The Effect of a Knowledge-Based Curriculum Using Science Read-Alouds on Vocabulary, Content, and Listening Comprehension Outcomes with Preschoolers

By

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Dedicated to …

This paper is first and above all dedicated to my four beautiful daughters. I pray that they will always go after their dreams even when life takes unexpected turns. They never complained when I came to ballgames with study cards for tests, stayed home most nights and weekends working on assignments, or talked endlessly about school the past four years. Being their mother is truly my greatest accomplishment in life.

This paper is also dedicated to my parents and sister who are my biggest cheerleaders. They have always been there with encouraging words when I needed them the most. The pride I see in their eyes and hear in their words as they tell others of my accomplishments has kept me on my path to graduation when some days it seemed an impossible task. When I wanted to give up, a phone call to them would get me centered. And finally, my friends. These people are my village. They are my constant supporters and have forgiven me for missing many celebrations and night outs because of my school obligations. They are always encouraging and genuinely happy for me.

Journeys are not easy but they should always be worth it. People often ask me why I went back for my PhD, especially in education. My answer is simple, I love to learn. It is not about the money or the status, it is about achieving goals and being a life learner. I want my girls to know they can achieve anything in this life if they want it. It may not always be easy, but it will always be worth it if they believe in their goal and purpose. And above all, I thank God for giving me this opportunity and knowledge to achieve this goal.

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ABSTRACT

Educators have been trying diligently to raise reading proficiency scores for decades to little avail. Children from all SES homes, but especially low-SES homes, are not achieving reading proficiency by fourth grade. One possibility for the low achievement is children do not possess the vocabulary and knowledge to comprehend texts once they are reading independently. The purpose of this quasi-experimental study was to determine if incorporating a knowledge-based curriculum using science read-alouds impacted vocabulary, listening comprehension, and content knowledge in 89 preschool students attending VPK in a Title I district in Tennessee beyond the impact of the traditional curriculum. Analysis of covariances (ANCOVA) were used to minimize the effects of group differences on the three research questions (Gall, Gall, & Borg, 2003). The present research will add to the current literature of exposing emergent learners to content vocabulary and knowledge through interactive read-alouds within a knowledge-based curriculum. The primary goal of the research was to answer the following questions: (1) What is the effect of a knowledge-based curriculum with interactive science read-alouds on a researcher-designed vocabulary outcome? (2) What is the impact of a knowledge-based curriculum with interactive science read-alouds on listening comprehension? (3) What is the effect of a knowledge-based curriculum with interactive science read-alouds on a researcher-designed content knowledge outcome? All analyses revealed positive effect sizes of 0.68, 0.07, 0.39 respectively.

Keywords: preschool, vocabulary, content knowledge, read-aloud

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Definition of Key Terms

Academic vocabulary- words encountered in school setting but not used in everyday conversations.

Background knowledge- information a person knows prior to new learning.

Breadth of vocabulary- the quantity of words they know

Conceptual understanding- the ability to go past basic recall and transfer knowledge to new ideas/situations.

Constrained Skills- limited skills that can be mastered, such as decoding.

Content instruction- instruction that focuses on domain or content specific instruction (e.g., science and social studies).

Cultural knowledge- the knowledge of some cultural characteristics of history, arts, values, beliefs, and behaviors of other cultural groups.

Curriculum-based measures (CBM)- a measurement of a target skill and can be taken directly from a curriculum to demonstrate a student's mastery.

Depth of vocabulary- the ability to know a word and use it correctly in multiple situations

Dialogic reading- teachers preplan questions throughout the read-aloud to encourage conversation with students beyond the yes or no type answers

Domain vocabulary- words that are specific to a domain/content of study, such as science or social studies

Domain knowledge- knowledge that expands a topic and transfers to the whole domain of study, such as life cycle of frogs (topic) to all animal and human life cycles

Explicit instruction- direct instruction to teach a skill or concept to students

Fourth Grade Slump- term coined by Jeanne Chall (1983) to describe the shift in reading instruction from a focus on decoding in the primary grades to "reading to learn" with a predominant focus on informational texts and vocabulary.

Interactive read-alouds (IRA)- teachers read texts aloud to students with preplanned questions to engage students in discussion before, during, and after reading of text.

Intertextuality- interrelationship between texts, especially texts in different genres but on same content

Knowledge-based curriculum- a curriculum designed to build knowledge both horizontally and vertically throughout grade levels.

Knowledge hypothesis- word meanings should be learned in conceptual frameworks rather than individual word meanings

Matthew Effect-bible reference of the rich get richer and the poor get poorer. In reading education, it refers to students who know more (better readers) learn more and students who have less knowledge continue to stay behind.

Oral language- development of skills and knowledge that involves speaking and listening and contributes to reading and writing comprehension

Schema- mental representations constructed of an individual's accumulated knowledge

SES- socio-economic status

Situation model- mental representative of events, actions, etc. of a word that encompasses all the knowledge one has of the word or phrase

Taxonomy- grouping of words based on a relationship

Theme Curriculum- each skill area is connected to a topic within a broad theme

Topic knowledge- knowledge about a specific topic within a domain of study

Unconstrained skills- skills that develop across a person's lifetime without reaching mastery, such as vocabulary and knowledge acquired through more complex texts

VPK- Voluntary Prek program in Tennessee is grant funded and emphasizes the enrollment of low SES four-year-old students

World knowledge- similar to cultural knowledge, world knowledge refers to knowledge of all people of the world (history, culture, beliefs, etc.)

CHAPTER I: INTRODUCTION

The following dissertation reports on a quasi-experimental study of implementing a knowledge-based curriculum in preschool classrooms. The present study will use researcher-designed vocabulary and content assessments, a curriculum-based measure (CBM) of vocabulary, and standardized assessments to address vocabulary and listening comprehension. The remainder of the chapter presents significance of the present study, the statement of problem, overview of methodology, limitations, delimitations, and definitions of terms.

Significance of Study

Educators have been trying diligently to raise reading proficiency scores for decades to little avail. In the fourth cycle of the PIRLS (Progress of International Reading Literacy Study) international study, U.S. has remained stagnant since 2001 (Warner-Griffin et al., 2017). The 2019 NAEP (National Assessment of Educational Progress) reported only 35% of fourth graders performed at or above proficient level, which is slightly lower than 2017 but up from 1992 (NCES, 2019). Students performed similar in Science with only 38% of 4th graders at levels of proficient and advanced (NCES, 2015a). Fourth grade students who performed low in science had teachers who reported little to no instruction in science inquiries (NCES, 2015b). Because of the urgency to increase language development socio-economic status (SES) has come to the forefront of concerns. Gaps appear as early as 18 months in children and can grow as large as a 6-months gap between high and low SES children at 2 years-old and continues to widen throughout the primary years (Chatterji, 2006; Fernald et al., 2013). Children from low SES families experience less talk, which limits their exposure with oral

language that enhances vocabulary, background knowledge, text structure, morphology, syntactical structures, and motivation to learn new skills (Dymock, 2007; Gottfried, 1984; Hart & Risley, 1995; van Kleeck, 2008).

Children who come from stable and literate-rich homes have large vocabularies which have been nourished since birth (Hirsch, 2001; Snow, 2002). These children have gained knowledge over time through both implicit and explicit means (Hirsch, 2001). They have been read to and exposed to cultural knowledge and vocabulary that their disadvantaged counterparts have not (Hirsch, 2001). Children who have not been exposed to a high volume of language whether it due to SES, learning disability, etc. have to close the gap (Hirsch, 2001; Snow, 2002).

A child from a literacy poor environment who begins school with ineffective teachers and/or instruction will increase their risk of failure, whereas children from literacy rich homes are less at risk for academic difficulties (Chall et al., 1982). To try and eliminate ineffective instruction and the growing gap between low and high performing children, disadvantaged children need more exposure and explicit instruction to build oral language skills and cultural knowledge (Chall et al., 1982; Hirsch, 2001; Quinn et al., 2020; Stanovich, 1986).

It is not surprising children from low SES families, whether they have a learning disability or not, and children who have weaknesses in oral language, struggle to learn to read (Becker, 1977; Catts & Kamhi, 2005). In a longitudinal study conducted by Murphy and colleagues (2016), they found weaknesses in language skills in preschool children correlated to comprehension difficulties in reading five years later. To help close the gap before formal schooling begins, preschool programs have become instituted on both the

state and federal levels. Preschool programs target oral language skills that lead to successful school experiences (Catts et al., 2016; Coyne et al., 2001; Justice et al., 2013).

Regardless of SES, students from poor and rich literacy homes are not achieving successfully past the primary grades. With overall low achievement on fourth grade assessments and many children not being identified with reading difficulties prior to fourth grade, the "fourth-grade slump" seems to be in full force (Catts et al., 2005; Chall et al., 1990). Chall and colleagues (1990) revealed students from low SES homes achieved proficient growth from grades 2-3; however, in grade 4 discrepancies started to appear. One theory for the low achievement past the primary grades is the overemphasis of basic skills (Pearson et al., 2010) and less of a focus on vocabulary, background knowledge, and little exposure to informational texts during the early and primary years (Biemiller, 2001; Chall et al., 1982; Hirsch, 1987; McNamara et al., 2011; Pelatti et al., 2014; Snow et al., 1998).

Problem Statement of the Study

Children from all SES homes, but especially homes considered low-SES, are not achieving reading proficiency by fourth grade. One possibility for low achievement is children do not possess the vocabulary and knowledge to comprehend texts once they are reading independently. Although the state Tennessee has campaigned for the adoption of a knowledge-based curriculum to be used in K-12 classrooms, the knowledge gap begins before formal schooling. Voluntary PreK (VPK) programs in Tennessee target students from low-SES environments to bridge the learning gap, primarily with a skills-based focus. Previous research documented VPK lose their advantage over students who do not attend VPK by first grade (Lipsey et al., 2013). The purpose of the current study is to

determine if incorporating a knowledge-based curriculum impacts vocabulary and content knowledge in preschool students attending VPK in a Title I district in Tennessee beyond the impact of the traditional curriculum.

Overview of Methodology

The present study will use a quasi-experimental research design at the classroom level. Analysis of covariance (ANCOVA) will be used to minimize the effects of group differences (Gall, Gall, & Borg, 2003).

CHAPTER II: REVIEW OF LITERATURE

Vocabulary and knowledge are unconstrained skills that continue to develop throughout a person's life (Cain & Oakhill, 2011). Research suggests both knowledge and vocabulary are independent factors in comprehension (Stahl, Hare, et al., 1991). In a study of sixth graders, Stahl and colleagues (1989) found activating prior knowledge and vocabulary difficulty impacted students' recall of text information, however they did not interact. Children need to have accurate background knowledge and understand the vocabulary to successfully comprehend a text.

Vocabulary is considered to be highly correlated with reading comprehension (Biemiller, 1999; Carlisle et al., 2013). It is estimated an average child learns between 800-900 root words a year. This would accumulate to around 9,000 root words by the end of the elementary years (Biemiller & Slonim, 2001). Word knowledge of that magnitude accrues over time with multiple exposures to the word through various exposures to become part of the student's background knowledge (Spencer & Guillaume, 2006).

Educational initiatives have focused on early literacy because of its critical role in later academic outcomes. Between birth and five years old, oral language skills develop and are a leading predictor of future reading comprehension (Dickenson et al., 2011; NICHD, 2005; Pace et al., 2019; Storch & Whitehurst, 2002). Read-alouds are one of the most effective ways parents and teachers foster oral language, print exposure, academic and domain vocabulary, and comprehension in the early childhood years for all children (Bus et al., 1995; Cunningham & Stanovich, 1997; National Center for Family Literacy, 2008; Scarborough & Dobrich, 1994).

Read-alouds

As teachers and students engage in meaningful conversations around read-alouds, vocabulary and conceptual understanding of ideas foster children's learning (NRP, 2001; Schwanenflugel et al., 2005; Sinatra et al., 2012). During read-alouds, students learn by listening, which is the most effective way they learn until their independent reading equals that of their listening, which occurs around middle school (Sticht et al., 1974). The focus, however, should be on quality of language used in read-alouds, not only the quantity, to ensure comprehension (Rowe, 2012). Simply reading a book to a child will not generate the depth that is needed to for the read-alouds to be effective (Noble, 2019). Depth of comprehension depends on a child's oral language such as vocabulary, background knowledge, and print exposure in addition to phonemic awareness (Albert Shanker Institute, 2009; Biemiller, 2003; Dickinson et al., 2006); which are strong predictors of later reading success (Paris & Stahl, 2005; Snow & Dickinson, 1991; Stanovich et al., 1995; Storch & Whitehurst, 2002).

Incorporating Content

A current challenge is changing ELA practice from a skill focus (i.e., teaching skills in isolation with requiring mastery of one skill before preceding to the next), to exposing children to content and academic vocabulary while incorporating skills (Cervetti & Wright, 2020). With a focus on skills in the early elementary years, content knowledge and vocabulary have not been a priority. Educators will need to include more content and vocabulary in the early elementary years instead of waiting until the middle elementary grades. It will continue to be difficult to bridge the literacy gap of low achieving students or address the "fourth-grade slump" dilemma without early

instruction. Children need to be engaged in informational books along with narratives from the beginning of school if they are to evaluate, synthesize, and apply information in the long-term (Wright, 2014).

When students start learning domain content like science, even in the preschool years, the knowledge will build as they progress through school, especially if there is an alignment and continuity of expectation of content that fosters deep, conceptual learning (Albert Shanker Institute, 2009; Hirsch, 2006; Khan & Justice, 2020; Vygotsky, 1978). Deep, conceptual learning is essential in today's technology world. Kids must problem solve, apply background knowledge to text, make inferences based on accurate background knowledge, and synthesis information from multiple sources to be successful (Anderson & Guthrie, 1996).

To prepare students for the future, mainstream curricula should be a focus. Most curricula, especially preschool and primary grades, are built in themes with brief exposures to content areas that are not connected to allow the deep learning to take place to build content knowledge (Duke & Gray, 2020; Moss, 2008; Winnett et al., 1996). In contrast, content-rich curricula incorporate various texts from multiple genres through read-alouds, while using the context to develop reading and writing skills while building knowledge (Biemiller, 2012; Moats, 2020; Neuman & Roskos, 2012; Pollard-Durodola et al., 2012). Exposing children to multiple genres with content rich information can help reduce the difficulty children face in fourth grade (Jeong et al., 2010). However, this does not seem to be the trend.

