of grammar, supralinguistics, and pragmatics of these students.

**Research Questions**

The following research questions investigated in this study were:

**RQ1:** Is there a significant difference between the knowledge and use of words and word combinations scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

**RQ2:** Is there a significant difference between the knowledge and use of grammar scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

**RQ3:** Is there a significant difference between the supralinguistic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?
RQ4: Is there a significant difference between the pragmatic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

Hypotheses

The following null hypotheses were used for this study:

H₀₁: There is no statistically significant difference between the knowledge and use of words and word combinations scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores.

H₀₂: There is no statistically significant difference between the knowledge and use of grammar scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores.

H₀₃: There is no statistically significant difference between the supralinguistic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores.

H₀₄: There is no statistically significant difference between the pragmatic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores.

Participants and Setting

The participation of typically developing children in research can provide data on the cognitive processing demands associated with various types of technology, in particular, on AAC devices and apps (White et al., 2010). Therefore, this study included a convenience sample of
registered kindergarten students between 5 and 6 years of age. The data collection and symbol-supported communication app intervention took place over a 7-week period. Each group received 15 lessons, and each lesson was 20 minutes. One group included students who used a symbol-supported communication app (intervention group), while the other group included students who did not use a symbol-supported communication app (comparison or control group). Due to the nonrandom convenience sampling method, there were several threats to the internal validity of this study, which include selection history, selection maturation, and selection mortality. Given the nature of the study, it was not possible to ensure equivalence of learning experience in the two groups of participants. Moreover, there was little control over external events that might have affected learning that occurred between the pretest and the posttest. It was also possible that some students may have discontinued participation in the study. Students were not forced to participate and were told they could leave the study at any time. Efforts were made to address these issues, and any threats to selection-testing and selection-instrumentation were reduced significantly with the use of a national instrument that is considered credible, reliable, and valid.

The study was conducted within the selected prekindergarten through fifth grade public elementary school. This site was chosen because of its diverse population. All sessions were convened in the kindergarten classroom during the students’ recess in order to not interfere with the daily learning of each participant. For the school year 2018–2019, the kindergarten classrooms were comprised of children from the surrounding community, which included African Americans, Asian Americans, Hispanics, Caucasians, free and reduced lunch recipients, and moderate- to middle-income students.
The kindergarten classrooms from which the students were selected comprised about 17 students each, with a projected enrollment of 22 students in each class for the school year 2018–2019. For this study, the number of participants exceeded the required minimum for the appropriate effect size with a statistical power of .05 level (Gall, Gall, & Borg, 2007). The sample used consisted of 22 boys and 23 girls. The researcher selected this school because of her professional relationship with the school’s principal and teachers, proximity to the school, and the principal and teachers’ expressed interest in participating in the research project.

All kindergarten classrooms were led by teachers who were deemed highly qualified—as determined by the standards outlined by the Office of the State Superintendent of Education—and trained on basic functions of the AAC with a symbol-supported communication app setup and initiation. There were two classroom assistants, one in each classroom, who were certified paraprofessionals as defined by the educational governing body that employs them. They were vetted and met safety criteria to work with children and were trained on the basic functions of the AAC with a symbol-supported communication app setup and initiation. Additionally, the classrooms were developmentally appropriate learning centers that met the criteria for use within the school district’s general education curriculum as outlined by the educational governing body.

A parent grade-level meeting was held during which the research study was introduced. The meeting agenda included an explanation about the study, including the reasons why the study was needed, and why their school was an optimal location. The researcher sought the students’ participation and parental consent and explained what procedures would be used and the role of the participants and answered questions. Furthermore, it was explained that all members from the sample population had an equal chance of participating, and a nonrandom selection would be used to ensure there was no selection bias. The parents were told that
participants could opt out of the study at any time for any reason without penalty. Finally, the researcher shared that those students not part of the experiment group would have access to the symbolic symbol software after the research was completed.

A full disclosure of the study was available to the sample population and parents that revealed the following information:

- All participants whose parents agreed to allow them to participate in the study would receive the intervention in the classroom.
- All information was confidential, there would be no use of identifying information, and a number would be assigned to each participant.
- If the researcher was a service provider to any of the students in the study, the relationship was not changed or influenced.
- All identifying materials (i.e., consent forms) would be kept in a locked cabinet.
- The researcher would not share or use any confidential information and data collected for any purpose other than the study.
- The researcher/teacher would provide the intervention and had the full support of the classroom assistants.
- The researcher would communicate the results to student participants and their parents in summary form only.

**Instrumentation**

The CASL-2 was administered as a pretest and posttest. Permission to use this instrument was granted through contact with the instrument’s publisher and was free of charge (see Appendix G). The data were analyzed using a MANCOVA design conducted with SPSS (Statistical Package for Social Sciences). This inferential statistical test was used to determine
whether there was a statistically significant difference between the means in the two independent groups because the purpose of the test was to determine whether there was statistical evidence that the scores of the treatment and control groups differed significantly, while controlling for pretest scores. A difference in the groups’ averages was more likely to be meaningful if the difference between the averages was large, the sample size was large, and the standard deviation as low. If the value of the difference in the two groups’ means was statistically significant, then the null hypothesis could be rejected.

This researcher, a trained and nationally certified speech and language pathologist, orally administered the CASL-2 to the study participants, and it was used for both the pretest and posttest evaluation of skills. The CASL-2 is a research-based, theory-driven oral language assessment battery for ages 3 through 21. Specifically, the CASL-2 is a norm-referenced assessment of 15 individually administered core and additional tests. Each test can be used alone to identify language difficulties, or the test results can be combined to form a composite score. The core composite provides a global measure of language performance. The core tests are those tests that theoretically and developmentally best represent and most reliably measure the language skills developed at a particular age. Furthermore, the core composite is reported as a standard score with a mean of 100 and an $SD$ of 15. This test can be used as both a pretest and as a posttest due to the test-retest temporal stability of test scores over time (Carrow-Woolfolk, 2016).

The 15 tests on the CASL-2 measure language-processing skills, including comprehension, expression, and retrieval, in four language structure categories: lexical/semantic (knowledge of words and word combinations), syntactic (knowledge of grammar), supralinguistic (comprehension of complex language whose meaning is not directly known from
lexical or grammatical information), and pragmatic (use of appropriate language), (Carrow-Woolfolk, 2016).

Four subtests were administered to the participants: expressive vocabulary, grammatical judgment, inference, and pragmatic judgment. The expressive vocabulary subtest comprised 71 items and required the students to express word knowledge, retrieval, and oral expression in a linguistic context. The grammatical judgment subtest contains 57 items and required the students to judge the accuracy of syntax and construct of grammatically correct sentences. Inferencing is a 65-item subtest that assessed the use of previously acquired word knowledge to derive meaning from inferences in spoken language. The final subtest administered was the pragmatic language and is a 56-item subtest. The students were required to demonstrate knowledge of pragmatic language rules and their appropriate application (CASL-2, 2017).

The internal reliability of the CASL-2 ranges from 0.80 to 0.94, which indicates high reliability, and its reliability demonstrates consistency among the subtests. The validity of the CASL-2 allows for more in-depth study of specific language skills. Developmental progression of scores, intercorrelations of tests, and factor structures of the indexes show construct validity (Carrow-Woolfolk, 2016). The construct validity of the CASL-2 shows that the scores increase as expected with age (dramatic increase in the early years and a more gradual increase in the later years). Moreover, a factor analysis was reviewed for different age groups to determine whether the characteristics of student performance supported the theoretical model of the test. Based on these statistical analyses, modifications to the test, such as only providing the index scores of the factor analysis, supported a one-factor model for 3–6 years. The clinical validity of the CASL has been demonstrated by Hayward (2008) using eight different clinical groups.
matched for gender, race/ethnicity, SES, and region. The CASL-2 accurately detects individuals who demonstrate speech impairment, language delay, language impairment, intellectual disability, learning disability (reading), emotional disturbance, and hearing impairment. The tasks of the CASL-2 subtests for this study were chosen based on both theoretical design and prior research studies. Additionally, researchers have used the CASL-2 in numerous studies and have proven that it is reliable and valid for obtaining expressive language data of the development in children (Daltrozzo et al., 2017; Geers, Mitchell, Warner-Czyz, & Wang, 2017; Owens & Pavelko, 2017; Tomblin, Olsen, Ambrose, Walker, & Moeller, 2014).

The test-retest was used to measure reliability. A correlation coefficient was calculated between individual scores on the same measure on two separate occasions. The CASL-2 has a correlation coefficient of ranges from .65 to .95, and test-retest reliability coefficients for the individual tests range from .65 to .95 (Carrow-Woolfolk, 2016). A study by Barnett, Robinson, Webster, and Ridgers (2015) found that the test-retest reliability and internal consistency of an instrument designed to assess perceived competency in young children is a reliable measure.