Integrating Texts Genres

Exposure to narrative text structure has been predominated in primary classrooms and is important for learning text structure and applying background knowledge to the text (Brandao & Oakhill, 2005; Cain, Oakhill, & Bryant, 2004; Pentimonti et al, 2011). However, Duke (2000) reported teachers spent an average of 3.6 minutes per day reading informational texts. Jeong et al. (2010) concluded in grades 2 through 4, the average time spent on informational text was one minute in second grade and 16 minutes in grades 3 through 4. Yopp and Yopp (2006) found preschool through third-grade teachers read aloud from predominantly fiction (77%), with minimal informational texts (8%), and a small number of mixed genres (14%) (e.g., poetry). Wright (2012) discovered similar trends. Teachers who incorporated read-alouds read 83% from fiction and 17% from informational text.

To initiate a shift in read-aloud selections, the teacher is a critical component. It is recommended classrooms have a 50/50 split between narrative and information texts to help facilitate a content-rich curriculum (Duke, 2013). However, Teachers report informational texts are not developmentally appropriate for the earliest learners (Duke, 2003; Price et al., 2012) and must choose fun, simple books, because they believe kids will not be engaged (Donovan & Smolkin, 2001). Nevertheless, young children, especially boys, often select informational books when given a choice of genres (Caswell & Duke, 1998; Cervetti et al., 2009; Duke, 2000, 2003; Kraemer et al., 2012; Pappas, 1991; Yopp & Yopp, 2006) and with enough exposure can begin to understand the complex syntax in these types of books (Arya et al., 2011; Neuman et al., 2016). Preschoolers can be found pretend-reading informational books in pretend play and

recalling factual details from the text (Duke & Kayes, 1998; Maduram, 2000; Moss, 1997; Pappas, 1993; Tower, 2002). Most importantly, children with little to no exposure to informational texts will demonstrate their lack of knowledge of the genre when they are expected to learn from informational texts by third- and fourth-grades (Kamberelis & Bovino, 1999).

Informational texts are the key to building background knowledge. The National Research Council (2007) reported children are naturally curious about the world around them and come prepared with some background knowledge. This prior exposure allows students to add new knowledge and experiences to their existing schema to develop deeper understandings of science and social studies (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010; Stanovich & Cunningham, 1993). General knowledge is a strong predictor of children's science achievement in the elementary grades (Morgan et al., 2016; Pinkham et al., 2012); with primary teachers allocating around 19 minutes a day for science instruction (Banilower et al., 2013).

Science Integration

Teachers help students gain new ideas and literary experiences by using science informational texts during read-alouds to expose students to scientific vocabulary, concepts, and informational texts features (Donovan & Smolkin, 2002; Snow, 2002). The lack of exposure to informational texts is important since large gaps in science appear as early as third grade and continue to widen throughout the elementary years (Morgan et al., 2016). Incorporating scientific read-alouds are opportunities to build domain knowledge with science vocabulary and begin to link new knowledge to their

background knowledge (Krajcik & Sutherland, 2010; Neuman & Wright, 2013). The more domain knowledge a student has, the greater their ability to learn new vocabulary, increase their fluency, make connections between new and previous learned knowledge, and ultimately deepen their comprehension on the topic (Hirsch, 2003; Kaefer et al., 2015). This fosters richer conversations during the read-aloud and encourages children to use their knowledge to state opinions, evidence, and make inferences based on the text (Brenneman, 2009; Neuman & Roskos, 2012).

Studying a domain knowledge, like science, does not guarantee success in the domain. Young children need scaffolding to help understand new and abstract concepts (Nagy & Townsend, 2012). However, without the opportunity to explore domain topics such as science in the primary years, the gaps in vocabulary, general knowledge, reading, and science content knowledge continues to widen (Neuman, 2003). If children are to achieve academic, social, and economic equality, educators must provide students with developmentally appropriate instruction that builds knowledge as well as skills (Neuman, 2006) and is especially crucial for students from low SES backgrounds (Neuman & Celano, 2006).

Theoretical Frameworks

Reading

For more than three decades, the Simple View of Reading (SVR) has been a prominent reading theory. The SVR states reading comprehension is a product of decoding and language comprehension. The product of these two components influences a child's ability to read (Hoover & Gough, 1990). Both strands are equally important to

overall reading comprehension, however, the focus of this paper is on the language comprehension strand.

Over time, language knowledge continues to expand and becomes the stronger predictor of reading comprehension, due to decoding reaching a ceiling effect (Davis et al., 2017; Hoover & Gough, 2018). Language comprehension can be developed through read-alouds to give children access to vocabulary (Gough & Tunmer, 1986; Scarborough, 2001). Access to vocabulary allows words to become part of their schemata and eventually able to use the word in appropriate contexts both generalized and specific (Christ, 2011).

Knowledge Hypothesis

Because vocabulary can be used as a proxy for background knowledge (Mancilla-Martinez & McClain, 2020) both components are critical factors in reading achievement. Anderson and Freebody's (1981) knowledge hypothesis states that word meaning should be learned in conceptual frameworks rather than in isolation. Words should be learned as concepts which are connected to other concepts that develop into a person's schema. New material is easier to learn if it can be connected to an existing schema (Willingham, 2006) and taught in relation to content (Mancilla-Martinez & McClain, 2020).

Schema. Schema extends beyond domain specific knowledge to go across content domains. Mental representations are constructed of an individual's accumulated knowledge (Bartlett, 1932). For example, when a person plants something, their schemata incorporate all their knowledge of planting not just the particular item they are planting (Rumelhart & Ortony, 1977). Schema theory was tested using the topic of laundry. Bransford and Johnson (1972) had participants read a paragraph about laundry.

Some of the participants knew the topic before reading the paragraph and the rest did not. The ones who did not know the topic beforehand performed poorly on the recall task. The reason explained by the schema theory is the participants could not activate their prior knowledge, or schema of laundry, to help understand the passage (Bransford & Johnson, 1972).

The knowledge a person has on a topic, even in young readers, highly correlates to their comprehension of the topic (Bjorklund & Buchanan, 1989; McNamara et al., 1996; Pearson et al., 1979). Expertise in a domain depends more on a person's knowledge than on their IQ (Chi, 1978) and can compensate for low-reading skills (Cervetti & Wright, 2020). When knowledge bases are equal, low skilled readers remember as much as high skilled readers. Comprehension becomes the ease in which students can retrieve or active the needed information from their memory rather than the skill of reading the text (Bjorklund & Bernholts, 1986). However, skilled readers with prior knowledge are more sensitive to low and high coherent passages as compared to low-skilled readers (Johnston & Pearson, 1982), demonstrating an interaction between text cohesion and knowledge (O'Reilly & McNamara, 2007; Ozuru et al., 2009).

A reader must connect new learning to their schema, to gain a new understanding of a text. The situation model allows for a deeper understanding of a text past basic recall questions (Best et al., 2008; Johnston, 1984; Kintsch, 1986; Kintsch & van Dijk, 1978). Students connect learning from their short-term memory to knowledge in their long-term memory. The overlap between new knowledge from a text and existing knowledge is necessary for optimal learning. This "learnability" zone should overlap enough for a reader to get the gist of the text, but still be able to learn something new and produce

inferences especially with informational texts (Anderson et al., 1977; Kintsch, 1994; van Dijk & Kintsch, 1983; Wolfe & Woodwyk, 2010).

Background Knowledge

Background Knowledge is a general term to describe information a person has accumulated. This knowledge is activated to help children form a situational model to understand the topic being learned (Tunmer & Hoover, 2019). Knowledge does not occur at one time point, rather it is a process of integrating new concepts with a person's existing knowledge (Adams, 1990). This knowledge continues to grow and increase exponentially as students are exposed to more knowledge. Students with richer background knowledge, regardless of skill ability, can connect information to their schemata to form a more accurate situation model and read more fluently which frees up cognitive process for better comprehension (Kaefer et al., 2015; Wexler, 2020; Willingham, 2006).

Research supporting the importance of background knowledge dates back 5 decades from children to adult participants (e.g., Anderson et al., 1977; Arya et al., 2011; Rawson & Kintsch, 2002; Shapiro, 2004; Talwater et al., 2018). In Recht and Leslie's (1988) baseball study, sixty-four middle-schoolers were divided into groups of high-ability and poor-ability readers based on a standardized reading measure. They were administered a baseball knowledge test and students with high-reading ability and high knowledge of baseball performed best on outcome measures. However, the next highest performing group was students with low-reading ability but high baseball knowledge. Students with high reading ability but low baseball knowledge scored about the same as student with low-ability and low knowledge of baseball.

Background knowledge is present as early as preschool. Kaefer and colleagues (2015) conducted a study using birds as the topic to determine how background knowledge impacts the youngest learners. They found significant effects of background knowledge between low and middle-income children with middle-income children having more background knowledge about birds, learned more novel words out of context, and demonstrated greater comprehension. Both SES groups performed comparable when words were in familiar contexts. The results also demonstrate background knowledge plays a role before formal schooling begins (Kaefer et al., 2015).

When students are equipped with background knowledge, they are able to make more inferences and recall the most important information of a text, such as the main idea and key details (Afflerbach, 1990; Stahl & Jacobson, 1986). Basic recall questions can be answered from text, whereas probing or inferencing questions often require the background knowledge in addition to the text (Hanenggi & Perfetti, 1992; Marr & Gormley, 1982). Younger children may require more repetition to learn the content (Barnes et al., 1996), but are still capable of acquiring new knowledge (Hirsch, 1987).

Studies have demonstrated that children who have inaccurate prior knowledge on a topic often allowed this inaccuracy to override information stated in the text (Alvermann et al., 1985). Lipson (1982) presented third grade students with eight different texts to read and then administered pretests to determine their prior knowledge. Students who had accurate prior knowledge performed the best on the outcome measures. Whereas students who had inaccurate prior knowledge performed worst on the posttest on items that contradicted their prior knowledge. This inaccuracy hindered their learning.

When children have inaccurate background knowledge, they often let the inaccuracy override the learning of new content. The contradiction then impacts comprehension monitoring and ultimately comprehension (Kendeou & van den Broek, 2007; van Loon et al., 2013) and forms inaccurate situational models. It is important to understand children's prior knowledge, even if it is inaccurate, to guide them to accuracy by rich discussions with probing questions and inquiries (Anderson & Nagy, 1993). Teachers lead discussions and give accurate and explicit information necessary to understanding a text. This is especially important for building knowledge and correcting inaccurate knowledge (Dole et al., 1991).

Vocabulary

Vocabulary knowledge can be divided into two components: breadth and depth. The breadth of one's vocabulary is the quantity of words they know. However, the depth of vocabulary knowledge is the ability to know a word and use it correctly in multiple situations; such as multi-meaning of a word (Anderson & Freebody, 1981). Both components are important because the ultimate goal is for a reader to apply their vocabulary knowledge appropriately so their word knowledge can continue to grow as they encounter more words (Beck & McKeown, 1991).

Children who are identified with reading difficulties tend to have weak vocabularies (Snow et al., 1998; Spencer et al., 2019). Vocabulary, as early as preschool and kindergarten, predicts reading comprehension in middle elementary and high school (Biemiller, 2003, 2005; NRP, 2000; Ouellette & Beers, 2010; Roth et al., 2002; Scarborough, 2001; Thorndike, 1973). For students to learn to read, vocabulary growth must start before they can read independently (Stahl & Nagy, 2006).

Children must know the meaning of words used by parents, teachers, texts, etc. to understand new ideas, this includes understanding words that have multiple meanings and knowing which definition to use (Adams, 1990). The more words a reader knows, the easier it is to learn new words (Stahl & Nagy, 2006) and improve comprehension (Hirsch, 2006; Nagy, 2005). In a study by Tunmer and Chapman (2012), they found vocabulary influences reading comprehension both directly and indirectly. In addition, when vocabulary is considered its own component, its contribution was above and beyond that of word recognition and listening comprehension.

In Hart and Risley's (1995) iconic study of language experiences in homes of various SES families, the differences were staggering. By four-years-old, the average child from a professional family was exposed to around 45 million words, compared to 26 million words of a child from a working-class family, and 13 million words of children in welfare families. In a continuation of this data, they found for the 29 participants, the rate of the vocabulary growth at three-years-old was strongly correlated with language skills and reading comprehension at nine- and ten-years-old (Hart & Risley, 2003).

Recent studies report variations to Hart and Risley's results. A replication study revealed the gap might not be as large between the SES classes, when one considers all caregivers and not just the primary (Sperry et al., 2019). The quality of vocabulary children is exposed to versus the quantity are important factors (Golinkoff et al., 2019). General overheard adult speech lacks the richness to help children learn new words to connect to their prior knowledge. Conversations with children should be engaging, meaningful, and interesting to children (Golinkoff et al., 2019). Weizman and Snow

(2001) reported the number of sophisticated words and the depth to which they were used contributed to vocabulary and reading comprehension in the kindergarten and second grades. In another study examining neural processing, the conversational experience (the number of conversational turns between an adult and a child, not the number of words), impacts language skills beyond that of SES and quantity of words (Romeo et al., 2018).

Regardless of SES, vocabulary in all its facets including quantity and quality of words, plays a critical role in reading comprehension. Students enter kindergarten with varying degrees of vocabulary knowledge (Biemiller, 2012). By second grade, the biggest difference is apparent between the low and high vocabulary children (Biemiller & Slonim, 2001) with close to a 4,000-root word gap and 2,000 between the average and low quartiles which is equivalent to two grade levels (Biemiller, 2005).

The average child will encounter between 500,000 to 1,000,000 words of text as they continue through the ninth grade (Nagy & Anderson, 1984). Considering the hundreds of thousands of words children will be exposed to during their school careers, the best estimate is that the average child learns about 3,000 new words a year. Avid readers could learn between 5,000 to 10,000 new words (Anderson & Nagy, 1993). If possible, children with low vocabularies would need to learn an additional 1,000-1,500 words to catch up, which is about 25 words per week (Biemiller & Boote, 2006). However, even the addition of 10 words per week over a school year can greatly impact a child's vocabulary (Biemiller, 2012).

Because the difference appears early in life and the vocabulary gap continues to increase, prevention and early intervention is necessary especially for children at risk. It is in the preschool and primary grades that a foundation for vocabulary can be built

(Baker et al., 1998; Biemiller, 2002; Rand, 2002; Stahl & Nagy, 2006). Vocabulary instruction should make kids curious about words and be word conscious. Discussing words in texts, hallways, posters, conversations, etc. and bringing them into the classroom can foster this curiosity (Anderson & Nagy, 1993; Stahl & Stahl, 2012).

With the amount of vocabulary needed to be successful, vocabulary instruction and exposure is essential and can be accomplished in whole-group or small-group settings (Neuman & Kaefer, 2013). To combat this issue, definition instruction has dominated vocabulary instruction in education with minimal effects. The last several decades of vocabulary research suggest there is no one perfect vocabulary instruction, rather a combination of approaches depending on grade levels and skill level (Bos & Anders, 1990; Elleman et al., 2017; Nagy, 2005; NRP, 2000).

Vocabulary learned by explicit instruction is especially important for children who have low vocabulary exposure (Cain, Oakhill, & Lemmon, 2004; Coyne et al., 2004; Jitendra et al., 2004; Nagy & Scott, 2000). Teaching vocabulary prior to reading a text helps all student learn essential words to understand text (Collins, 2009; Elleman et al., 2017; Graves, 2006; NRP, 2001; Silverman, 2007). Some text, especially informational, require explicit instruction if it is complex with new concepts (NRP, 2000). When students, especially students with initial lower vocabularies, are presented with a difficult or novel text, the chances of a reader learning an unfamiliar word is minimal (Anderson & Nagy, 1993; Coyne et al., 2004; Robbins & Ehri, 1994; Se′ne′chal et al, 1995). Teachers need to model and encourage children to identify unknown words and celebrate their willingness to learn (Duke, 2013).

Teaching target words through explicit instruction allows students to focus on overall comprehension versus word level comprehension (Perfetti, 1985). This is important when introducing children to academic or content vocabulary. Academic words, or words that are common in school, need to be taught to students because they are relevant across subject areas and will support a student's learning (Baker et al., 1998; Foorman et al., 2016). To achieve this, depth of vocabulary instruction is required.

To be a successful comprehender, additional methods such as incidental exposure to explicit instruction have to be incorporated (Nagy & Anderson, 1984; Stahl, 1986). Children learn a large percentage of words through incidental exposure (NRP, 2000). Children's literature is abundant with complex vocabulary (Hayes & Ahrens, 1988). Children can learn vocabulary through read-alouds and class discussions without explicitly teaching every unknown word (NRP, 2000; Stahl & Nagy, 2006) with positive impacts on reading comprehension outcomes (Cain & Oakhill, 2011; Ouellette, 2006). Children who learn vocabulary through repetition of rich literature, can be sustained months later (Brett et al., 1996; Nash & Snowling, 2006).

Students learn target words when they see them multiple times in different contexts which allows for a deeper understanding (Anderson & Freebody, 1981; Anderson & Nagy, 1993; Gipe, 1979; Nagy & Scott, 2000; NRP, 2001; Stahl & Fairbanks, 1986; Wasik & Bond, 2001). Depth of word knowledge is necessary to use a vocabulary in correct contexts that often requires knowing multiple meanings of words (Beck & McKeown, 1991; Beck et al., 1987; Cronbach, 1943). These nuances of word meanings are important to create accurate situational models (Anderson & Nagy, 1993).

Vocabulary in Preschool

Learning vocabulary in contexts prepares a reader for comprehension (NRP, 2000). Complex vocabulary can be introduced at the preschool level in terms young learners can understand and build on throughout their school careers (Biemiller, 2001; Lieberman, 1967). Vocabulary, even scientific vocabulary, should be taught to the youngest learners (Gelman & Brenneman, 2004). Words should be selected carefully and taught in concepts to connect to a child's schema and through concepts. Vocabulary words that are essential to understand the story can usually be explained by student-friendly definitions or synonyms (Biemiller & Boote, 2006; Elley, 1989; Justice et al., 2005; Penno et al., 2002).

Preschoolers often learn words of objects, actions, or definition through fast-mapping (Albert Shanker Institute, 2009; Carey 1985). However, deeper conceptual knowledge can begin by extending the knowledge about concrete nouns and verbs by learning their function and/or action (Booth, 2009; Booth & Waxman, 2002; Hadley et al., 2015). Children also learn words through taxonomies. This occurs mostly in informational texts where concepts are learned and can be generalized across content domains like science and social studies (Hadley, 2017; Nelson et al., 2008). Neuman and colleagues (2011) used the World of Words program as an intervention to determine if children in Head Start would learn and retain the knowledge of words taught through taxonomic categories. The intervention group outperformed the control group and utilized categories to identify new words. This learning was sustained six months later.

Interactive Read-Alouds

Reading aloud to children has been a long-standing tradition with emergent learners and benefits children of all SES backgrounds (Adams, 1990; Blok, 1999; Bus et al., 1995; NRP, 2000; Robbins & Ehri, 1994; Snow, 1991; Stahl, Richek, & Vandevier, 1991; Whitehurst et al., 1999). Even in the home before a child starts their formal education, read-alouds have positive impacts on oral language including vocabulary (Bus et al., 1995; Mol & Bus, 2011; Mol et al., 2008; Whitehurst et al., 1988). Multiple exposures to words through read-alouds and discussions (Dickinson et al., 2019) impact phonological and semantic skills as well. These two components along with oral language skills provide a strong foundation for reading success (Landi & Perfetti, 2007).

Reading aloud to children provides an opportunity to expose children to words outside of everyday conversations. Children learn words they hear the most, around things that interest them, and in meaningful contexts (Hirsh-Pasek & Golinkoff, 2012). If a child cannot recognize a word when they hear it, they will not be able to comprehend what is read to them (Se′ne′chal et al., 2006; Sticht et al., 1974). Children's books average 30.9 rare words per 1,000. This is more than all adult conversation and television (Hayes & Ahrens, 1998).

Exposure to these rare and rich vocabulary has implications for vocabulary growth (Cunningham & Stanovich, 1998) and additional gains with extended activities (McKeown & Beck, 2014; McKeown et al., 1985). Read-alouds designed to increase vocabulary and content knowledge should be about two grade levels above the student's level (Fisher et al., 2004; Pollard-Durodola et al., 2018; Walsh, 2003). This gives

children an opportunity to hear and discuss interesting, yet complex text that is beyond their decoding skills to build language and knowledge (Hirsch, 2006).

Teachers should be deliberate in their read-aloud planning. This includes selecting appropriate books that align to standards and objectives, choosing both informational and narrative texts, understanding the complexity of the book, choosing target words, understanding which words need explicit instruction, simple explanations, and which do not, incorporating background knowledge, understanding the ideas of the text, and model reading with fluency and expression (Beck & McKeown, 2001; Biemiller, 2012; Fisher et al, 2004; Pentimonti et al., 2010; Pollard-Durodola et al., 2012).

When reading aloud complex texts to children, rich discussions during read-louds help encourage children to learn new ideas and relate them to previous learning or experiences (Brabham & Lynch-Brown, 2002; Beck & McKeown, 1991, 2007; Fisher et al, 2004; Hirsch, 2003, 2006; Justice, Jiang et al., 2018; Lennox, 1995; NRP, 2001; Stahl & Nagy, 2006; Walsh, 2003) and learn new vocabulary that has positive impacts on vocabulary outcomes (Baker et al., 2013; Elleman et al., 2009; Gonzalez et al., 2014; Mol et al., 2009; Zucker et al., 2013). This is essential when some children come to school with less communication experiences than others (Hart & Risley, 1995). A rich literature environment provides opportunities to develop vocabulary and concepts through rich conversations between teacher and students which builds a knowledge base for understanding a text and relating future texts (Duke & Pearson, 2002; Se′ne′chal et al., 1995; Sinatra et al., 2012).

One of the most recognized and researched strategies to engage children in read-alouds is through dialogic reading (e.g., Arnold et al., 1994; Flack et al., 2018; Hargrove & Se′ne′chal, 2000; Swanson et al., 2011; Zevenbergen et al., 2003). In dialogic reading, teachers preplan questions throughout the read-aloud to encourage conversation with students beyond the yes or no type answers (Lonigan & Whitehurst, 1998; Whitehurst & Lonigan, 1988). Dialogic reading both in homes, preschools, and in primary grades can have positive outcomes for emergent literacy (Wasik & Bond, 2001; Whitehurst et al., 1999; Whitehurst, Epstein, et al., 1994).

A main characteristic of dialogic reading is including open-ended questions. Open-ended questions allow children to elaborate on their thinking, learn and use new vocabulary from the read-aloud, and express their feelings. Extending their conversations after the read-aloud, encourages children to make connections outside of the read-aloud to make inferences (Dickinson & Smith, 1994; Duke, 2003; Foorman et al., 2016; Shanahan et al., 2010; Walsh & Blewitt, 2006; Wasik et al., 2006). When teachers use dialogic strategies, especially with informational texts, teachers and children make more references to target vocabulary and make more contextualized and decontextualized references (Cochran-Smith, 1984; Dickinson & Porche, 2011; Dickinson & Tabors, 2001, 2002; Ezell & Justice, 2005; Hindman et al., 2012; Price et al., 2009; Price et al., 2012; Wasik & Hindman, 2014).

Dialogic strategies, similar to extratextual talk (Blewitt et al., 2009), OWL (Dickinson et al., 2009), and Text Talk (Beck & McKeown, 2001, 2003, 2007), incorporate questioning before, during, and after reading aloud and elicits the use of vocabulary from the read-aloud. It is the questions that foster the learning throughout the

text. Hearing new words in repetition can help increase the breadth of vocabulary knowledge, but the depth comes from engaging children in talking and thinking about words and ideas past the reading of the text.

To get children talking, teachers can incorporate think-alouds in addition to questions. Teachers model their thinking through think-alouds to demonstrate inferential thinking when students cannot respond to questions (Duke, 2013; Tompkins et al., 2013; Zucker et al., 2010). Students' lack of response can be due to lack of background knowledge. Think-alouds are a way to model how to connect a person's background knowledge to a new topic or concept, creating a new situational model for that idea (van Kleeck, 2008). This is especially useful during informational read-alouds when information may be new to students and students need encouragement to engage in discussions and questions (Foorman et al., 2016; Zucker et al., 2010).

Content Literacy in Young Students

As discussed earlier, knowledge comes in many forms, world to academic to content or domain, knowledge is essential to reading comprehension (Connor et al., 2017; Hirsch, 2006; Snow, 2010). Content knowledge focuses on domain knowledge like science and social studies (Connor et al., 2017) but little attention has been paid to it in reading research (Catts, 2018) especially during English Language Arts (ELA) instruction. In addition, little research has focused on systematically building knowledge to support comprehension (Cervetti & Wright, 2020).

Teaching in concepts, like content knowledge, can help students learn new concepts by building on their existing schemata. The interrelationship between new and existing knowledge, anchors complex vocabulary and ideas to where the overlap of prior

knowledge and new knowledge is manageable (Anderson & Nagy, 1993). Children begin building knowledge by listening to texts and applying it to the world around them. Literacy concepts, both informational and narrative, create experiences for understanding new ideas (Anderson & Guthrie, 1996), including when they are taught in the context of a content area (Beck et al., 1982).

When content read-alouds are implemented, the science domain has received most of the attention (Arya et al., 2011). Incorporating science read-alouds is needed especially when primary teachers (grades 1-4) spend less than 30 minutes a day on science instruction (Blank, 2012) and kindergarten teachers spend around 2.3 minutes on science instruction and 1.6 minutes per day on informational read-alouds (Wright, 2014; Wright & Neuman, 2014). This is a decrease from Duke's, report of 3.6 minutes (2000). Therefore, including content literacy during ELA instruction is necessary and benefits both reading and science comprehension (Morrow et al., 1997).

As noted earlier, science is a viable domain to incorporate with primary and young learners because they are curious about the natural world around them (e.g., Pappas, 1991; Yopp & Yopp, 2006). Although science vocabulary can seem technical and too advanced for young learners, students can learn these terms when connections are made to prior knowledge. For more advanced or primary students, teaching students that most scientific terms have Greek or Latin roots is helpful (Anderson & Nagy, 1993). Once children learn, it can make learning new scientific vocabulary easier (Anderson & Nagy, 1993).

Incorporating the 50/50 split between narrative and informational genres can illuminate their intertextual relationship. Text sets compiled to build knowledge around

topics or content can be implemented in primary classrooms including both literature and informational texts to benefit vocabulary and reading comprehension. However, few primary classrooms succeed with aligning read-alouds in text sets to a unit of study (Hoffman et al., 1993).

There are a few studies in the primary grades that explored science read-alouds, some during ELA and others during science instruction. Varelas and Pappas (2006) conducted a study using read-alouds in two primary classrooms with two units, States of Matter and the Water Cycle. They found intertextuality discussion was evident in classroom discourse. The students were able to connect the multiple texts through discussions to further their understanding of each topic using both narrative and scientific language.

Romance and Vitale (1992) investigated the integration of ELA and Science instruction into a two-hour lesson using the science textbook with fourth graders using the in-depth expanded application of science (IDEAS) model. This integrated approach used content reading strategies (main idea/cause-and-effect), hands-on activities, science textbooks, along with trade book reading assignments. The intervention group produced significantly greater results on standardized measures and students displayed positive attitudes towards science compared to their counterparts (Romance & Vitale, 1992).

In a later study, Romance and Vitale (2001) conducted a 5-year longitudinal study of the IDEAS model with students in second through fifth grades regardless of reading ability. The authors reported positive effects for science ($d = 0.93$) and reading assessments ($d = 0.3$). Additionally, students displayed positive attitudes toward learning science and self-confidence in reading (Romance & Vitale, 2001).

To expand the idea of ELA and science integration, Vitale and Romance (2012) conducted a study in first and second grade classrooms. The intervention included daily 45-minute lessons throughout the school year. The core-concept "clusters" integrated science and literacy. Results were consistent with previous studies with intervention students scoring significantly higher on reading and science standardized assessments compared to the control group (Vitale & Romance, 2012).