**Procedures**

Before commencing the study, approval from the participating school’s principal was received. Then, review and approval were sought from the Liberty University Institutional Review Board (IRB) during the 2018 term (see Appendix A for IRB approval). Once ethics approval was authorized, a request was made for the use of the AAC with a symbolic symbol communication app device from the participating school. A meeting was then held with all of the parents of the potentially participating kindergarten students that delineated the following elements: (a) the study was explained; (b) the reason for the study was explained; (c) the reason why their school was selected was explained (optimal location); and (d) their permission to test
their children with the CASL-2 was requested. In addition, the researcher explained that parental consent forms would be provided. Furthermore, the procedures that would be used to conduct the research were explained, and parental questions were answered. The parents were also told a nonrandom selection would be used to establish experiment and control groups consisting of at least 32 typically developing kindergarten students (16 in each group) in the age range of 5–6 years.

After receiving parental permission, the researcher met with teachers to develop lesson plans based on the school’s kindergarten curriculum, and pseudonyms (code numbers) were randomly assigned. Once the lesson plans were developed and the AAC devices with a symbol-supported communication app were acquired, the CASL-2 pretest assessment was administered to participants and scored. Then, students in the experimental/treatment group were provided instruction in two 30-minute lessons during the first week on the use of the AAC with the symbolic symbol communication app. The intervention began during Week 4, with five lessons on words and word combinations, grammar, and supralinguistics. In Week 5, five lessons were provided on words and word combinations, grammar, and pragmatics. Finally, in Week 6, the students were given lessons on words and word combinations, grammar, supralinguistics, and pragmatics. Overall, the schedule consisted of 15 lessons, with each lesson being 20 minutes in length. During Week 7, the CASL-2 was administered as the posttest and scored. Finally, the accuracy of the responses provided by the participants was determined. The answers were then analyzed for interpretation of the responses as they pertained to the given questions.

**Data Analysis**

A quantitative quasi-experimental, pretest-posttest, nonequivalent, comparison group design study was used to address four research questions. A MANCOVA was used to test each
of the hypotheses because it controls for the effects of one or more covariates, which demonstrates the true effect of the independent variable on the dependent variables without unwanted interference. In each case, the independent variable was the group assignment of the students in the treatment group (those students using the symbol-supported communication app), and of the students in the comparison group (those students not using a symbol-supported communication app, but instead using traditional curriculum strategies). The dependent variables were the students’ posttest scores on each of the four factors from the CASL-2. These factors were syntax (knowledge and use of words and word combinations), lexical and semantics (knowledge and use of grammar), supralinguistics (knowledge and the use of language in which meaning is not directly available), and pragmatics (knowledge of the language that is appropriate across different situational contexts and the ability to modify language according to the social situation). The covariates were the students’ pretest scores on each of the four factors of the CASL-2.

The data were analyzed by inspecting them for a range of potential participant response biases, such as an acquiescence bias or extreme responding, wherein a participant completed all the items with the same response. From the raw data, a mean (average) score was computed for each scale, and each scale was examined for skewness or kurtosis to ensure it met the assumption of normality, which is required to perform inferential statistics. This process entailed dividing the skewness and kurtosis statistics for each variable by their standard errors to ensure all values were within the criterion of 3.29, \( p < .05 \). If the skewness or kurtosis score was above the critical value, indicating a non-normal distribution, then the scale distribution was evaluated via a boxplot to determine outlier scores. The outlier scores were transferred to the next available score according to procedures recommended by Oliver and Norberg (2010). Finally, the
Shapiro-Wilk test of normality was implemented to assess the internal consistency of each subscale for the study.

Moreover, each research question was addressed by conducting a MANCOVA to investigate the hypotheses of this study. The covariates used students’ pretest scores, which were correlated with the dependent variable of the posttest scores on each of the four measures. An important assumption underlying the MANCOVA was that the dependent variables require normal distribution, equality of variance, and univariate outliers. However, additional assumptions were checked as well, such as the absence of multivariate outliers and equality of covariance.

Accordingly, the normality test was performed on the four posttest scores using the nonparametric Shapiro-Wilk test in SPSS. Moreover, assumption of equality of covariance was tested with Levene’s (1960) procedure to ensure equal variances in posttest scores between the students in the treatment and control groups. Finally, the MANCOVA compared the mean posttest scores of the knowledge of words and word combinations, knowledge of grammar, supralinguistics, and pragmatics between the two groups of kindergarten students.

Furthermore, the MANCOVA was used to evaluate the posttest scores between the treatment and control groups. The group source was then evaluated (treatment and control group) against the null hypothesis, which stated that the mean posttest expressive language skills scores are equal. The MANCOVA showed that if the significance level were less than 0.05, then the null hypothesis—that no statistically significant difference existed in posttest scores between the group using the symbol-supported communication app and those who did not—would be accepted and the hypothesis rejected. That is, the MANCOVA assessed the differences between the adjusted means in each factor’s posttest scores for the two groups. It was used to determine
if the mean of the dependent variables would be the same when comparing the treatment group and control group. All data were analyzed using SPSS 25®. After completion of the study, the findings from the study were reported to the participating principals and school staff who had expressed interest in being informed of the results.
CHAPTER FOUR: FINDINGS

Overview

This chapter describes the analysis conducted and presents the empirical results to examine the null hypotheses of this research. The first section incorporates the research questions and the null hypotheses. The next section contains the descriptive statistics of each research question. Finally, the last section of this chapter details the multivariate results.

Research Questions

The research questions and hypotheses investigated in this study were the following:

RQ1: Is there a significant difference between the knowledge and use of words and word combinations scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

RQ2: Is there a significant difference between the knowledge and use of grammar scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

RQ3: Is there a significant difference between the supralinguistic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?

RQ4: Is there a significant difference between the pragmatic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores?
Hypotheses

The following null hypotheses were developed for this study:

**H₀₁:** There is no statistically significant difference between the knowledge and use of words and word combinations scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores.

**H₀₂:** There is no statistically significant difference between the knowledge and use of grammar scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores.

**H₀₃:** There is no statistically significant difference between the supralinguistic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling for pretest scores.

**H₀₄:** There is no statistically significant difference between the pragmatic scores of kindergarten students who use a symbol-supported communication app and those who do not use a symbol-supported communication app, while controlling of pretest scores.

**Descriptive Statistics of the Sample**

The data in the study were derived from the use of the CASL-2. The CASL-2 has four sections that measure expressive language skill usage in (a) knowledge and use of words, (b) grammar, (c) supralinguistics (inferencing), and (d) pragmatics. The scores of 30 participants from both before and after the intervention were compiled into the four areas listed above as outlined in the CASL-2 by its author, Carrow-Woolfolk (2016). The reliability and validity are discussed in Chapter 3.
The researcher gave kindergarten students within the same school a pretest at the beginning of the study period. The kindergarten students were then provided the intervention and completed the posttest at the end of the study. After the pretest, the treatment group was given a tablet with symbolic symbol software and then received the intervention. The control group also received the intervention; however, they were not exposed to the tablet with symbolic symbol software after participating in the pretest assessment.

The kindergarten classes were the identified sample for this study. The school has an enrolled population of 44 kindergarten students in the general education setting, of which 31 students participated. One class was used as the treatment group, and one class was used as the control group. This grouping allowed the students to participate without creating confusion as to why some students used the tablet with symbolic symbol and some did not.

Of the 44 possible participants for this study, four students experienced absenteeism that prevented them from participating in all aspects of the study during the time they were scheduled to participate. In addition, seven other students opted out of the study, and two students moved, resulting in a total sample size of 31 participants. The remaining 31 kindergarten students—74% of the school’s kindergarten population—participated in all aspects of pretesting, intervention, and post-testing events. Seventeen kindergarten students participated in the treatment group (54.8% of the sample), and 14 participated in the control group (45.2% of the sample). In terms of gender, 14 of the participants were male (45.2%), and 17 participants were female (54.8%; see Table 1). After a review of the students’ records, it was determined that 18 participants (valid percentage = 60%) spoke only English, 12 (valid percentage = 40%) were bilingual, and one participant’s language information was not known. The participants’ ethnicity was determined based on a review of student records: seven participants were
Caucasian (22.6%), 11 were African American (35.5%), 11 were Hispanic (35.5%), and two were Asian (6.5%; see Table 1).