Anderson and Guthrie (1996) developed a science literacy instructional framework that through concept learning and motivation. The intervention was comprised of seven dimensions: classroom contexts are observational, conceptual, self-directed, strategic, collaborative, self-expressive, and coherent. During the intervention, students became experts on topics they chose to learn about (Anderson & Guthrie, 1996).

In another study using the same intervention, Anderson and Guthrie (1999) implemented the intervention with third graders. The intervention group who combined observational activities with texts, outperformed the business as usual (BAU) group who only used observations (Anderson & Guthrie, 1999). In another study with third and fifth graders, Guthrie and colleagues (1999) conducted a quasi-experimental intervention that compared traditional reading and science instruction with the intervention. The intervention included the integration of reading/language arts and science instruction. Intervention students demonstrated more engagement and conceptual learning than their counterparts (Guthrie et al., 1999).

Guthrie and colleagues (2004) compared the CORI intervention to strategy instruction (SI) (without motivation) and traditional instruction (TI) with third graders. Intervention students scored higher than SI and TI students on measures of reading

comprehension, motivation, and strategies. Intervention students also scored significantly higher on the standardized reading assessment as compared to SI (d = 1.48) and TI (d = 2.75) groups (Guthrie et al., 2004). In a follow up study with fifth graders, intervention students outperformed their counterparts on reading comprehension and content knowledge. The effect size for reading comprehension was moderate (d = 0.59) with large effect sizes for content knowledge (d = 1.59) (Ecological knowledge for this study) and word recognition (d = 0.87). This method was successful for both low and high achieving students (Guthrie et al., 2009).

In 2017, Connor and colleagues conducted the intervention with 418 students in kindergarten through fourth grades. The lessons contained four phases: connect, clarify, research, and apply (Connor et al., 2014). Large content treatment effects were found for students in the intervention (d = 2.10) when compared to the BAU group. In addition, students in intervention classrooms outperformed the BAU classrooms with positive, significant effects on measures of vocabulary (d = 1.20), oral language (d = 0.47), and passage comprehension (d = 0.22) for the CALI fourth graders (Connor et al., 2017).

Cervetti and colleagues (2012) created a unit of study around the concept of light. The intervention consisted of 40 sessions with four investigations per 10 sessions. The intervention included reading text sets, investigations, discussions, and writing. Teachers in the BAU group completed a similar unit using their normal curriculum. The intervention group scored predominantly higher on the science understanding, writing, and vocabulary measures with small (d = 0.23) to moderate (d = 0.40) effect size. Students in both groups performed about the same on reading outcomes.

In another study, Cervetti and colleagues (2016) examined text sets with fourth-grade students. The intervention group read a set of conceptually coherent text sets about birds. The BAU group read a set of unrelated informational set of texts. The intervention group acquired word knowledge from incidental exposure as they read the text set. At posttest, intervention students had more knowledge of the words, even considering the intervention group had rarer words as compared to the BAU group's texts. This indicates that reading conceptually coherent text has a benefit to vocabulary and knowledge building with moderate to large effect sizes for knowledge (d = 1.18), elaborations (d = 0.73), general academic words (d = 0.48), concept words (d = 2.38), and retelling (d = 0.61) and small effects for reading comprehension (d = 0.13) (Cervetti et al., 2016).

In addition, background knowledge was a significant predictor of posttest results. Students who knew more about birds prior to studying the unit, scored better than those with little to no prior knowledge. This study emphasized the ability to use ELA instruction not just as a means of exposure to genres, but as an approach to building general and content knowledge. This concept is especially important for children who come to school with less academic and content knowledge to try and eliminate the Matthew Effect in reading comprehension (Cervetti et al., 2016).

Kim and colleagues (2020) applied the unit concept in a study that included first grade students involved in a 10-day unit covering the topic of Artic animal survival taught by the classroom teachers. The intervention focused on helping students connect new learning to existing schema while learning the domain knowledge with conceptually connected science texts, concept maps, argumentative writing, read-alouds, and

discussions. The study had three conditions: school only, school plus home, and traditional school. Positive and significant results were found for the intervention group in depth of vocabulary knowledge of target words (d = 0.56), listening comprehension (d = 0.40), and argumentative writing (d = 0.24). The intervention improved reading comprehension while not having and adverse effect on basic skills. However, there was evidence of Matthew effect concerning vocabulary. In addition, the intervention condition did not have a statistically significant effect on reading engagement measures.

Wright and Gotwals (2017) implemented a curriculum with high-poverty kindergarten classrooms. The 20-day unit incorporated best practices of asking questions, engagement, science exploration, interactive read-alouds, discussions, and emergent writing. Students in the intervention outperformed their counterparts of science vocabulary and making claims and supporting those claims. Their findings support the concept that young learners can learn and understand science discourse.

In young students, promising results have been found for incorporating content instruction in the primary classrooms. From kindergarten to first grade students, positive effects were evident in vocabulary, discussing content, and writing (Kim et al., 2020; Wright & Gotwals, 2017). Unfortunately, Matthew effects were present as well (Kim et al., 2020).

In the remaining studies with a focus on 3rd and 4th graders primarily, positive effects were found in multiple areas. Positive results were found for vocabulary, content discussions, and retellings (Cervetti et al., 2016). In addition, positive findings were evident for science knowledge, intertextuality discussions, integrating reading strategies with science texts, writing in scientific format, and oral language. For standardized

measures, positive results were indicated on reading and vocabulary assessments (Anderson & Guthrie, 1996; Connor et al., 2017; Romance & Vitale, 1992; Varelas & Pappas, 2006).

Preschool

Young learners are curious about their world around them. Discussions, as previously documented, provide opportunities to explore ideas especially around science (Brenneman, 2009). Besides basic skills, knowledge is an important predictor of literacy development and academic success in young children (Pinkham et al., 2012). Incorporating science content into ELA instruction has demonstrated some promising outcomes on building academic and content knowledge specifically in our primary grades (e.g., Cervetti et al, 2016; Connor et al., 2017; Guthrie et al., 2009; Wright & Gotwals, 2017). Integrating high-quality content in preschool children's vocabulary helps prepare them for kindergarten and future reading success (Albert Shanker Institute, 2009). Since the gap appears before most students come to school (Hart & Risley, 1995), what has been researched at the preschool level to help close this knowledge gap?

Preschoolers learn words at an amazing rate during the first years of school. Preschoolers are capable of learning complex vocabulary and ideas especially when they are engaged in learning about concepts in their environments through read-alouds and rich discussions (Gelman & Brenneman, 2004; Leung, 2008).

Conezio and French (2002) created a program to connect knowledge about the world with preschoolers in Head Start. The thematic modules consisted of science-centered read-alouds followed by center activities. Read-alouds included both narrative and informational texts. The curriculum was built in four modules with each module

containing 10-12 lessons. The lessons are designed to build vocabulary, literacy skills, problem solving, and interaction around science concepts. French (2004) included the curriculum in an intervention study. Preschoolers in the intervention had statically significant higher receptive vocabulary from pre- to posttest compared to the BAU group (French, 2004).

Peterson and French (2008) again used the same curriculum with preschoolers. This time the purpose was to see if adult-child discussion nurtured the development of a child's explanatory language. In a unit about color mixing, Head Start students engaged in conversations with their teachers and peers about the color mixing concept. Throughout the intervention, the children used color terms to explain color mixing activities. Teachers supported and scaffolded students learning by encouraging observations and predictions as well as creating an environment of scientific discourse in which children were immersed in throughout the activities and the unit.

Roskos and colleagues (2008) implemented an intervention using three units of a curriculum with topics of interest to preschool children (e.g., transportation, animals). The primary focus of the intervention was vocabulary acquisition of root and rare words, with students recalling more root or basic words than rarer ones. An additional finding was typical achieving students made greater growth in vocabulary over time compared to children at-risk or children with special needs (Roskos et al., 2008).

Pollard-Durolola and colleagues (2011) implemented an intervention that incorporated Texas's preschool standards and Core Knowledge topics. Teachers taught the curriculum using an overarching science theme with smaller topics so children could connect their background knowledge to the new knowledge in the curriculum. The

curriculum included best practices which combined explicit instruction with interactive read-alouds to foster vocabulary and concept knowledge. Read-alouds were a mixture of narrative and informational texts. No statistically significant effects were found on standardized measures of vocabulary, however, on proximal measures, there were statistically significant main effects for both receptive and expressive vocabulary (Pollard-Durodola et al., 2011). This finding on researcher versus standardized measures are consistent with previous research that proximal measures are more sensitive to vocabulary interventions as compared to standardized measures (Elleman et al., 2009; Marulis & Neuman, 2010; NRP, 2001; Stahl & Fairbanks, 1986).

Gonzalez and colleagues (2011) examined a read-aloud intervention implemented by classroom teachers with preschool children from low-income families. The focus was on science and social studies read-alouds to build vocabulary and content specific knowledge. The intervention consisted of four themes, two social studies units and two science units, completed over an 18-week period with daily 20-minute lessons. Statistically significant effects were found for researcher-developed measures on content specific measures of both expressive (d = 1.01) and receptive (d = 1.41) vocabulary, and standardized measure of receptive vocabulary. Again, students who scored higher at pretest scored higher at posttest

Neuman and colleagues (2016) conducted an intervention study using the WOW curriculum that builds domain knowledge through read-alouds and activities with primarily low-income preschoolers. The intervention included four 2-week topics with a supplemental vocabulary and concept knowledge component. Standardized and researcher-designed assessments were used as outcome measures. Children in the

intervention group outgained their counterparts on conceptual knowledge and science vocabulary, effect sizes of 0.33 and 1.10 respectively. The growth of conceptual knowledge indicated a child's depth of understanding that helps connect new knowledge to prior knowledge. Intervention students were also able to use text features through the read-alouds and discussions. Finally, the pattern continues, students with lower initial vocabulary knowledge scored lower on posttest, however, the rate of the learning was the same for both low and high-vocabulary knowledge students (Neuman et al., 2016).

Neuman and Kaefer (2018) implemented read-alouds to promote vocabulary and content knowledge building in science in preschool and kindergarten study. Findings demonstrated statistically significant effects, with preschoolers making larger gains (d = 1.14) compared to the kindergarteners (d = 0.48). Standardized measures of vocabulary indicated large effects for expressive vocabulary (d = 0.94) for preschoolers but not for kindergarteners (d = 0.03) with negligible benefits for either grades on receptive language. Overall, compared to their counterparts in preschool and kindergarten, the intervention had larger effects for preschool intervention students than kindergarten students.

Overall, implementation of science instruction through read-alouds have found positive effects for students in grades prek-5. Encouraging outcomes in vocabulary, content knowledge, writing, and overall reading comprehension are evident. However, a concern is the noted Matthew Effect in some of the studies (Gonzalez et al., 2011; Neuman et al., 2016; Roskos et al., 2008).

Present Study

The purpose of the present study is to investigate integrating science content read-alouds from a knowledge-based curriculum to promote vocabulary and content knowledge in preschool. This research will add to the current literature of exposing emergent learners to content vocabulary and knowledge through a mixture of informational and narrative interactive read-alouds within a knowledge-based curriculum. Best practices for read-alouds suggest selecting texts of both narrative and informational that are conceptually linked to build vocabulary as well as connect new knowledge to a child's prior knowledge through rich discussion and explicit teaching of new vocabulary essential to comprehension. The primary goal of this research was to answer the following questions:

1. What is the effect of a knowledge-based curriculum with interactive science read-alouds on researcher-designed vocabulary?
2. What is the impact of a knowledge-based curriculum with interactive science read-alouds on listening comprehension?
3. What is the effect of a knowledge-based curriculum with interactive science read-alouds on researcher-designed content knowledge?

CHAPTER III: METHODS

Research Design

This study was a pretest posttest control group quasi-experimental research design using an intervention and business as usual (BAU) comparison. Six teachers at five schools were included in the study. All teachers were females and have bachelor or advanced degrees. Nine preschool teachers were given the option to implement a knowledge-based curriculum in their classrooms. Three teachers volunteered to use the curriculum to make up the intervention group. Three additional classrooms were selected that closely matched the demographics of the intervention classrooms for the BAU group.

Participants

Participants 89 preschool students attending Voluntary Pre-K (VPK) program implemented in public schools. All students were eligible to participate since this was a tier 1 curriculum. Participants were predominantly children from low-income homes as VPK is a grant that emphasizes enrollment of low-income students. All participants attended the same Title I school district in Tennessee. The district uses direct certification which calculates poverty based on the children from households who participate in the Supplemental Nutrition Assistance Program (SNAP), in foster care, identified as homeless, and federal poverty guidelines.

Procedures

The unit of study, Animals, is the third unit or domain in the Core Knowledge curriculum (Core Knowledge Foundation, 2014). The Core Knowledge curriculum is a knowledge-based curriculum designed to build across the school year and vertically across grades. The read-alouds are above grade-level reading to include important

information children cannot access independently (Hirsch, 2013). The science-related units develop vocabulary and concepts by building on children's background knowledge (Hirsch, 2006). The read-alouds contained scripted questions, think-alouds, and discussion prompts that engaged children around the topic. This interactive read-aloud allowed for a deeper understanding of the topic and vocabulary introduced in the unit.

The Animals unit consisted of 16 total days of instruction. Fourteen days were for direct instruction, two days were for Pausing Point days, and one day for assessments. Daily lessons lasted around 30-minutes. Pausing Point days were opportunities to review, reinforce, and extend learning from the first part of the unit. The intervention took four total weeks. This included pretest and instruction.

The units have two components: Skills instruction and Listening and Learning instruction. The Listening and Learning component incorporates interactive read-alouds, read-aloud reviews, and explicit vocabulary instruction in effort to provide students with experiences to develop domain-specific vocabulary and content knowledge (Core Knowledge Foundation, 2014). For this intervention, the teachers only used the Listening and Learning component.

Skill instruction was taught as normal at a different time in the day. Skill instruction in this unit covered early literacy skills. These skills included syllable blending and segmenting, fine motor skills, initial sound identification, and working with letter/sound m.

Intervention Condition

The interactive read-alouds were a mixture of high-quality texts of both fiction and informational as seen in Appendix A, Table 1. Picture Talks were used to engage

students in rich discussions and were initiated through read-alouds, image cards, and transition cards. Samples can be found in Appendix C. Explicit vocabulary instruction was given for specific content words that deepened a child's understanding of the words and comprehension of the information (Core Knowledge Foundation, 2014).

Teachers in the intervention group participated in a 1-day professional development (PD) training led by the researcher. The day focused on implementation of the unit, so it was taught with fidelity across the intervention groups. The curriculum suggested teachers spend time in a deeper learning of the content, beyond the simple reading of the lesson plan, so teachers are prepared when preschoolers ask questions that may go beyond the read-alouds and beyond the teacher's individual knowledge. A key difference found in successful implementation of a knowledge curriculum is the teachers' personal knowledge of the content (See et al, 2017).

BAU Condition

The BAU condition continued their regular curriculum, *Big Day for PreK*. The program components focused on developing oral language, emergent skills, and social-emotional skills. The curriculum is arranged in thematic units around eight themes. The BAU teachers taught theme 4, Awesome Animals. The theme was four-weeks and consisted of weekly topics: All Kinds of Animals, Animal Homes, Creepy, Crawly Insects, and Animals Grow and Change (Andrews et al., 2015). Read-alouds were read without being interactive. This meant the texts were read with no scripted questions, think-alouds, or discussions. A list of read-alouds can be found in Appendix A, Table 2. The intervention and BAU groups covered the same ELA and Science standards as seen in Appendix A, Table 3, as well as vocabulary.

Fidelity

To ensure fidelity of the intervention, the researcher conducted two visits per classroom during the intervention. The fidelity form can be found in the Appendix C. The researcher did not perform the instruction. The instruction occurred independent of the researcher. That is, the district implemented the instruction in the current design. The researcher collected additional measures as opposed to designing or implementing any coursework.

Pretest and Outcome Measures

Researcher-designed vocabulary assessment. The researcher designed vocabulary assessment was measured using pretest as a covariate in the ANCOVA analysis. This ANCOVA was used to answer research question one. The researcher designed vocabulary assessment targeted specific words taught during the science unit. The assessment consisted of 20 questions and was administered orally. Students were shown 10 picture cards of specific animals taught in the unit. The child was asked to identify the animal. Reliability was established using Cronbach's alpha.

Once the child identified the animal, the child was asked to identify what a specific feature of an animal was called (e.g., What is this animal? ____. What is this part of the animal called?). This test was given pretest and posttest to assess vocabulary growth, however the posttest contained six additional questions. It was discovered after the pretest was given three vocabulary terms were taught to demonstrate some words have multi-meanings. To capture this finding, a picture of the word was shown to the child with each of the meanings. For example, the children were shown a picture of an

animal lapping water and a child sitting on a lap. Both assessments can be found in Appendix A.

Researcher-designed content knowledge assessment. Researcher designed content knowledge was measured using pretest as a covariate in the ANCOVA analysis to address research question three. The researcher designed content knowledge test was orally administered to each child. Each child was asked 11 questions that required yes or no answers about content learned in the unit (e.g., Do giraffes use their tails to brush off flies? Are white rabbits able to hide in the snow?). This measure was given pretest and posttest to assess growth of content knowledge. Reliability was established using Cronbach's alpha. The assessment can be found in Appendix A.

Strictly Outcome Measures

Researcher-designed listening comprehension. Researcher designed listening comprehension was one outcome measure. The assessment can be found in Appendix D. The participants' Aims web scores were used as a covariate in an ANCOVA analysis to answer research question two. Aims web is a curriculum-based measurement (CBM) used for universal screening and progress monitoring. The reliability is .81 as stated in the manual. The rationale for using Aims web as a covariate was to account for differences in vocabulary knowledge. As mentions previously, vocabulary is highly correlated with reading comprehension.

Analysis

This study was a pretest posttest control group quasi-experimental research design using an intervention and business as usual (BAU) comparison. Descriptive, correlation, and ANCOVAs were computed. Three ANCOVAs were conducted. For research

question one, researcher designed vocabulary pretest was used as the covariate for researcher designed vocabulary outcome. For research question two, Aims web vocabulary CBM was used as the covariate for listening comprehension measure. For research question three, researcher designed content knowledge pretest was used as the covariate for the researcher designed content knowledge outcome. Bonferroni correction was applied to account for Type 1 error.

CHAPTER IV: RESULTS

Three ANCOVAs were performed to address each of the research questions, testing for effect of a knowledge-based curriculum with interactive science read-alouds on researcher-designed (1) vocabulary, (2) listening comprehension, and (3) content measures. Table 4 displays the final sample demographic information.

Table 4

Demographic Information for Sample

	Intervention *n* = 48	%	BAU *n* = 41	%
Gender				
Female	20	41.7	23	56.1
Male	28	58.3	18	43.9
ELL				
No	42	87.5	37	90.2
Yes	6	12.5	4	9.8
IEP				
No	47	97.9	37	90.2
Yes	1	2.1	4	9.8
Income Eligibility				
No	6	12.5	8	19.5
Yes	42	87.5	33	80.5

Note. N = 89 (n = 48 for intervention, n = 41 for BAU). BAU = Business as Usual; ELL=English Language Learner; IEP=Individualized Education Plan

All classrooms were observed twice during the intervention to ensure fidelity. Teachers in the Intervention used the correct materials, read the correct read-aloud, and taught the designated vocabulary during both visits. There was only one intervention teacher who did not follow the plan at 100% at the first fidelity visits. She asked most, but not all, of the scripted questions, skipped two discussion questions, and altered the last activity. The researcher met with the teacher after the lesson and discussed the

issues. At the next fidelity visit, she completed the intervention with all its parts as prescribed.

However, variations were also found in the BAU group. It was discovered through the study that even though they all used the same curriculum, each teacher implemented it to their own liking. Fifty percent of the time, BAU teachers read a different read-aloud not designated by their curriculum but is used each year based on their preference. The BAU did not have the interactive portion of the IRA with scripted questions, discussion prompts, or think-alouds to follow. Only two of the three BAU teachers taught the designated vocabulary by the curriculum but not as the curriculum scripted; rather, they taught the lessons as they normally do to the class. The third teacher did not focus on vocabulary during the lessons.

The descriptive statistics are shown in Table 5. Skewness and kurtosis were all in normal range. Reliability of researcher-designed measures were conducted using Cronbach's alpha. All measures, both pretest and posttest, were in the acceptable reliability range except pretest for researcher-designed content, whose reliability was .039. Hedge's *g* was used to calculate effect sizes.

Table 5

Descriptive Statistics

	Intervention (n = 48) M	SD	BAU (n = 41) M	SD	Cronbach's α (N = 89)
Pretest Vocabulary	15	3.025	16.12	3.051	.791
Posttest Vocabulary	22.44	4.047	20.78	3.581	.849
Aims web	17.73	4.630	17.85	4.616	.81*
LC	12.25	2.514	12.05	2.655	.727
Pretest Content	6.27	1.469	6.90	1.546	.039
Posttest Content	9.13	2.100	8.41	1.516	.589

Note. *as stated in the manual; LC = Listening Comprehension Measure

Table 6 displays the correlational data. All measures except one had a strong positive relationship, which indicated as one measure significantly increased so did the other measures. Pretest content was the exception. Pretest content and posttest vocabulary had a minimal positive relationship, which meant as pretest content had a small increase, posttest vocabulary slightly increased. Pretest content had a similar small positive relationship with posttest content and listening comprehension. As pretest content slightly increased, posttest content and listening comprehension did as well. However, pretest content and pretest vocabulary has a significant positive relationship.

Table 6

Correlation Statistics

	Posttest Vocabulary	Posttest Content	Listening Comprehension	Pretest Vocabulary	Pretest Content	Aims web
Posttest Vocabulary	1					
Posttest Content	.641**	1				
Listening Comprehension	.684**	.601**	1			
Pretest Vocabulary	.590**	.428**	.462**	1		
Pretest Content	.099	.131	.079	.317**	1	
Aims web	.602**	.544**	.566**	.683**	.328*	1

**. Correlation is significant at the 0.01 level (2-tailed).

For the first analysis, an ANCOVA was conducted to determine if there was a difference between the intervention group and the BAU group on researcher-designed vocabulary posttest. Pretest vocabulary was used as a covariate. Independent sample t-test was run to establish pretest equivalency. The intervention group (n = 48, M = 15, SD = 3.03) and the BAU group (n = 41, M = 16.12, SD = 3.05). Equal variances could be assumed. On average, students in the intervention group were higher than the BAU group by a magnitude of 1.12. The difference was not statistically significant, t(87) = 1.74, p = 0.86.

The Levene's test showed that the variance for post vocabulary met the homogeneity assumption ($F_{(1, 87)}$ = .557; p = .457). The overall model was statistically significant ($F_{(2, 86)}$ = 35.80, p < .001). There was a significant difference between the

Intervention and BAU ($F_{(1, 86)} = 16.78$, $p < .001$). The adjusted means indicated the Intervention group ($M = 22.87$, $SD = 4.05$) outperformed the BAU group ($M = 20.28$, $SD = 3.58$). In addition, the standardized mean differences effect size of $g = 0.67$ exceeded the educationally meaningful effect as prescribed by the US Department of Education. This finding supports research question one.

In addition, a regression analysis was run to determine if the impact of pretest vocabulary on posttest vocabulary outcomes was the same for each condition. For the intervention group, the pretest vocabulary was found to be a statistically significant predictor of the posttest: $F_{(1, 46)} = 40.62$, $p < .001$, $B = .685$. The Durbin-Watson test was 1.01, suggesting that there was no threat of autocorrelation in the data. For the BAU group, the pretest vocabulary was found to be a statistically significant predictor of posttest vocabulary as well: $F_{(1, 39)} = 24.10$, $p < .001$, $B = .618$. The Durbin-Watson test was 1.69, suggesting that there is no threat of autocorrelation in the data. The similarity of the slope of the covariate between the two groups were compared and were found to be close enough to be considered acceptable.

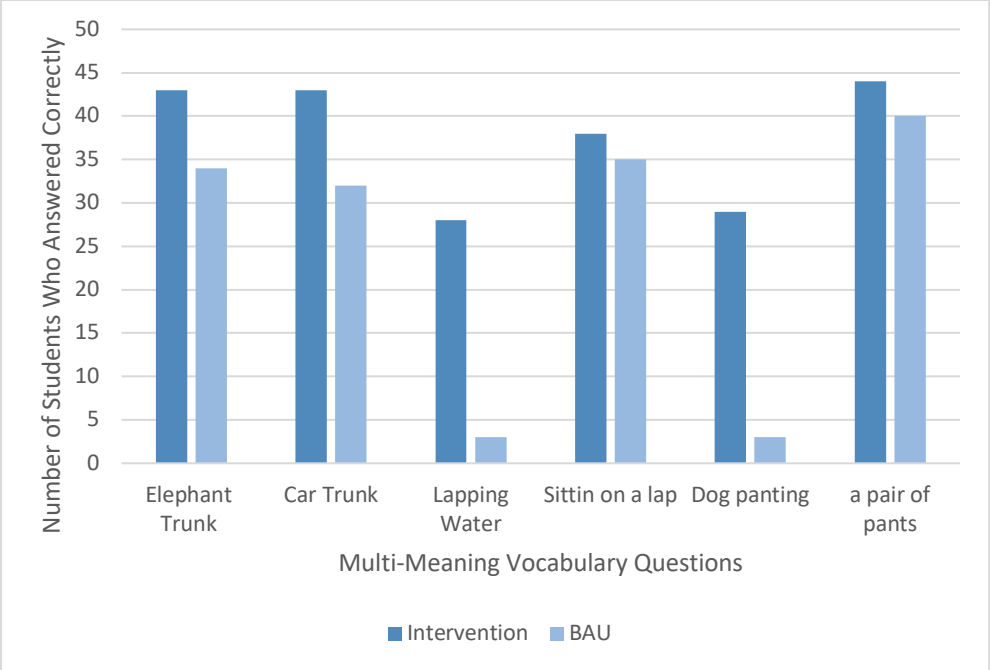
The vocabulary posttest contained six extra questions as compared to the pretest measure, including three vocabulary words that contained multiple meanings. The word "trunk" was referred to the animal trunk in the unit; however, participants were also shown a picture of a trunk of a car to see if they could identify it. The words "lap" and "pants" were also included as multiple meaning words. In addition to being shown the picture of a lion lapping up water and a dog panting, the kids were shown a picture of a baby sitting on a lap and a pair of pants. The inclusion of the additional words

demonstrated if children could understand the depth of the three words with their multi-meanings. A chi-squared test was run for each question.

Figure 1 below displays the results for the additional six multi-meaning vocabulary questions. Children in the intervention group overall performed better on the six additional vocabulary questions. Two questions referenced the trunk of the elephant and the trunk of the car, respectively. The percentage of students answering the elephant trunk correctly did not differ between groups, χ^2 (1, N = 89) = 0.84, p = .359. A similar finding was found for percentage of students answering the trunk of the car question correctly χ^2 (1, N = 89) = 2.22, p = .136. The next two questions referred to an animal lapping up water and a child sitting in a parent's lap. The percentage of students who answered the lapping up water question correctly had a significantly differed between the two groups χ^2 (1, N = 89) = 25.35, p < .001. However, on the question regarding sitting on a lap, the two groups did not differ significantly χ^2 (1, N = 89) = 0.576, p = .448. The final two questions addressed a dog panting to cool off and a pair of pants. A significant difference was found between the percentage of students who answered the question regarding a dog panting correctly χ^2 (1, N = 89) = 27.07, p < .001, but not a significant difference between the groups answering correctly on the question identifying a pair of pants χ^2 (1, N = 89) = 1.45, p = .229.

Figure 1

Multi-Meaning Vocabulary Words



The most noticeable differences between the two groups were questions regarding the definition of lapping of water and a dog panting to stay cool. Questions referring to a parent's lap and a pair of pants were both similar in the number of children who answered the questions. This outcome was expected since most children from an early age understand a pair of pants and sitting on someone's lap. For the question about an animal lapping up water, 28 children in the intervention group knew the correct usage of the word laps as compared to only three in the BAU group. The question about a dog panting displayed similar results with 29 children in the intervention group answering correctly versus three in the BAU.

The second analysis was conducted to determine if there was a difference between the Intervention and BAU group on the researcher-designed listening comprehension

measure. An ANCOVA was ran using the students' Aims web vocabulary as a covariate. Independent sample t-test was run between the intervention group (n = 48, M = 17.73, SD = 4.63) and the BAU group (n = 41, M = 17.85, SD = 4.62) to establish pretest equivalency. The results indicated equal variances could be assumed. On average, students in the intervention group were higher than the BAU group by a magnitude of 0.12. The difference was not statistically significant, t(87) = 0.12, p = 0.63.