Table 1

Descriptive Statistics for the Frequencies and Percentages of the Demographic Variables

<table>
<thead>
<tr>
<th>Demographical variable</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>17</td>
<td>54.8</td>
</tr>
<tr>
<td>Control</td>
<td>14</td>
<td>45.2</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>14</td>
<td>45.2</td>
</tr>
<tr>
<td>Female</td>
<td>17</td>
<td>54.8</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English only</td>
<td>18</td>
<td>60</td>
</tr>
<tr>
<td>Bilingual</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>Total (missing = 1)</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>7</td>
<td>22.6</td>
</tr>
<tr>
<td>African American</td>
<td>11</td>
<td>35.5</td>
</tr>
<tr>
<td>Hispanic</td>
<td>11</td>
<td>35.5</td>
</tr>
<tr>
<td>Asian</td>
<td>2</td>
<td>6.5</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 2, the sample was approximately evenly split by gender in each of the two groups. A cross-tabulation analysis indicated that seven of the 14 male participants were members of the treatment group, and seven were members of the control group. Meanwhile, 10 of the 17 female participants were members of the treatment group, while seven were members of the control group. A chi-square analysis, $\chi^2(1) = .24, p = .62$, yielded a nonsignificant value, indicating that the gender distribution was not significantly different across the two groups.
Table 2

Descriptive Cross Tabulation Between Treatment/Control Groups and Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Treatment</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>7</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>14</td>
<td>31</td>
</tr>
</tbody>
</table>

As shown in Table 3, the sample was approximately evenly split by language spoken at home (English vs. bilingual) in each of the two groups. A cross-tabulation analysis indicated that 10 of the 18 participants who only spoke English were members of the treatment group, and eight were members of the control group. Six of the 12 participants who were bilingual were members of the treatment group, and six were members of the control group. A chi-square analysis, $\chi^2(1) = .15, p = .70$, yielded a nonsignificant value, indicating that the language distribution was not significantly different across the two groups.

Table 3

Descriptive Statistics for Cross Tabulation Between Treatment/Control Groups and Language

<table>
<thead>
<tr>
<th>Language</th>
<th>Treatment</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>English only</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Bilingual</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>14</td>
<td>30</td>
</tr>
</tbody>
</table>

As shown in Table 4, the sample was approximately evenly split by race and ethnicity between the two groups. A cross-tabulation analysis indicated that four of the seven participants who self-identified as Caucasian were members of the treatment group, and three were members of the control group. Eight of the 11 participants who self-identified as African American were members of the treatment group, and three were members of the control group. Four of the 11
participants who self-identified as Hispanic were members of the treatment group, and seven were members of the control group. The participants who self-identified as Asian were equally split, with one participant in each of the two groups. A chi-square analysis, $\chi^2(3) = 3.84$, $p = .28$, yielded a nonsignificant value, indicating that the racial and ethnic distribution was not significantly different across the two groups.

Table 4

*Descriptive Statistics for Cross Tabulation Between Treatment/Control Groups and Race and Ethnicity*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Treatment</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>African American</td>
<td>8</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>14</td>
<td>31</td>
</tr>
</tbody>
</table>

**Results**

**Data Screening**

The data screening was conducted to ensure that the variables were correctly entered, that the data set was free from missing values and outliers, and to confirm that the distributions of the data were normal (Little, 2016). The variables examined in this study through data screening were the pretest and posttest values of (a) knowledge and use of words and word combinations, (b) knowledge and use of grammar, (c) supralinguistics (inferencing), and (d) pragmatics.

**Replacing Missing Values**

Missing data occur when there is no information for one or more cases relating to a variable. Little and Schluchter (1985) stressed that missing up to 5% of data might not cause any problems in the interpretation of the findings. The screening of the data indicated that the
quantity of missing data for all variables was zero, below the threshold of 5% recommended by Little (2016). Thus, no missing replacements were needed for the scale variables. Table 5 shows the missing value analysis for the four scale variables at pre- and posttest.

Table 5

**Number and Percentage of the Missing Values**

<table>
<thead>
<tr>
<th>Source</th>
<th>Variable</th>
<th>Valid</th>
<th>Missing</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>Knowledge of words</td>
<td>31</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Grammar</td>
<td>31</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Supralinguistics (inferencing)</td>
<td>31</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Pragmatics</td>
<td>31</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Posttest</td>
<td>Knowledge of words</td>
<td>31</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Grammar</td>
<td>31</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Supralinguistics (inferencing)</td>
<td>31</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Pragmatics</td>
<td>31</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Removing Outliers**

Hair, Anderson, Tatham, and Black (1998) noted that the treatment of outliers is a crucial step in the data screening method to obtain accurate parametric statistic estimates. Outliers refer to observations with a unique combination of characteristics identifiable as distinctly different from the other observations. Outliers could affect the normality of the data, which could then distort the statistical results (Tabachnick & Fidell 2007). For outlier detection, besides examining box-plots, each variable was examined for the standardized (z) score. According to Hair et al. (1998), for a small sample size, absolute (z) > 1.5 is characterized as an extreme observation. Therefore, any z-score greater than 1.5 or less than 2.5 was considered an outlier.

As shown in Table 6, the outlier results revealed that the lower-bound z-score for pragmatics was -3.53 for both pretest and posttest scores, which was less than the threshold of -3.
The corresponding case was respondent Number 11, as shown in Figure 1. Therefore, this case was eliminated from the data set, which then reduced the sample size from 31 to 30. After elimination, the remaining z-scores were computed. The results indicated that the z-scores of the remaining cases for the scale variables ranged from -1.56 (upper bound) to 1.91 (lower bound) for pretest scores and from -1.59 (upper bound) to 1.87 (lower bound) for posttest scores. None of the variables exceeded the threshold of ±3. Thus, there were no additional outliers among the remaining 30 cases.

Table 6

*Univariate Outlier Analysis Based on Standardized Values*

<table>
<thead>
<tr>
<th>Source</th>
<th>Variable</th>
<th>Initial standardized value (z-score)</th>
<th>Second standardized value (z-score) after eliminating respondent #11 (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pretest</strong></td>
<td>Knowledge of words</td>
<td>-2.43  1.73</td>
<td>-1.56  1.82</td>
</tr>
<tr>
<td></td>
<td>Grammar</td>
<td>-1.68  1.89</td>
<td>-1.64  1.90</td>
</tr>
<tr>
<td></td>
<td>Supralinguistics (inferencing)</td>
<td>-1.67  1.90</td>
<td>-1.78  1.91</td>
</tr>
<tr>
<td></td>
<td>Pragmatics</td>
<td>-3.53  1.44</td>
<td>-1.87  1.72</td>
</tr>
<tr>
<td><strong>Posttest</strong></td>
<td>Knowledge of words</td>
<td>-2.45  1.69</td>
<td>-1.59  1.78</td>
</tr>
<tr>
<td></td>
<td>Grammar</td>
<td>-1.60  1.70</td>
<td>-1.70  1.69</td>
</tr>
<tr>
<td></td>
<td>Supralinguistics (inferencing)</td>
<td>-1.66  1.87</td>
<td>-1.77  1.87</td>
</tr>
<tr>
<td></td>
<td>Pragmatics</td>
<td>-3.53  1.44</td>
<td>-1.87  1.72</td>
</tr>
</tbody>
</table>
Figure 2. Detecting outliers related to pragmatics.

Assumption of Data Normality

The normality assumption is made for unobservable variables. Therefore, an estimate of the model parameters and then test normality on the fitted variables was performed (Bontemps & Meddahi, 2012). The normality assumption test performed for this study was the Shapiro-Wilk test, which was used to confirm the results of the multivariate normality test. The Shapiro-Wilk value determined whether the data set of the variables were well-modeled by a normal distribution. Shapiro-Wilk’s $p$-value above the standard significance level of 0.05 indicates a normal distribution of the data (Taeger, 2014). In this study, it was sufficient for normality to inspect the value of the skewness and kurtosis and observe the shape of the distribution. On the one hand, skewness values reflect the symmetry of the distribution score, and a skewed variable means that the score is not at the center of the distribution. On the other hand, kurtosis gives information about the peakedness of the distribution (Tabachnick & Fidell, 2007). Table 7 contains the results of normality test for the variables. The result of the Shapiro-Wilk test of normality indicated that the data sets of knowledge of words, knowledge of grammar,
supralinguistics (inferencing), and pragmatics were normally distributed at posttest. If the significance level was less than the designated value of 0.05, then the assumption that the dependent variable posttest level was normally distributed was rejected. The result of the Shapiro-Wilk test of normality indicated that the data was normally distributed at posttest scores because of the nonsignificant \( p \)-values greater than 0.05.