The Levene's test again showed that the variances for listening comprehension met the assumption of homogeneity ($F_{(1, 86)}$ = .078; p = .781). The overall model for listening comprehension was statistically significant ($F_{(2, 85)}$ = 20.20; p < .001). However, there was not a significant difference between the Intervention and BAU ($F_{(1, 85)}$ = .169; p = .682). The adjusted means demonstrate the Intervention group (M = 12.27, SD = 2.51) did not statistically or practically significantly perform differently from the BAU group (M = 12.08, SD = 2.67), g = 0.07. The findings do not support research question two.

In addition, a regression analysis was run to determine if pretest vocabulary could predict posttest vocabulary outcomes. For the intervention group, the pretest vocabulary was found to be a statistically significant predictor of the posttest: $F_{(1, 46)}$ = 18.20, p < .001, R^2 = .28. The Durbin-Watson test was 1.58, suggesting that there was no threat of autocorrelation in the data.

For the BAU group, the pretest vocabulary was found to be a statistically significant predictor of posttest vocabulary as well: $F_{(1, 38)}$ = 22.18, p < .001, R^2 = .38. The Durbin-Watson test was 1.61, suggesting that there is no threat of autocorrelation in the data. The similarity of the slope of the covariate between the two groups were compared and were found to be close enough to be considered acceptable.

For the third and final analysis, an ANCOVA was conducted to determine differences between the Intervention and BAU groups using pretest researcher-designed content measure. When checking the reliability of the pretest measure, the reliability did not meet the recommended minimum standard. The pretest Cronbach's alpha was .039. Since this is below .60, results should be treated with caution.

The final analysis was conducted to determine if there was a difference between the Intervention and BAU group on the researcher-designed content measure. Independent sample t-test was conducted to compare the intervention group (n = 48, M = 6.27, SD = 1.47) and the BAU group (n = 41, M = 6.90, SD = 1.55) and their pretest equivalency. Results indicated equal variances could be assumed. On average, students in the intervention group were higher than the BAU group by a magnitude of 0.63. The difference was not statistically significant, t(87) = 1.97, p = 0.59.

An ANCOVA was ran to determine if there was a statistical difference between the Intervention group (M = 9.19, SD = 2.10) to the BAU group (M = 8.34, SD = 1.52) on the researcher-designed content measure. However, the Levene's test did not indicate equal variances could be assumed ($F_{(1, 87)}$ = 7.922; p = .006). Results are significant between the Intervention and BAU groups ($F_{(1, 86)}$ = 4.519; p = .036), g = 0.46, which could be considered educationally meaningful . The posttest content researcher-designed measure had a ceiling effect. Twenty-one students in the Intervention group scored a perfect 11/11. Only four students in the BAU group obtained the ceiling effect. The findings support question three but should be treated with caution to the low reliability of the measure.

In addition, a regression analysis was run to determine if pretest vocabulary could predict posttest vocabulary outcomes. For the intervention group, the pretest vocabulary was not found to be a statistically significant predictor of the posttest: $F_{(1, 46)} = 0.67$, $p = .42$, $R^2 = .01$. The Durbin-Watson test was 1.87, suggesting that there was no threat of autocorrelation in the data.

For the BAU group, the pretest vocabulary was not found to be a statistically significant predictor of posttest vocabulary as well: $F_{(1, 39)} = 3.16$, $p = .083$, $R^2 = .08$. The Durbin-Watson test was 1.77, suggesting that there is no threat of autocorrelation in the data. The similarity of the slope of the covariate between the two groups were compared and were found to be close enough to be considered acceptable.

CHAPTER V: DISCUSSION

Many students from poor and rich literacy homes are not achieving successfully past the primary grades. There is overall low achievement on fourth grade assessments and many children are not being identified with reading difficulties prior to fourth grade (Catts et al., 2005; Chall et al., 1990). The lack of vocabulary and content knowledge, which are unconstrained skills that continue to develop throughout a person's life, could be contributing factors (Cain & Oakhill, 2011). Research suggests both knowledge and vocabulary are independent factors in comprehension (Stahl, Hare, et al., 1991).

Depth of comprehension depends on a child's oral language such as vocabulary, background knowledge, and print exposure in addition to phonemic awareness (Albert Shanker Institute, 2009; Biemiller, 2003; Dickinson et al., 2006). When students start learning domain content like science, even in the preschool years, this knowledge will build as they progress through school, especially if there is an alignment and continuity of expectation of content that fosters deep, conceptual learning (Albert Shanker Institute, 2009; Hirsch, 2006; Khan & Justice, 2020; Vygotsky, 1978).

The present study used a knowledge-based preschool unit about animals to determine if the youngest learners, from primarily low SES backgrounds, can learn vocabulary and content through science read-alouds. The first research question asked if using a knowledge-based curriculum with science read-alouds can impact researcher-designed vocabulary measures. The results demonstrated the Intervention group outperformed the BAU group with an effect size of $g = 0.67$. This finding is consistent with research findings on vocabulary achievement in preschoolers (Conezio & French, 2002; French, 2004; Peterson & French, 2008; Roskos et al., 2008).

The present study did not include a standardized vocabulary assessment. With the shorter duration of the study, past research has indicated standardized vocabulary measures are not sensitive to the vocabulary taught in shorter more specific units of study (Elleman et al., 2009; Marulis & Neuman, 2010; NRP, 2001; Stahl & Fairbanks, 1986). What is unique about this study as compared to previous studies is the positive effect size compared to the length of the study. The vocabulary interventions mentioned previously have lasted between eight and twelve weeks (e.g., Conezio & French, 2002; French, 2004; Peterson & French, 2008; Roskos et al., 2008).

One reason for the great vocabulary growth in a short period of time could be the topic of the unit. Children are familiar with animals and come with some background knowledge about animals. Young children are also very curious and interested in animals. Following the knowledge hypothesis (Anderson & Freebody, 1981), new vocabulary words are learned better in concepts and when the vocabulary can connect to an existing schema (Mancilla-Martinez & McClain, 2020). New knowledge connects to a child's background knowledge to allow for a deeper understanding and can compensate for low-reading skills that occurs over time (Adams, 1990; Cervetti & Wright, 2020).

An example would be the depth of the multi-meaning vocabulary words learned in the animal unit by the students in the intervention group. Children, in both groups, had surface knowledge of the word meanings for trunk, laps, and pants. The trunk of an elephant and trunk of a car can be connected to a child's existing knowledge. Most children have seen pictures of an elephant through books, magazines, technology, or in person at a zoo. In addition, most children have parents/caregivers who drive vehicles with trunks and/or have seen trunks of cars through various media outlets.

However, the depth of the vocabulary came through the multi-meaning words "laps" and "pants". Over half of the students in the intervention group were able to correctly identify a lion lapping up water and a dog panting. By taking words that are familiar to children (e.g. trunk, laps, pants) and building on their background knowledge, allowed the students to connect the new learning (new meanings), with previous learning (Adams, 1990; Cervetti & Wright, 2020).

The second research question addressed the impact of a knowledge-based curriculum with interactive science read-alouds on researcher-designed listening comprehension measure. The two groups performed similar on the listening comprehension measure with a minimal effect size ($g = 0.07$). This finding is not surprising due to the nature of listening comprehension which includes read-alouds. Reading aloud to children, especially preschoolers, has been proven to succeed with all students including those of low-SES background (Adams, 1990; Bus et al., 1995; NRP, 2000; Robbins & Ehri, 1994; Snow, 1991).

The finding regarding the listening comprehension outcome, supports integrating science content through interactive read-alouds. Interactive read-alouds allow children to be engaged in informational learning and exposes them to concepts long before they can read informational texts independently (Wright, 2014). Children in the Intervention and BAU groups were able to listen to informational passages, understand the content, and answer questions correctly. Children, even early learners, can begin to learn science content through informational read-alouds and understand the content especially when they can connect the learning to their previous learning as in this study. Even though the

BAU curriculum did not go into the depth of content as the Intervention, children were still able to connect their prior knowledge and understand passages read aloud to them.

The third and final research question addressed the effect of a knowledge-based curriculum with science interactive read-alouds on a researcher-designed content measure. The Intervention group outperformed the BAU group with an effect size of g = 0.46. This finding is consistent with previous literature when using near transfer measures, where preschool students gained science content knowledge through read-alouds (Pollard-Durolola et al., 2011; Gonzalez et al., 2011; Neuman et al., 2016). However, previous research interventions ranged from 8-12 weeks. The current study had an intervention with positive results and effect size achieved in a four-week period, which indicates that similar gains can be found in shorter interventions than in the past. However, these findings should be treated with extreme cautions due to the low reliability on the pretest (α = .039) and posttest measures (α = .589).

The content assessment allowed the children to demonstrate their comprehension of the unit. Even though both groups learned about animals, the Intervention group were engaged in IRA which contains rich discussion, think-alouds, and open-ended questions that promoted comprehension, whereas, the BAU were just read to. Rich discussions keep children engaged in listening and encourages children to link new learning to existing knowledge (Beck & McKeown, 1991, 2007; Hirsch, 2003; Justice, Jiang et al., 2018).

Think-alouds were also incorporated into the intervention. Think-alouds give teachers the opportunities to model their thinking when new information is presented to students and students need help connecting the new ideas to existing ideas (Duke, 2013;

Zucker et al., 2010). The scripted open-ended questions helped guide the Intervention teachers away from the typical recall questions asked of younger children as seen in the BAU classrooms. Preplanning questions and think-alouds are two strategies to ensure children are engaged during the read-aloud and benefited students in their learning of the content.

There was a ceiling effect in the Intervention group on the researcher-designed content outcome. Twenty-one of the 48 students in the Intervention group answered all eleven content questions correctly. The content was taught in both groups. One reason for the ceiling effect could be the depth of knowledge the intervention students gained through the strategies such as, discussions, think-alouds, and open-ended questions used in the intervention study as mentioned in the previous paragraph. These strategies could also help the students connect their new learning to previous learning so they could have a deeper understanding of the science content taught through the read-alouds.

Based on the present study, future studies should look at a couple of variables. One variable would be the length of the intervention. Studies should try implementing a knowledge-based curriculum for the duration of a school year instead of a few weeks. Allowing an intervention to go across the length of a school year (180 days) would be more informative of the effectiveness. Exposing students to content knowledge and vocabulary across a school year, could have more of an impact on standardized measures not just proximal measures.

Teacher training on the curriculum would be essential for fidelity of implementation. Over the last several decades, schools have been adopting skill-based curriculums with no continuity through the grade levels and little to no scope and

sequence on building knowledge and vocabulary. Veteran and new teachers alike, will need to understand the purpose and structure of knowledge-based curriculums to be effective in delivering the content and instruction. While skills are important and explicitly teaching phonics is essential, it is also critical to incorporate content knowledge and vocabulary starting with the youngest learners and continuing throughout their educational careers.

Limitations

Several limitations were present in this study. One limitation is the lack of randomization at the student level. Randomization at the student level allows the findings to be generalized to the population (Gall et al., 2003). With only one preschool class in each school, except for one school, student level randomization was not possible. Another reason for lack of randomization was COVID-19 procedures put in place in the district. The school district where the study took place, added additional curriculum requirements due to pacing and materials to ensure all students would receive the same content in the event of another shutdown.

As mentioned in the results, an additional limitation is the lack of reliability with the pre-content measure. After examining the data and discussing the issue with the classroom teachers, the consensus was the kids were randomly guessing at pretest. All teachers agreed the test was given the same at pretest and posttest and did not notice anything particularly different between the two administrations of the test except for the obvious fact the kids had been exposed to the new content and felt more confident in their answers at posttest.

Another limitation is the sample size. Sample size is a common limitation in the field of education. In the case of the present study, each classroom was considered an intact group and received the same treatment (Gall et al., 2003). Additional classrooms were added to the study to help increase the sample. In addition, the BAU classrooms were matched to intervention classrooms based on similar demographics so the same population would be represented.

There was a ceiling effect on the researcher-designed content measure for students in the Intervention group, which indicates the measure did not fully capture their knowledge. Considering almost half of the intervention group obtained perfect scores on the content outcome measure, additional questions should be considered to allow students to demonstrate more depth of learning. Including open-ended questions to the measure would add another dimension to the assessment.

A final limitation was not using a standardized measure due to the shortened intervention. The results found positive growth on the near transfer measure but not on standardized measures which were included in previous studies.

Delimitations

The present study had delimitations due to COVID-19 guidelines. The school system the study was conducted in limited people allowed in buildings and interacting with students. Because of this, the classroom teacher administered all the measures. Due to past research regarding standardized vocabulary measures and duration of the study, it was decided to eliminate the standardized measure.

Participating teachers administered the vocabulary CBM and the three researcher-designed measures. Another delimitation was limiting the study to one unit of four

weeks, versus three units lasting 12 weeks. With the uncertainty of COVID-19, there was a possibility schools may shutdown and go virtual at any point. School officials felt this possibility was likely especially during flu season when the intervention took place. With this in mind, it was decided to shorten the study to four weeks to complete the intervention in person before potential shutdown.

Conclusion

The present study produced several important findings. Preschool students can begin a lifelong love of learning by being read to and engaged in the reading process. Being purposeful in book selections to expose children to content knowledge and vocabulary is an important endeavor for educators and parents. Reading to children has always been encouraged but planning questions to engage students in the book and connect new learning to background knowledge is a simple task that can produce great benefits in gaining knowledge and vocabulary.

Preschool students can show positive results in vocabulary, knowledge, and listening comprehension in as few as four weeks. Connecting new concepts, whether that be vocabulary or knowledge, to an existing schema, gives children the ability to learn at a deeper depth. The children in the study exemplified this statement by understanding multi-meaning words and understanding new content knowledge.

Future Studies

In the future, studies should focus on integrating the read-alouds with content knowledge and vocabulary for longer periods. If positive results can be found after a four-week study, imagine the depth of learning that could occur over a school year. Purposeful selection of read-alouds, engaging questions, think-alouds, and discussions

across an academic school year could have an impact on standardized measures, such as vocabulary. With a vertical focus of building content knowledge and vocabulary, in addition to the necessary skills children need to be successful readers and learners, students could overcome the fourth-grade slump and excel in their academic careers.

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APPENDICES

Appendix A: Texts

Table 1

Core Knowledge Texts

Title	Author	Genre	Grade Level/Lexile
"Humans are Animals"	Core Knowledge Foundation	Informational	N/A
What Do You Do with a Tail Like This?	Steven Jenkins and Robin Page	Informational	PK-3/510L
"Animals Have Three Basic Needs"	Core Knowledge Foundation	Informational	N/A
"Animals Protect Themselves"	Core Knowledge Foundation	Informational	N/A
Is Your Mama a Llama?	Deborah Guarino	Fiction	PK-3/290L
See Me Grow	Penelope Arlon and Tory Gordon-Harris	Informational	PK-1/640L
"Groups of Animals: Birds, Fish, and Insects"	Core Knowledge Foundation	Informational	N/A
"Groups of Animals: Mammals"	Core Knowledge Foundation	Informational	N/A

Note. L = Lexile Measure; PK = Preschool, N/A = Not Applicable

Table 2

Big Day for PreK Texts

Title	Author	Genre	Grade Level/Lexile
Biggest, Strongest, Fastest!	Steve Jenkins	Informational	PK-2/AD540L
Is Your Mama a Llama?	Deborah Guarino	Fiction	PK-3/290L
Big Earth, Little Me	Kate Endle and Thom Wiley	Informational	PK-K/N/A
Dot the Fire Dog	Lisa Desimini	Fiction	PK-K/AD400L
Animal Homes	Sally Hewitt	Informational	PK-K/IG700L
Bear Snores On	Jane Chapman and Karma Wilson	Fiction	3-5/AD470L
Click, Clack, Quackity-Quack	Doreen Cronin and Betsy Lewin	Fiction	PK-2/NP290L
Bugs! Bugs! Bugs!	Bob Barner	Informational	PK-K/NP
Over in the Meadow	Olive Wadsworth	Fiction	PK-K/NP
What Do Insects Do?	Pamela Chanko and Susan Canizares	Informational	PK-K/BR10L
Butterflies	Gilda Berger and Melvin Berger	Fiction	PK-K/N/A
Dora's Eggs	Julie Sykes	Fiction	PK/N/A

Note. AD = Adult Directed; BR = Beginning Reader; IG = Illustrated Guide; K = Kindergarten; L = Lexile Level; N/A = Not applicable; NP = Non-Prose; PK = Preschool

Appendix B: TNELDS

Table 3

Tennessee Early Learning Developmental Standards (TNELDS)

Standard	Description of Standard
PK.RI.KID.1	With modeling, prompting, and support, ask, and answer questions about informational text read aloud.
PK.RL.KID.1	With modeling, prompting, and support, ask, and answer questions about a story read aloud.
PK.RI.KID.2	With prompting and support, orally identify a main topic and retell details of texts, discussions, and activities.
PK.RL.KID.2	With prompting and support, orally retell familiar stories including details.
PK.RI.CS.4	With prompting and support, answer questions about the meaning of words and phrases in a text relevant to pre-K topic or subject-area.
PK.RL.CS.4	With prompting and support, respond to questions about the meaning of unknown words in a story.
PK.RI.CS.5	Recognize various text features.
PK.RL.CS.5	Recognize common types of text.
PK.RI.IKI.7	With prompting and support, orally describe the relationship between illustrations and the text in which they appear.
PK.RL.IKI.7	With prompting and support, orally describe the relationship between

Table 3

Tennessee Early Learning Developmental Standards (TNELDS)	
PK.RL.IKI.7	illustrations and the story in which they appear.
PK.RI.IKI.9	With prompting and support, orally identify basic similarities and differences between two texts on the same topic.
PK.RL.IKI.9	With prompting and support, orally compare and contrast the experiences of characters in a story to personal experience or to the experiences of characters in another familiar story.
PK.RI.RRTC.10	Listen and respond to informational texts of appropriate complexity for pre-k.
PK.RL.RRTC.10	Listen and respond to stories and poems of appropriate complexity for pre-k.
PK.F.5	Interact with text to support comprehension.
PK.FL.VA.7a	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on pre-k conversations, reading, and content.
PK.FL.VA.7b	With guidance and support from adults, explore word relationships and nuances in word meanings.
PK.LS1.01a	Identify common attributes of familiar living things.
PK.LS1.01b	Recognize differences between living organisms and non-living materials.

Note. CS = Craft and Structure; F = Fluency; FL = Foundational Literacy; IKI = Integration of Knowledge and Ideas; KID = Key Ideas and Details; LS = Life Science; PK = PreK; RRTC = Range of Reading; RI = Reading Informational; RL = Reading Literature; TNELDS = Tennessee Early Learning Developmental Standards; VA = Vocabulary Acquisition

Appendix C: Researcher-Designed Measures

Researcher-Designed Vocabulary Measure

Animal Name	Body Part
Elephant	Trunk
Eagle (or bird)	Wings
Duck	Beak
Turtle	Shell
Goldfish	Fins
Dog	Fur or hair
Butterfly	Wings
Cow	Tail
Cat	Eyes
Human	Hands
*Elephant/Car	Trunk
*Lion/Mom and child	Laps
*Dog/Child	Pants

Note. * denotes additional vocabulary on posttest. Pretest score was out of 20 and posttest score was out of 26

Researcher-Designed Content Measure

Question	Answer
Is a human an animal?	Yes
Does a shark use its teeth to help it swim?	No
Do giraffes use their tails to brush off flies?	Yes
Does an elephant have a short nose?	No
Do tiny bugs drink water from droplets found on leaves?	Yes
Do some birds use their wings to fly away when they are scared?	Yes
Do animals need apple juice to survive?	No
Do dogs pant so that they stay cool?	Yes
Do turtles stick their heads out of their shell when they are scared?	No
Are white rabbits able to hide in the snow?	Yes
Do all animals need food, water, and shelter to stay healthy and grow?	Yes

Note. Each question was worth 1 point.

Listening Comprehension Measure

Passage 1

Animals, like humans, have basic needs to survive. They need food, water, and shelter. Without all three things, animals would not live.

1. How many things do animals need to survive? 3
2. What three things do animals need? Food, water, and shelter
3. Can animals survive without water? No
4. Do animals need food to survive? Yes
5. Do humans need food, water, and shelter to survive? Yes

Passage 2

Animals have special body parts to keep them alive. An elephant has a long trunk to get food and water. A skunk has a scent to keep it safe from predators and giraffes have long necks to help them reach leaves in trees for food.

1. Body parts help animals to stay alive. Yes
2. An elephant has a nose like a human's nose. No
3. What does an elephant use his trunk for? To get food and water
4. Does a skunk have a scent to protect itself from predators? Yes
5. What do giraffes use their long necks for? To get food (leaves from trees)

Passage 3

Some baby animals, like humans, are born and look like their parents, but some do not. Bear cubs, rabbits, and kittens look like their parents when they are born. Other animals do not look like their parents when they are born. For example, frogs are born as tadpoles and change into frogs. Butterflies are born as caterpillars, form a chrysalis, and change into butterflies.

1. All baby animals look like their parents. No
2. Bear cubs look like their parents. Yes
3. Name an animal from the story that does not look like their parents when they are born. Frog or butterfly
4. A frog begins life as a tadpole. Yes
5. Butterflies are born as butterflies. No

Appendix D: Fidelity Checklist

Fidelity Checklist

Dissertation-Content Knowledge

Teachers *

- Teacher A
- Teacher B
- Teacher C
- Teacher D
- Teacher E
- Teacher F

Date of Observation *

Month, day, year

Start Time of Observation *

Time

End Time of Observation *

Time

Lesson being Taught *

- [ ] Day 1
- [ ] Day 2
- [ ] Day 3
- [ ] Day 4
- [ ] Day 5
- [ ] Day 6
- [ ] Day 7
- [ ] Day 8-Pausing Point 1
- [ ] Day 9-Pausing Point 1
- [ ] Day 10-Pausing Point 1
- [ ] Day 11
- [ ] Day 12

- [ ] Day 13
- [ ] Day 14
- [ ] Day 15
- [ ] Day 16
- [ ] Day 17
- [ ] Day 18
- [ ] Day 19
- [ ] Day 20

Teacher follows intervention/BAU procedures *

- [ ] Teacher read the correct read-aloud
- [ ] Teacher asked the scripted questions-Intervention only
- [ ] Teacher modeled the scripted think-aloud-Intervention only
- [ ] Teacher taught the vocabulary per curriculum

Follows wording in lesson *

	1	2	3	4	5	
Low Implementation	○	○	○	○	○	High Implementation

Completes all components of daily lesson *

	1	2	3	4	5	
Low implementation	○	○	○	○	○	High implementation

Provides opportunities for students to ask questions and responds

Linear scale

1 to 5

1 Low implementation

5 High implementation

Required

Teacher has materials prepared for lesson *

- ○ Yes
- ○ Partially
- ○ No

Teacher demonstrates familiarity with content *

- Yes
- No
- At times but not consistently

The average student is engaged and on task *

- Yes
- No
- At times

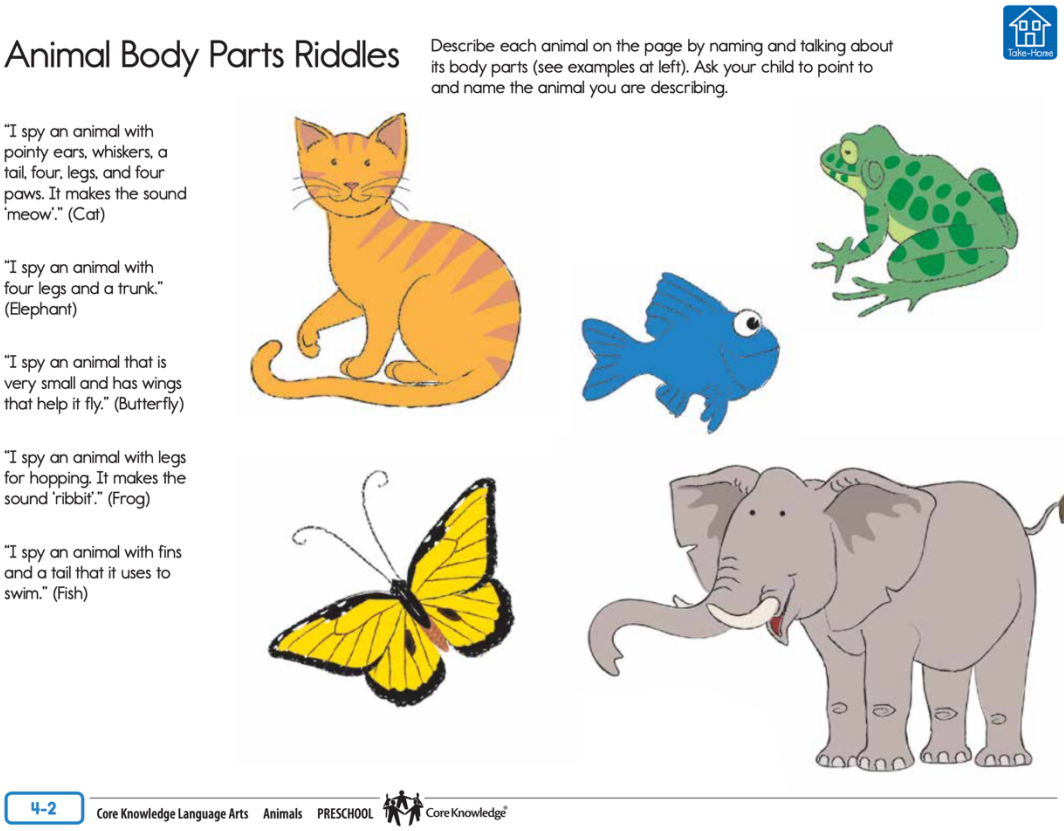
Overall, the teacher implemented the intervention *

	1	2	3	4	5	
Not at all						Above Expectations

Additional Comments

Long answer text

Appendix E: Sample Materials



Animal Body Parts Riddles

Describe each animal on the page by naming and talking about its body parts (see examples at left). Ask your child to point to and name the animal you are describing.

Take-Home

"I spy an animal with pointy ears, whiskers, a tail, four, legs, and four paws. It makes the sound 'meow'." (Cat)

"I spy an animal with four legs and a trunk." (Elephant)

"I spy an animal that is very small and has wings that help it fly." (Butterfly)

"I spy an animal with legs for hopping. It makes the sound 'ribbit'." (Frog)

"I spy an animal with fins and a tail that it uses to swim." (Fish)

Sample Activity Page

Sample Flip Book Read-Aloud

SHOW FLIP BOOK PAGE 1-2: King penguins, chameleon, bottle-nose dolphin, chimpanzee, elephant, monarch butterfly

Animals come in all colors, sizes and shapes.
Some have big ears and brown hair, like this ape.

Some have a tail or wings they can flap,
And some float in water when taking a nap.

Animals look different from you and from me,
But we are all animals as you shall soon see.

- Point to the penguins in the picture.

  "These animals are called penguins. They are black and white and have special wings that they use as flippers on the sides of their bodies. Penguins use their flippers to swim. What do you have instead of flippers on your body?"
- Call on a few students to respond. (arms, legs)
- Point to the dolphin and tell students that dolphins take naps by floating at the top of the ocean.

  "This is a dolphin. Dolphins live in water and when they take a nap, they float in the water. Where do you take a nap? Would you like to float in the water while taking a nap?"
- Call on a few students to respond.
- Point to and name the other animals on the page (chameleon, chimpanzee, elephant, and butterfly).