Table 7

**Shapiro-Wilk Test of Normality**

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Group</th>
<th>Statistic</th>
<th>( df )</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word knowledge</td>
<td>Control</td>
<td>0.93</td>
<td>14</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>0.94</td>
<td>16</td>
<td>0.31</td>
</tr>
<tr>
<td>Grammar</td>
<td>Control</td>
<td>0.95</td>
<td>14</td>
<td>0.56</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>0.91</td>
<td>16</td>
<td>0.12</td>
</tr>
<tr>
<td>Inference</td>
<td>Control</td>
<td>0.9</td>
<td>14</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>0.9</td>
<td>16</td>
<td>0.09</td>
</tr>
<tr>
<td>Pragmatics</td>
<td>Control</td>
<td>0.93</td>
<td>14</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>0.91</td>
<td>16</td>
<td>0.10</td>
</tr>
</tbody>
</table>

*Note.* Each Shapiro-Wilk test yielded a nonsignificant value (\( p > .05 \)), indicating normality.

A multivariate test of normality was conducted to examine whether the MANCOVA assumption was met in the current data set. The Henze Zirkler test result (0.98, \( p = > 0.05 \)) suggests the variables were normally distributed. According to Santos-Fernández (2013), the Henze Zirkler test is a high-performance multivariate normality test.

**Descriptive Statistics of Dependent Variables**

In the next step of the analysis, the descriptive statistics of the scale variables were calculated. The mean measures central tendency, while SD indicates the degree to which individuals within each variable differed from the variable mean. Table 8 delineates the descriptive statistics of each of the scale variables for the entire sample (disregarding participant condition). As shown in Table 8, the highest mean score belonged to pragmatics, with a mean
value of 97.43 for both the pretest and posttest, followed by knowledge of words, with mean values of 92.75 and 93.65 for the pretest and posttest, respectively. The lowest mean rating belonged to supralinguistics and inferencing, with mean values of 89.30 at pretest and 89.43 at posttest. Among the studied variables, the individual value of grammar deviated the most from its mean ($SD = 12.45$ at pretest and 12.97 at posttest). This $SD$ suggests a reasonably high degree of variability in the respondents’ grammar skills. In other words, the respondents mostly varied from each other in this variable. The lowest deviation from mean belonged to pragmatics, with the $SD$ of 5.57 at both the pretest and posttest. Figures 3–6 display the mean and dispersion of all study variables at pretest and posttest. As illustrated, each variable is approximately normally distributed.

![Histogram and normal curve of knowledge of word scores at pretest and posttest.](image)

*Figure 3.* Histogram and normal curve of knowledge of word scores at pretest and posttest.
Figure 4. Histogram and normal curve of grammar scores at pretest and posttest.

Figure 5. Histogram and normal curve of supralinguistics scores at pretest and posttest.
Figure 6. Histogram and normal curve of pragmatics scores at pretest and posttest.

Table 8

Results of Descriptive Statistics for Scale Variables for Entire Sample

<table>
<thead>
<tr>
<th>Time</th>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>Knowledge of words</td>
<td>92.75</td>
<td>9.477</td>
<td>78</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>Grammar</td>
<td>90.4</td>
<td>12.447</td>
<td>70</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>Supralinguistics (inferencing)</td>
<td>89.30</td>
<td>11.381</td>
<td>69</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Pragmatics</td>
<td>97.43</td>
<td>5.569</td>
<td>87</td>
<td>107</td>
</tr>
<tr>
<td>Posttest</td>
<td>Knowledge of words</td>
<td>93.65</td>
<td>9.1935</td>
<td>79</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>Grammar</td>
<td>92.07</td>
<td>12.972</td>
<td>70</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>Supralinguistics (inferencing)</td>
<td>89.43</td>
<td>11.521</td>
<td>69</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Pragmatics</td>
<td>97.43</td>
<td>5.569</td>
<td>87</td>
<td>107</td>
</tr>
</tbody>
</table>

Note. n = 30.

A MANCOVA was used as a parametric comparative test to examine the difference between the two groups on posttest scores, while controlling for average pretest values. Multivariate analysis of covariance is a statistical model that extends the analysis of covariance; it is the MANOVA with a covariate. Multivariate analysis of covariance was used to assess
statistical differences on multiple continuous dependent variables by the independent grouping variable, while controlling for a third variable called the covariate; multiple covariates were used. Covariates were added in order to reduce errors and so that the analysis eliminated the covariates’ effect on the relationship between the independent grouping variable and the continuous dependent variables (Gall et al., 2007). Before conducting the MANCOVA, Levene’s (1960) test was conducted to determine whether the two samples being compared had an equal variance or not. A series of Levene’s tests of equality of error variances (see Table 9) revealed that equality of error variances could be assumed for word knowledge and pragmatics’ scores but not for grammar and supralinguistics’ scores. The equality of error variances in word knowledge and pragmatics is inferred from the Levene’s test \( p \)-value of greater than .05. Given this finding, Wilk’s lambda was interpreted in subsequent analyses because it is robust to violated assumptions.

Table 9

*Levene’s Test of Statistics and Significance Values*

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>df</th>
<th>( F )</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of words</td>
<td>1, 28</td>
<td>0.01</td>
<td>0.92</td>
</tr>
<tr>
<td>Grammar</td>
<td>1, 28</td>
<td>5.63</td>
<td>0.03</td>
</tr>
<tr>
<td>Supralinguistics</td>
<td>1, 28</td>
<td>4.72</td>
<td>0.04</td>
</tr>
<tr>
<td>Pragmatics</td>
<td>1, 28</td>
<td>0</td>
<td>0.99</td>
</tr>
</tbody>
</table>

A MANCOVA was conducted to determine if there was no statistically significant difference in scores of (a) knowledge and use of words, (b) knowledge of grammar, (c) supralinguistics (inferencing), and (d) pragmatics between the treatment and control group, controlling for average pretest scores on each of the four dependent variables.

The results of the MANCOVA analysis suggest that, controlling for other variables, the pretest scores unsurprisingly have statistically significant impact \( p < 0.001 \) on the posttest
scores. These scores are controlled for within the statistical model. After controlling for pretest scores, the one-way MANCOVA, analyzing the effect of the intervention on four language outcomes, revealed a significant main effect of the treatment group: $F(3, 22) = 3.59, p = .03$, Wilk’s $\lambda = .67$, partial $\eta^2 = .33$. Significance is inferred by the associated $p$-value being smaller than .05. The results of the MANCOVA were probed further to relate the model results to each of the four hypotheses.

**Null Hypothesis One.** This hypothesis stated, “There is no statistically significant difference between knowledge and use of the words and word combination scores of kindergarten students who use a symbol-supported communication app and of those who do not use a symbol-supported communication app, while controlling for pretest scores.” The MANCOVA model revealed a significant between-subjects effect of the intervention on word knowledge—$F(1, 29) = 7.52, p < .001$, partial $\eta^2 = 0.24$ (see Table 10 and Figure 7). An examination of mean scores by group revealed that the treatment group ($M = 93.63, SE = 0.33$) performed significantly better on the word knowledge subscale than the control group ($M = 92.87, SE = 0.30$; see Table 11). Thus, Null Hypothesis One was rejected.

**Null Hypothesis Two.** This hypothesis stated, “There is no statistically significant difference between knowledge and use of grammar scores of kindergarten students who use a symbol-supported communication app and of those who do not use a symbol-supported communication app, while controlling for pretest scores.” The MANCOVA model revealed a significant between-subjects effect of the intervention on grammar—$F(1, 29) = 6.29, p = .02$, partial $\eta^2 = 0.21$ (see Table 10 and Figure 7). An examination of mean scores by group revealed that the treatment group ($M = 93.38, SE = 0.67$) performed significantly better on the grammar
knowledge subscale than the control group ($M = 90.56, SE = 0.73$; see Table 11). Consequently, Null Hypothesis Two was rejected.

**Null Hypothesis Three.** This hypothesis stated, “There is no statistically significant difference between supralinguistic scores of kindergarten students who use a symbol-supported communication app and of those who do not use a symbol-supported communication app, while controlling for pretest scores.” The MANCOVA model failed to reveal a significant between-subjects effect of the intervention on supralinguistics—$F(1, 29) = .01, p = .94$, partial $\eta^2 = 0.00$ (see Table 10 and Figure 7). An examination of mean scores by group revealed that the treatment group ($M = 89.44, SE = 0.14$) performed similarly on the supralinguistics subscale to the control group ($M = 89.43, SE = 0.16$; see Table 11). Thus, Null Hypothesis Three failed to be rejected.

**Null Hypothesis Four.** This hypothesis stated, “There is no statistically significant difference between pragmatic scores of kindergarten students who use a symbol-supported communication app and of those who do not use a symbol-supported communication app while controlling of pretest scores.” The MANCOVA model failed to reveal a significant between-subjects effect of the intervention on pragmatic scores—$F(1, 29) = .00, p = .99$, partial $\eta^2 = 0.00$ (see Table 10 and Figure 7). An examination of mean scores by group revealed that the treatment group ($M = 97.43, SE = 0.00$) performed similarly on the pragmatics subscale to the control group ($M = 97.43, SE = 0.00$; see Table 11). Therefore, Null Hypothesis Four failed to be rejected.
Table 10

Test of Between-Subject Effects

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>df</th>
<th>F</th>
<th>p-value</th>
<th>partial η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word knowledge</td>
<td>1, 29</td>
<td>7.52</td>
<td>0.01</td>
<td>0.24</td>
</tr>
<tr>
<td>Grammar</td>
<td>1, 29</td>
<td>6.29</td>
<td>0.02</td>
<td>0.21</td>
</tr>
<tr>
<td>Inference</td>
<td>1, 29</td>
<td>0.01</td>
<td>0.94</td>
<td>0</td>
</tr>
<tr>
<td>Pragmatics</td>
<td>1, 29</td>
<td>0</td>
<td>0.99</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 7. Effects of group on each language outcome.

Table 11

Estimated Marginal Means for Each Group and Pairwise Comparisons

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Group</th>
<th>M</th>
<th>SE</th>
<th>95% CI</th>
<th>Mean difference</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word knowledge</td>
<td>Control</td>
<td>92.87</td>
<td>0.33</td>
<td>92.19, 93.54</td>
<td>1.38</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>93.63</td>
<td>0.30</td>
<td>93.63, 94.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grammar</td>
<td>Control</td>
<td>90.56</td>
<td>0.73</td>
<td>89.05, 92.07</td>
<td>2.82</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>93.38</td>
<td>0.67</td>
<td>92.00, 94.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inference</td>
<td>Control</td>
<td>89.43</td>
<td>0.16</td>
<td>89.01, 89.75</td>
<td>0.01</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>89.44</td>
<td>0.14</td>
<td>89.14, 89.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pragmatics</td>
<td>Control</td>
<td>97.43</td>
<td>0.00</td>
<td>97.43, 97.43</td>
<td>0.00</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>97.43</td>
<td>0.00</td>
<td>97.43, 97.43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. M = mean; SE = standard error, CI = confidence interval.
CHAPTER FIVE: DISCUSSION

Overview

The purpose of this study was to examine the degree to which kindergarten students in the general education setting were able to increase their expressive language knowledge and usage using a symbol-supported communication app. The students’ knowledge and use of words, knowledge and use of grammar, supralinguistics (inferring), and pragmatics were measured and monitored over 7 weeks. The students were given a pretest, 15 days of intervention, and a posttest. The design was classified as a quantitative quasi-experimental, pretest-posttest, nonequivalent comparison group design that used a MANCOVA with the pretest scores as the covariates. This design was selected because of nonrandom assignments in the experiment that was performed using preestablished, nonrandom groups that occur in the school setting.

Discussion

Knowledge of Words and Word Usage

Research Question One examined the kindergarteners’ knowledge of and use of words and word combinations. Data from the current research reveal a significant difference between knowledge and use of words and word combinations scores of kindergarteners in the general education setting who used a symbol-supported communication app and the scores of those who did not. LAT (Chomsky, 1956) supports this finding and points out that once conceptual knowledge has been acquired, the next step in the process is the development of language usage (Kamsu-Foguem et al., 2014). In addition, the SETT framework suggests that because the students made growth in this area using a symbol-supported communication app, it is less likely to be abandoned (Zabala, 2005). These results, therefore, indicate that students who use symbol-
supported communication apps acquire language skills that exceed the skills of their peers who do not use the app. This study adds to the existing body of research by addressing the kindergarten population, which had been previously neglected in other language-based research, and by extending LAT and SETT frameworks to this population.

Knowledge and Use of Grammar

Research Question Two examined the kindergarteners’ knowledge of and use of grammar. The data findings indicate a significant difference in knowledge and use of grammar by kindergarteners who used a symbol-supported communication app in comparison to those who do not. This finding reveals that students who used the symbol-supported communication app increased their knowledge and use of grammar. LAT (Chomsky, 1956) supports this finding. As a child progresses through these stages of development, he or she can master progressively advanced levels of language development, specifically expressive language (Norbury et al., 2014). In addition, the SETT framework suggests that because the students made growth in this area using a symbol-supported communication app, it is less likely to be abandoned (Zabala, 2005). Therefore, this study addressed the research gap regarding the kindergarten population that had been previously neglected in other language-based studies and adds to the body of knowledge.

Knowledge of Supralinguistics (Inferencing)

Research Question Three examined the kindergarteners’ knowledge of and use of supralinguistics (inferencing). Data from this research revealed a slight difference; however, there was not a significant difference between the knowledge and use of supralinguistics pretest and posttest scores of kindergarteners in the general education setting who used a symbol-supported communication app and the scores of those who did not. Other researchers have
reported word-order difficulties for ages 4–6 and for adolescents who use AAC with symbolic symbols when retelling stories (Kent-Walsh, Binger, & Buchanan, 2015; van Balkom & Welle Donker-Gimbrère, 1996). Younger participants in other investigations have also demonstrated word-order errors when learning to produce early symbol combinations (Binger, 2004; Kent-Walsh et al., 2015; Nigam, Schlosser, & Lloyd, 2006). Their results suggest that students develop these skills by different methods. However, research by Jennische and Zetterlund (2015) showed improvement in this area, although their study did not allow for a distinction to be made between initial learning and retention. This current study, however, provides that distinction. As a result, a significant number of students did not develop supralinguistic (inferencing) skills using the symbol-supported app during this study. The SETT framework suggests that this type of symbol-supported communication app is likely to be abandoned if used in this area (Zabala, 2005). This finding, therefore, failed to reject the null hypothesis of the research question, which predicted that there would be no significant difference. More time than what was available for this study is needed to fully examine this area with the use of a symbol-supported communication app.

**Knowledge and Use of Pragmatics**

Research Question Four examined the kindergarteners’ knowledge of and use of pragmatics. Data from this research revealed no difference between knowledge and use of pragmatics pretest and posttest scores of kindergarteners in the general education setting who use a symbol-supported communication app and those who do not. These findings show that students did not develop additional pragmatic skills using the symbol-supported app during this study. Other researchers have reported that children struggle with social cues and conversational etiquette, such as turn-taking and acknowledging the other person in a conversation, when using
AAC devices with symbolic symbol software. Vygotsky (1962) hypothesized that language is learned during interactions with communicative partners, such as adults, who are experienced in the exchange of language (Iskandar & Baird, 2014). Of particular importance in these social interactions are verbal guidance and adult modeling (Donaldson, 2009). LAT provides insight into the awareness of language used within context and the speaker’s ability to change the language as needed. Children in late preschool and primary school years assign belief to speech acts that they create, as well as assign belief to a speaker’s intent when producing an utterance containing a statement of some kind. They are either disagreeing with the speaker, pragmatically judging, or judging how the speaker has used the utterance (metalinguistic judgment; Olson & Astington, 2013). The SETT framework suggests that this type of symbol-supported communication app is likely to be abandoned when used as a communication tool in this area (Zabala, 2005). Although this current study addressed the research gap regarding the kindergarten population’s pragmatic acquisition that had been previously neglected in other language-based studies, further research beyond what this study could offer is needed to fully examine this area and the efficacy of using a symbol-supported communication app.

**Interpretation of Findings**

The findings reveal that the utilization of a symbol-supported communication app among kindergarten students does impact language positively in the area of acquiring knowledge of words and knowledge of grammar and is neutral in its support in the areas of knowledge of supralinguistics and knowledge of pragmatics. The findings, therefore, rejected the first two null hypotheses but aligned with the second two null hypotheses proposed at the beginning of the study. Following is a discussion about the interpretation of the findings as it relates to each finding.
The first finding of the study rejected the null hypothesis regarding the difference between knowledge and word usage. This result was not surprising considering the abundance of research advocating for AACs. For instance, dating back more than a decade, legislators have signed specific laws into action that support the notion that AACs enhance the lives of individuals with communication needs (Hourcade et al., 2004). Such laws promote the concept that it is important for teachers to improve their efficacy with all students in the classroom by implementing innovative practices, techniques, and technologies (Edyburn et al., 2005; Hughes & Talbott, 2017). Not only is this helpful for traditional students, it is beneficial for students with learning disabilities as well (IDEA, 2004). Consequently, not only are there laws that support this finding, but researchers have found that there is a tangible benefit to students utilizing symbol-supported communication.

The second finding of the study rejected the null hypothesis regarding the difference between knowledge and use of grammar scores. This result is well supported by research relating to grammar abilities. In a study by Lund and Light (2003), the researchers found that students using AAC devices not only experienced success in learning complex grammar skills but also maintained those skills for two months following instruction. This finding was similar to one from a study by Binger and Light (2007), which revealed that children using AAC devices used the learned multisymbol combinations for up to two months, suggesting that direct instruction and use of these devices significantly improved the grammar abilities of students. Consequently, it is reasonable to assume that AAC devices enhance the grammar abilities of students, as the findings of the current study suggest. This current study adds to the body of research by addressing the kindergarten population that had been previously neglected in language-based research.
The third finding of the study failed to reject the null hypothesis regarding changes in supralinguistics’ scores of kindergarteners who use a symbol-supported communication app. The results show that there is no significant difference between the students who use AAC devices to improve supralinguistic abilities and the students who do not. According to prior research, supralinguistics refers to knowledge and the utilization of language that is not available directly (Carrow-Woolfolk, 2016). Supralinguistics is a student’s ability to understand how language is used to communicate those elements which are not stated. The findings, therefore, suggest that students may require a more direct approach in order to understand this aspect of language. This finding is especially significant in light of the results of Peters’ (2016) study, which determined that this learning ability is slower to develop than other language areas.

The last finding of the study failed to reject the null hypothesis regarding the difference between pragmatic scores of kindergarten students who use a symbol-supported communication app and those who do not. The study revealed a zero-mean difference between the pretest and posttest groups. Pragmatics refers to a student’s ability to use language for social use (i.e., taking turns in conversation; CASL-2, 2016). According to the results, there was no difference in the students’ ability to use language socially before or after using the symbol-supported app.

**Implications**

The findings for the first research question show that kindergartener students experienced a difference in their ability to use words and word combinations upon using the AAC device with a symbolic symbol app. This result is in direct agreement with previous research and the literature review findings and is significant because it will allow educators and practitioners to implement the use of AAC devices with a symbolic symbol app with students who are struggling in the areas of word use and word combinations. Doing so has implications that extend beyond
kindergarten and shows that AAC devices can help students remediate weaknesses and develop expressive language skills. The findings for the second research question show that kindergarten students experienced an increase in their ability to use grammar effectively. This finding is noteworthy because it shows that AAC devices can be used to help students in a critical stage of development. Last, this finding is significant because it shows that AAC devices can equip students with the ability to formulate cohesive written language output.

The findings for the third research question revealed no statistical difference between the pretest and posttest scores of the students who used a symbolic symbol-supported communication app. This finding is important because it raises additional questions that must be explored in order to understand why this was the case. The initial assumption is that the students in the study required additional time for optimal impact; this assumption must be verified by further research. The findings for the final research question reveal that there was not a significant difference between pragmatic scores of the kindergarten students who used a symbolic symbol-supported communication app and those who did not. This finding was significant because it reveals that the students could not enhance their pragmatic language usage, which is essential in order for students to convey the intended message. The implication of this finding, therefore, is that educators will need to (a) find alternative methods to ensure that students develop this critical skill and (b) seek to understand how an AAC device might be leveraged to help students develop a pragmatic skillset.

Limitations

The primary limitations of this study chiefly concern the inability to generalize the findings in two areas. The study focused on only kindergarten students, which makes it difficult to generalize the results to students in other grades. Due to the research suggesting the
importance of examining AAC devices with a symbolic symbol app support for kindergarten students, this is viewed as a minor limitation. Another limitation is that the sample selected for the research came from one school consisting of mostly minority students. The majority demographic population was limited compared to the minority population, which made it difficult to determine how this research might impact their success using an AAC with a symbolic symbol app. Also, the intervention portion provided for this study lasted only 3 weeks. This short timeframe may have contributed to the limited or no progress in the areas of supralinguistics (inferencing) and pragmatics. Last, another limitation to the study was that the researcher did not use a randomized design due to the selection of a convenience sample of participating classes.

**Recommendations for Future Research**

The study’s limitations provide a foundation for recommendations for future study. When adding this study to other research, a gap continues to remain in the knowledge of AAC with symbolic symbol-supported apps for kindergarten students in the general education setting. Elementary schools have an opportunity to enhance expressive language interventions for kindergarten students in the general education setting, which other researchers have validated (Binger, Kent-Walsh, King, & Mansfield, 2017; Lane, Lane, Shepley, & Lieberman-Betz, 2016; Naguib Bedwani et al., 2015; Soto & Clarke, 2017). The hope is that future studies will offer rigorous research methods to validate and build upon the results of this investigation. Moreover, the hope is that future research will consider how ethnic and cultural differences impact supralinguistics and pragmatics of students who use a symbol-supported communication app for expressive language remediation in the general education population. It is recommended that future research examine students in Grades 1 through 5 to determine if AAC with a symbolic
symbol app can assist them with enhancing expressive language and written language. Additionally, future research examining kindergartens in the general education setting to determine if AAC with a symbolic symbol app can assist in enhancing their written language will be greatly anticipated. Finally, it is recommended that future researchers conduct supralinguistics and pragmatics in this population over a longer intervention time.

**Conclusion**

The results of this study extend the knowledge concerning the use of a symbol-supported communication app to increase expressive language usage specifically within the general education kindergarten population. Previous research revealed that language interventions that utilize AAC with symbolic symbols are effective in improving functional expressive and receptive language growth in many heterogeneous populations (Meinzen-Derr, 2018). This study focused on the knowledge and use of the words and word combinations, knowledge and use of grammar, supralinguistics, and pragmatics.

The ethnically diverse participants experienced an increase in knowledge of words and word combinations and grammar. Other research studies have had similar results, such as the Naguib Bedwani et al. (2015) findings, which showed that most of the children in their study improved their functional communication and length of utterances using either the symbolic symbol communication app or spoken language. That result demonstrated that children are able to increase knowledge and use of the words and word combinations (lexical) and meaning (semantics) when provided this type of intervention. Additionally, an analysis of Kovacs and Hill’s (2017) study of grammatical morpheme usage in typically developing children ages 30 to 54 months revealed significant growth when paired with positional processing features and AAC. Nevertheless, increased usage of supralinguistics and pragmatics during this study did not
yield an increase in usage. These two areas seem to be the most challenging. In a systematic
review of 32 studies, only 19 demonstrated positive results for children with complex
communication needs (Gevarter & Zamora, 2018).

Expressive language development in kindergarten students is the foundation for
developing expression of learned knowledge verbally, reading comprehension, and writing
abilities (Roskos, Morrow, & Gambrell, 2015). The choice of AAC, which includes symbol-
supported communication apps, can have long-lasting implications on the development of
expressive language and academic areas that are impacted (Webb et al., 2019). Overall, this
research contributes to the research on expressive language development based on LAT and the
SETT theoretical framework to increase expressive language using an AAC device with a
symbol-supported communication app. This research is valuable to educators who aspire to help
students improve expressive language usage.
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Von Koss Torkildsen, J., Hansen, H. F., Svangsttu, J. M., Smith, L., Simonsen, H. G., Moen, I.,


October 5, 2018

Anna Camille McKelphin
IRB Approval 3387.100518: Measures for Comparing an Augmentative and Alternative Communication Application for Use Within a Kindergarten Curriculum

Dear Anna Camille McKelphin,

We are pleased to inform you that your study has been approved by the Liberty University Institutional Review Board. This approval is extended to you for one year from the date provided above with your proto number. If data collection proceeds past one year or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email. Your study falls under the expedited review category (45 CFR 46.110), which is applicable for certain kinds of research involving no more than minimal risk, and for minor changes in approved research.

Your study involves surveying or interviewing minors, or it involves observing the public behavior of minors, and you will participate in the activities being observed.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

[Signature]
Administrative Chair of Institutional Research
The Graduate School
APPENDIX B: PARENTAL/GUARDIAN CONSENT FORM

This form only needs to be returned if you do NOT want your child to participate.

PARENT/GUARDIAN CONSENT FORM
Measures for Comparing Augmentative and Alternative Communication
Application for Use Within a Kindergarten Classroom
Anna Camille McKelphin
Liberty University School of Education

Your student is invited to be in a research study designed to analyze how kindergarten students talk after using a tablet with a picture symbols app. Your child was selected as a possible participant because your student is in the general education kindergarten class. Please read this form and ask any questions you may have before agreeing to allow him or her to be in the study. Anna Camille McKelphin, a doctoral candidate in the school of education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to determine how kindergarten students talk after using a tablet with pictures that represent words. The research aims to identify if the use of picture symbols encourages kindergarten students to use more words when talking.

Procedure: If you agree to allow your kindergarten student to be in this study, I would ask him or her to do the following things:

1. Weeks 1 and 2—Complete a 20-minute pretest.
2. Week 3—Attend two instructional sessions, each lasting 20 minutes.
3. Weeks 4 and 5—Participate in 10 language development activities, each lasting 20 minutes.
4. Weeks 6 and 7—Complete a 20-minute posttest.

*All study procedures will be completed during recess.

**Participants will be split into two groups based upon the class they are enrolled in; an experimental group and a control group. The experimental group will receive instruction on expected behavior and how to use the iPad with symbolic symbol software to answer questions during week 3 and will complete language development activities using the symbolic symbol software during weeks 4 and 5. The control group will receive instruction on expected behavior and how to answer questions verbally during week 3 and will complete language development activities without the use of symbolic symbol software during weeks 4 and 5.
**Risks:** The risks involved in this study are minimal, which means they are equal to the risks your child would encounter in everyday life.

**Benefits:** Students in the research group may experience an increase in their expressive language.

**Benefit to Society Includes:** Developing classroom interventions that help students use more language when talking.

**Compensation:** Participants will not be compensated for participating in this study.

**Confidentiality:** The records of this study will be kept private. In any sort of report, I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records. The confidentiality of all data and materials will be maintained by the researcher through keeping such information locked in a file in her home office.

- Participants identities will be removed from the data and replaced by a numerical code.
- Data, files, and any identifying information will be kept in a secured file cabinet to which only the researcher has access.
- All data will be kept for three years after the conclusion of the study in a locked file cabinet after which all data, files, and any identifying information will be destroyed.

**Conflict of Interest Disclosure:** Although I am a speech language pathologist at the school where the research is taking place,

1. I have no grading authority over potential participants, and
2. I have no financial interest related to the conduct or outcome of the study.

**Voluntary Nature of the Study:** Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect his or her current or future relations with Liberty University or the District of Columbia Public Schools. If you decide to allow your child to participate, he or she is free to not answer any question or withdraw at any time

**How to Withdraw From the Study:** If your child chooses to withdraw from the study, please contact the researcher at the email address or phone number included in the next paragraph. Should your child choose to withdraw, any data collected from him or her will be destroyed immediately and will not be included in this study.

**Contacts and Questions:** The researcher conducting this study is A. Camille McKelphin. You may ask any questions you have now. If you have questions later, you are encouraged to contact A. Camille McKelphin at (240) 765-9380 or anna.mckelphin@liberty.edu. Additionally, you may also contact her dissertation chair, Dr. Barbara Jordan-White, Ph.D., at bawhite2@liberty.edu.
If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd, Green Hall 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to allow my child/student to participate in the study.

Please ONLY sign and return this form if you DO NOT want your child to participate in this study.

____________________________________________________________________________
Signature of Parent     Date

____________________________________________________________________________
Signature of Investigator
APPENDIX C: PARENTAL/GUARDIAN CONSENT FORM SPANISH VERSION

The Liberty University Institutional Review Board has approved this document for use from 10/5/2018 to 10/4/2019
Protocol # 3387.100518

Este formulario solo necesita ser devuelto si NO desea que su hijo participe.

FORMULARIO DE CONSENTIMIENTO DE PADRES / TUTORES
Medidas para comparar comunicaciones aumentativas y alternativas
Solicitud de uso dentro de un aula de Kindergarten
Anna Camille McKelphin
Liberty University
Escuela de Educación

Se invita a su estudiante a participar en un estudio de investigación diseñado para analizar cómo hablan los estudiantes del kinder después de usar una tableta con una aplicación de símbolos con imágenes. Su hijo(a) fue seleccionado como posible participante porque su estudiante está en la clase de kindergarten de educación general. Lea este formulario y formule cualquier pregunta que tenga antes de aceptar que él o ella participe del estudio.

Anna Camille McKelphin, candidata a doctorado en la escuela de educación de Liberty University, está realizando este estudio.

Información general: El propósito de este estudio es determinar cómo hablan los estudiantes de kindergarten luego de usar una tableta con imágenes que representan palabras. La investigación tiene como objetivo identificar si el uso de símbolos ilustrados alienta a los estudiantes de kinder a usar más palabras cuando hablan.

Procedimiento: Si acepta permitir que su estudiante de kindergarten participe en este estudio, le pediría que haga lo siguiente:

1. Semanas 1 y 2: Completar una prueba previa de 20 minutos.
2. Semana 3: Atender a 2 sesiones de instrucción, cada una con una duración de 20 minutos.
3. Semanas 4 y 5: Participar en 10 actividades de desarrollo del lenguaje, cada una con una duración de 20 minutos.
4. Semanas 6 y 7: Completar una prueba posterior de 20 minutos.

* Todos los procedimientos de estudio se completarán durante el recreo.

** Los participantes se dividirán en dos grupos según la clase en la que están inscritos; un grupo experimental y un grupo de control. El grupo experimental recibirá instrucciones sobre [sobre el comportamiento esperado y cómo utilizar el iPad con software de símbolos simbólicos para responder preguntas] durante la semana 3 y completará las actividades de desarrollo de lenguaje utilizando el software de símbolos simbólicos durante las semanas 4 y 5. El grupo de control recibirá instrucción sobre el comportamiento esperado y cómo responder las preguntas verbalmente durante la semana 3 y completará las actividades de desarrollo del lenguaje sin el uso de software de símbolos simbólicos durante las semanas 4 y 5.
Riesgos: Los riesgos involucrados en este estudio son mínimos, y esto significa que son iguales a los riesgos que su hijo enfrentaría en la vida cotidiana.

Beneficios: Los estudiantes en el grupo de investigación pueden experimentar un aumento en su lenguaje expresivo.

Los beneficios para la sociedad incluyen: Desarrollar intervenciones en el aula que ayuden a los estudiantes a usar más lenguaje al hablar.

Compensación: Los participantes no serán compensados por participar en este estudio.

Confidencialidad: Los registros de este estudio se mantendrán en privado. En cualquier tipo de informe que publique, no incluiré ninguna información que permita identificar un participante. Los registros de investigación se almacenarán de forma segura, y solo el investigador tendrá acceso a los registros. El investigador mantendrá la confidencialidad de todos los datos y materiales al mantener dicha información encerrada en un archivo en su oficina central.

- Las identidades de los participantes se eliminarán de los datos y se reemplazarán con un código numérico.
- Los datos, archivos y cualquier información de identificación se mantendrán en un archivador seguro al que solo tenga acceso el investigador.
- Todos los datos se conservarán por 3 años después de la conclusión del estudio en un archivador bloqueado, después del cual se destruirán todos los datos, archivos y cualquier información de identificación.

Divulgación de Conflicto de Interés: Aunque soy un patólogo del habla y lenguaje en la escuela donde la investigación se lleva a cabo,
   1. No tengo autoridad de clasificación sobre los posibles participantes, y
   2. No tengo intereses financieros relacionados con la conducta o el resultado del estudio.

Naturaleza voluntaria del estudio: La participación en este estudio es voluntaria. Su decisión de permitir o no que su hijo participe no afectará sus relaciones actuales o futuras con Liberty University o las Escuelas Públicas del Distrito de Columbia. Si decide permitir que su hijo participe, él o ella son libres de no responder ninguna pregunta o retirarse en cualquier momento.

Cómo retirarse del estudio: Si su hijo decide retirarse del estudio, comuníquese con la investigadora a la dirección de correo electrónico o al número de teléfono incluidos en el párrafo siguiente. Si su hijo opta por retirarse, cualquier información recopilada de él o ella será destruida inmediatamente y no se incluirá en este estudio.

Contactos y preguntas: El investigador que realiza este estudio es A. Camille McKelphin. Puede hacer cualquier pregunta que tenga ahora. Si tiene preguntas más adelante, le recomendamos que se comunique con A. Camille McKelphin al (240) 765-9380 o anna.mckelphin@liberty.edu. Además, también puede ponerse en contacto con mi presidente de la disertación, la Dra. Barabara Jordan-White, Ph.D., en bawhite2@liberty.edu.

Si tiene alguna pregunta o inquietud con respecto a este estudio y desea hablar con alguien que no sea el investigador, le recomendamos que se comunique con la Junta de Revisión Institucional, 1971 University Blvd, Green Hall 2845, Lynchburg, VA 24515 o envíe un correo electrónico a irb@liberty.edu.

Notifique al investigador si desea una copia de esta información para sus registros.
Declaración de consentimiento: He leído y entendido la información anterior. He hecho preguntas y he recibido respuestas. Doy mi consentimiento para permitir que mi hijo / estudiante participe en el estudio.

SOLAMENTE firme y devuelva este formulario si NO QUIERE que su hijo participe en este estudio.

______________________________________________________________________________
Firma del padre Fecha

______________________________________________________________________________
Firma del investigador Fecha
APPENDIX D: PARENTAL/GUARDIAN CONSENT FORM MANDARIN VERSION

The Liberty University Institutional Review Board has approved this document for use from 10/5/2018 to 10/4/2019
Protocol # 3387.100518

如果您不希望您的孩子参加，则只需退回此表。

父母/监护人同意书 比较增强型和非增强型教学措施对交流的影响”
申请在幼稚园课堂内使用
Anna Camille McKelphin
自由大学
教育学院

您的学生被邀请参加一项研究性研究，旨在分析幼儿园学生在使用带有图片符号应用程序的平板电脑后的谈话方式。您的孩子被选为可能的参与者，因为您的孩子在普通教育幼儿园班。在同意允许他或她参加研究之前，请阅读此表并询问您可能遇到的任何问题。

自由大学教育学院的博士候选人 Anna Camille McKelphin 正在进行这项研究。

背景资料：本研究的目的是确定幼儿园学生在使用平板电脑和图片代表文字后的谈话方式。该研究旨在确定图片符号的使用是否鼓励幼儿园学生在谈话时使用更多单词。

程序：如果您同意允许您的孩子参加本研究，我会要求他或她做以下事情：

1. 第1周和第2周 - 完成20分钟的试验前测试。
2. 第3周 - 参加2个教学课程，每个课程持续20分钟。
3. 第4周和第5周 - 参加10个语言发展活动，每个活动持续20分钟。
4. 第6周和第7周 - 完成20分钟的试验后测试。

*所有学习程序将在休会期间完成。

**参与者将根据他们注册的课程分为两组：实验组和对照组。实验组将在第3周接受关于预期行为以及如何使用带有符号符号软件的 Ipad 来回答问题的指导，并将在第4周和第5周期间使用符号符号软件完成语言开发活动。对照组将收到关于预期行为的指导以及如何在第3周期间口头回答问题，并将在第4周和第5周期间不使用符号符号软件完成语言开发活动。

风险：本研究涉及的风险很小，这意味着它们与您孩子在日常生活中遇到的风险相等。

好处：研究组的学生可能会增加他们的表达语言。

对社会的好处包括：开发课堂干预措施，帮助学生在交谈时使用更多语言。

补偿：参与者不会因参与本研究而获得报酬。
保密性：本研究的记录将保密。在我可能发布的任何类型的报告中，我都不会包含任何可以识别主题的信息。研究记录将安全存储，并且只有研究人员才能访问记录。所有数据和材料的机密性将由研究人员通过将这些信息锁定在其家庭办公室的文件中来保持。•参与者身份将从数据中删除，并由数字代码替换。

•数据、文件和任何识别信息将保存在只有研究人员才能访问的安全文件柜中。•所有数据将在研究结束后在锁定文件柜中保存3年，之后将销毁所有数据、文件和任何识别信息。

利益冲突披露：虽然我是研究所在学校的语言病理学家，
1. 我对潜在参与者没有评级权限
2. 我没有与研究的行为或结果有关的经济利益。

研究的自愿性质：参与本研究是自愿的。您决定是否允许您的孩子参加，不会影响他或她与Liberty University或哥伦比亚特区公立学校目前或未来的关系。如果您决定允许您的孩子参加，他或她可以随时回答任何问题或退出。

如何退出研究：如果您您的孩子选择退出研究，请通过下一段中提供的电子邮件地址或电话号码联系研究人员。如果您您的孩子选择退出，从他或她收集的任何数据将立即销毁，并且不会包含在本研究中。

联系方式和问题：进行这项研究的研究人员是A. Camille McKelphin。您现在可以提出任何问题。如果您以后有任何疑问，请致电(240)765-9380或发送电子邮件至anna.mckelphin@liberty.edu与A. Camille McKelphin联系。此外，您还可以通过bawhite2@liberty.edu联系我的论文主席，Barbara Jordan-White博士。

如果您对本研究有任何问题或疑虑，并希望与研究人员以外的其他人交谈，我们鼓励您联系机构审查委员会，1971 University Blvd，Green Hall 2845，Lynchburg，VA 24515或发送电子邮件至irb@liberty.edu。

如果您希望获得此信息的副本以供记录，请通知研究人员。

同意声明：我已阅读并理解上述信息。我已经提出问题并得到了答案。我同意让我的孩子/学生参加这项研究。

如果您不希望您的孩子参加本研究，请仅签名并返回此表格。

父母签名日期

签署调查员日期
APPENDIX E: PRINCIPAL CONSENT FORM

SEATON ELEMENTARY SCHOOL
1503 10th Street, NW • Washington, DC 20001 • 202-673-7215/fax 202-671-5014

April 20, 2018

Dr. Barbara Jordan-White
Dissertation Committee Chair/McKelphin
Liberty University
School of Education
1971 University Boulevard.
Lynchburg, VA 24515

Dear Dr. Jordan-White:

It is my understanding that Anna Camille McKelphin would like to conduct a research study at Seaton Elementary School on "Measures For Comparing an Augmentative and Alternative Communication Application within the Kindergarten Classroom". Mrs. McKelphin has informed me of the design of the study, meeting with teachers, the use of surveys, use of iPads, as well as the targeted population. She has my permission to conduct the study here at Seaton Elementary school located within the District of Columbia Public Schools.

I support this effort and will provide any assistance necessary for the successful implementation of this study. If you have any questions, please do not hesitate to call. I can be reached at (202) 673-7215.

Sincerely,

[Signature]

Principal
Seaton Elementary School
District of Columbia Public Schools
APPENDIX F: PERMISSION TO USE ASSESSMENT

My name is Anna Camille McKelphin. I am currently a doctoral candidate at Liberty University, I would like to use the comprehensive assessment of spoken language 2nd edition for use in a research study. My research is investigating if a symbolic symbol communication application influences the use of expressive language in the kindergarten, general education classroom. Your assessment would be used as a pretest and posttest measure to document growth, a decrease, or if language levels remain the same.

Thank you in advance for your support. I can be reached at anna.mckelphin@liberty.edu or on my cell phone, 240-765-9380.

Your assistance in helping me complete this research study is greatly appreciated.

Sincerely,
Anna Camille McKelphin, MS. Ed.S., CCC-SLP
Speech-Language Pathologist

*This information is found on the related website and provides information for usage.

The CASL-2 can be used by speech–language pathologists and other professionals in a variety of settings, including schools, clinics, hospitals, private practices, and intervention programs. When you need to evaluate response to intervention (RTI), you can use the CASL-2 to track improvement over time. It can help you answer a variety of referral questions, including eligibility for speech services, placement in special education, determining if a language delay or disorder is present, or measuring language abilities in English language learners. The CASL-2 provides important information for everyone involved in treatment, so you can help children and young adults reach their potential at school, at home, at work, and in the community. Using a commercially-available version of one of Pearson’s instruments in your research project, no additional permission is needed.
APPENDIX G: LETTER OF PERMISSION TO USE SYMBOLIC SYMBOL APPLICATION

2/24/2019 Gmail - AW {109931} Re: Using the Proloquo2go in a research study.
https://mail.google.com/mail/u/0?ik=160296d620&view=pt&search=all&permmsgid=msg-f%3A1599302285280268008&simpl=msg-f%3A15993022852… 1/1
Camille McKelphin cmckelphin3@gmail.com

AW {109931} Re: Using the Proloquo2go in a research study.

AssistiveWare <support@assistiveware.com>
Tue, May 1, 2018 at 6:25 PM
To: cmckelphin3@gmail.com
## Reply ABOVE THIS LINE to add a note to this request ##

Request update

Hi Camille,

Thank you for contacting AssistiveWare Support. It is my pleasure to assist you today. We would be happy to support your efforts and provide you with a copy of Proloquo2Go. Before we provide you with a copy of Proloquo2Go, we require a confirmation letter by email from your supervisor that the project has been approved. Additionally, we need a copy of the project time line from your supervisor. At the end of the project, they should also provide us with a PDF of the report.

Finally, please know that we cannot provide hardware, so you will be responsible for acquiring an iPad, iPhone, or iPod touch to run the app.

Please let us know if you have any additional questions. We look forward to assisting you with your project.

With kind regards,
Pam
AssistiveWare Support
APPENDIX H: KNOWLEDGE OF WORDS AND WORD COMBINATIONS
APPENDIX I: KNOWLEDGE OF GRAMMAR
APPENDIX J: KNOWLEDGE OF SUPRALINGUISTICS (INFERENCING)
APPENDIX K: KNOWLEDGE OF PRAGMATICS
APPENDIX L: MULTIVARIATE TEST RESULTS

Multivariate Test

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<th>Wilks' Lambda</th>
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Multivariate Tests

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Multivariate Tests

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a. Design: Intercept + T1WordKnowledge + T1Grammar + T1Inference + T1Pragmatics + Group b. Exact statistic
### APPENDIX M:

**TEST OF BETWEEN-SUBJECT EFFECTS**

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