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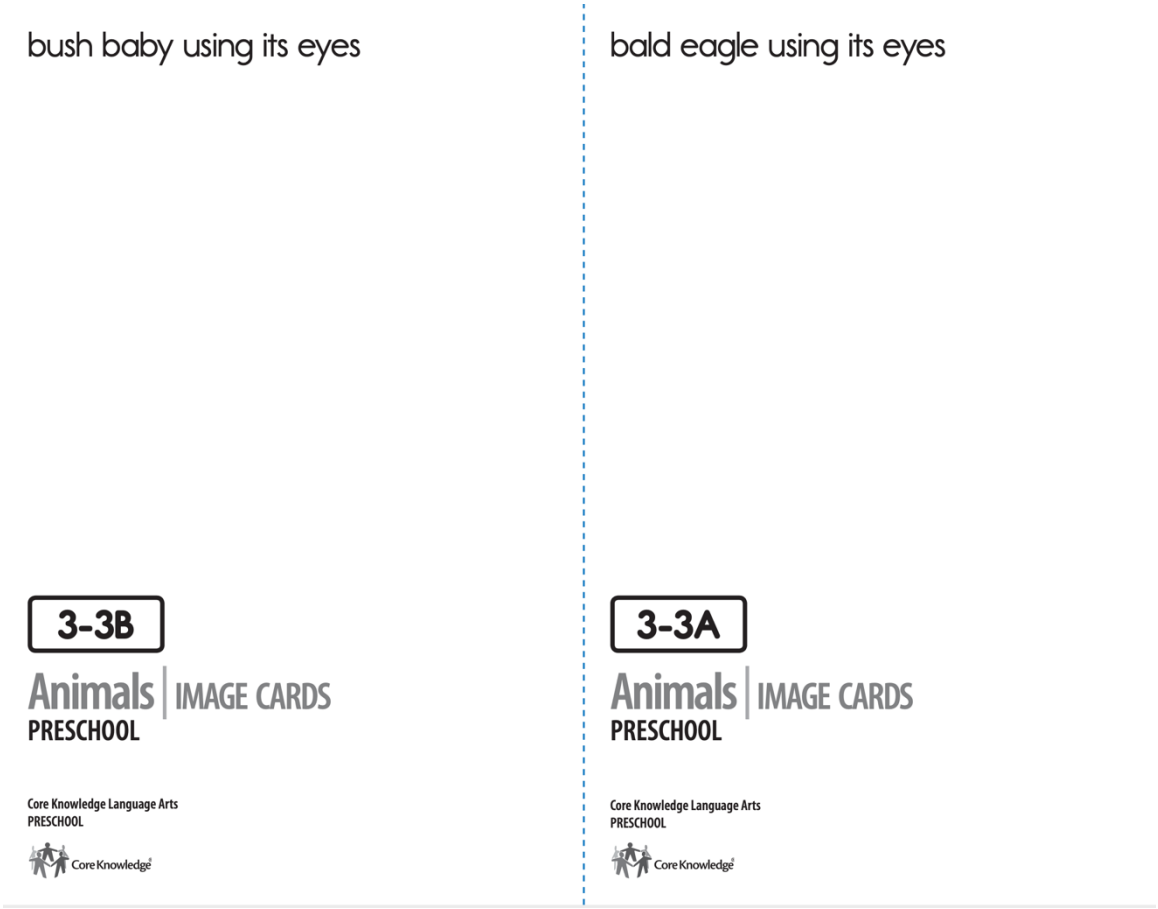
Sample Flip Book Read-Aloud

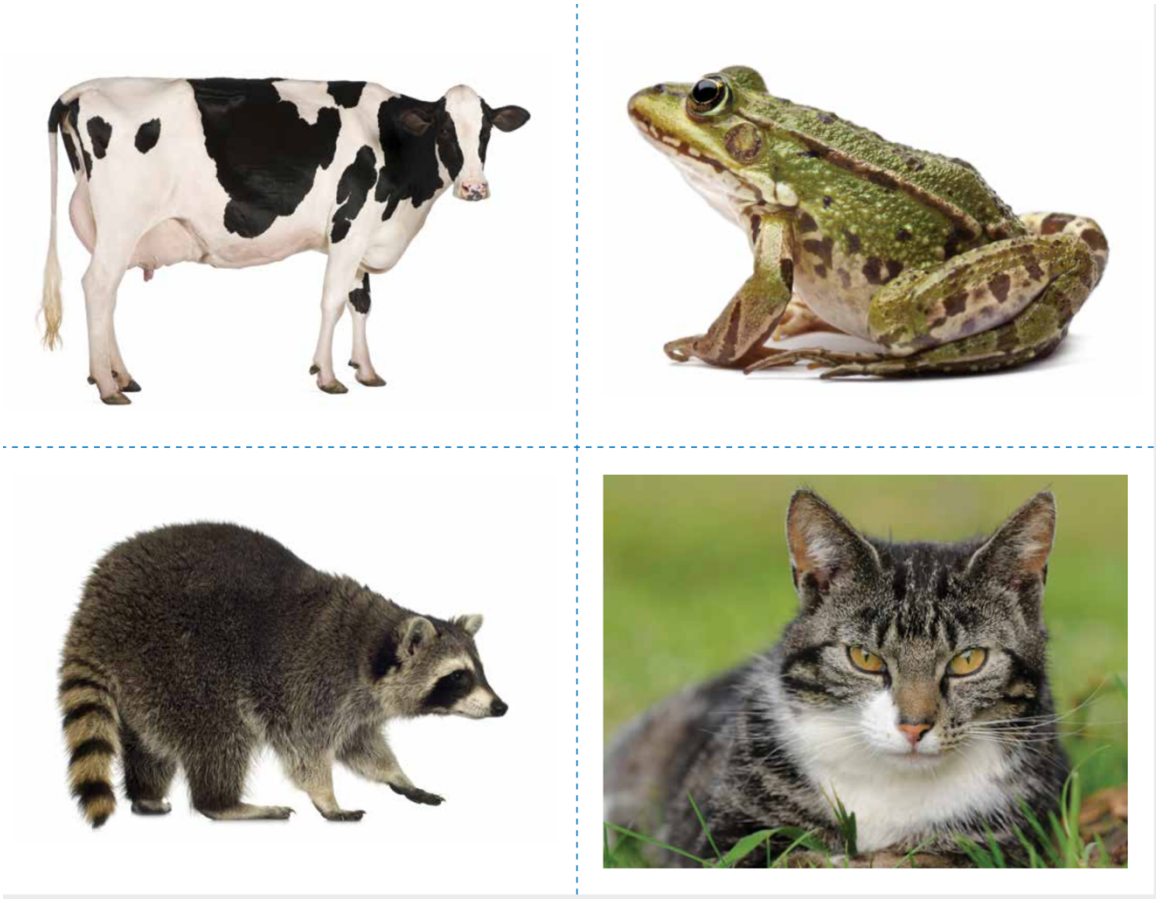
bush baby using its eyes

bald eagle using its eyes

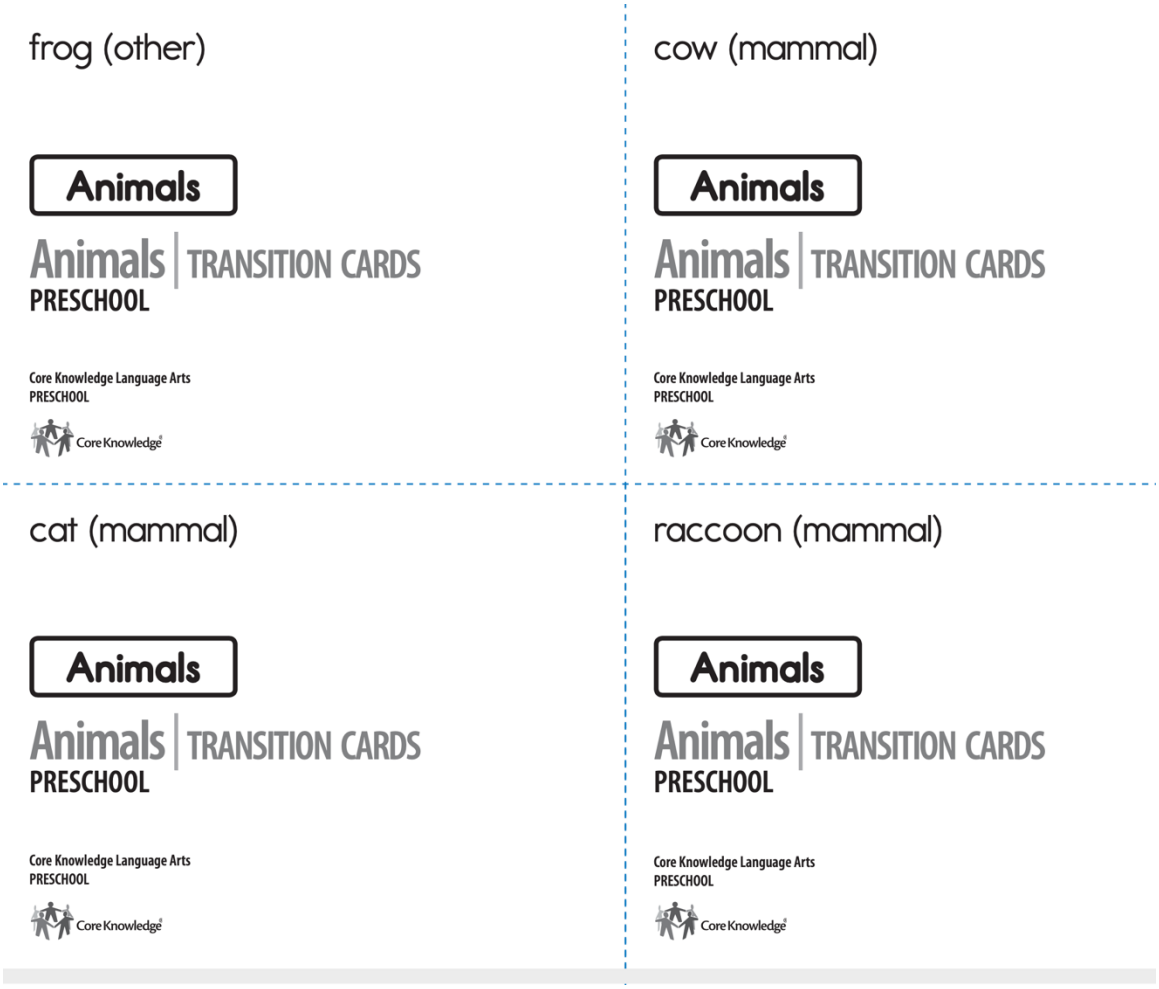
Sample Image Card



Sample Image Card



Sample Transition Card



Sample Transition Card

Appendix F: IRB Approval

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129
FWA: 00005331/IRB Regn. 0003571

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Wednesday, February 24, 2021

Protocol Title	***The Effect of Knowledge-Based Curriculum Using Science Read-Alouds on Vocabulary and Listening Comprehension Outcomes with Preschoolers***
Protocol ID	**21-2105 7i**
Principal Investigator	**Nicole Neal Crouch** (Student)
Faculty Advisor	Eric Oslund
Co-Investigators	NONE
Investigator Email(s)	*Nnc2i@mtmail.mtsu.edu; eric.oslund@mtsu.edu*
Department	Literacy Studies
Funding	**NONE**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU IRB through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(7) Research on individual or group characteristics or behavior.* A summary of the IRB action is tabulated below:

IRB Action	**APPROVED for ONE YEAR**		
Date of Expiration	**2/28/2022**	*Date of Approval*: 2/23/21	*Recent Amendment*: NONE
Sample Size	ONE HUNDRED (100)		
Participant Pool	*Target Population:* Primary Classification: **Healthy Minors (Age group 4-5)** Specific Classification: **Students enrolled in VPK program**		
Type of Interaction	☐ Virtual/Remote/Online interaction ☒ **In person or physical interaction – Mandatory COVID-19 Management**		
Exceptions	In person research is permitted with proper precautions		
Restrictions	**1. Mandatory SIGNED parental consent followed by independent ACTIVE child assent process.** **2. Other than the exceptions above, identifiable data/artifacts, such as, audio/video data, photographs, handwriting samples, personal address, driving records, social security number, and etc., MUST NOT be collected. Recorded identifiable information must be deidentified as described in the protocol.** **3. Mandatory Final report (refer last page).** **4. Research site restriction applies: Refer to Appeneix B for list of sites.** **5. CDC guidelines and MTSU safe practice must be followed**		
Approved Templates	*IRB Templates:* Parental consent and child assent *Non-MTSU Templates:* Recruitment scipt(s)		
Research Inducement	NONE		
Comments	NONE		

Post-approval Requirements

The PI and FA must read and abide by the post-approval conditions (Refer "*Quick Links*" in the bottom):

- ***Reporting Adverse Events:*** The PI must report research-related adversities suffered by the participants, deviations from the protocol, misconduct, and etc., within 48 hours from when they were discovered.
- ***Final Report:*** The FA is responsible for submitting a final report to close-out this protocol before **2/28/2022 (Refer to the Continuing Review section below)**; REMINDERS WILLNOT BE SENT. **Failure to close-out or request for a continuing review may result in penalties** including cancellation of the data collected using this protocol and/or withholding student diploma.
- ***Protocol Amendments***: An IRB approval must be obtained for all types of amendments, such as: addition/removal of subject population or investigating team; sample size increases; changes to the research sites (appropriate permission letter(s) may be needed); alternation to funding; and etc. The proposed amendments must be requested by the FA in an addendum request form. The proposed changes must be consistent with the approval category and they must comply with expedited review requirements
- ***Research Participant Compensation:*** Compensation for research participation must be awarded as proposed in Chapter 6 of the Expedited protocol. The documentation of the monetary compensation must Appendix J and MUST NOT include protocol details when reporting to the MTSU Business Office.
- ***COVID-19:*** Regardless whether this study poses a threat to the participants or not, refer to the COVID-19 Management section for important information for the FA.

Continuing Review (The PI has requested early termination)

Although this protocol can be continued for up to THREE years, The PI has opted to end the study by **2/28/2022**
The PI must close-out this protocol by submitting a final report before 2/28/2022 Failure to close-out may result in penalties that include cancellation of the data collected using this protocol and delays in graduation of the student PI.

Post-approval Protocol Amendments:

The current MTSU IRB policies allow the investigators to implement minor and significant amendments that would fit within this approval category. ***Only TWO procedural amendments will be entertained per year*** *(changes like addition/removal of research personnel are not restricted by this rule).*

Date	Amendment(s)	IRB Comments
NONE	NONE.	NONE

Other Post-approval Actions:

The following actions are done subsequent to the approval of this protocol on request by the PI/FA or on recommendation by the IRB or by both.

Date	IRB Action(s)	IRB Comments
02/24/2021	A "Listening Comprehension Measure" has been added after approval	NONE

COVID-19 Management:

The PI must follow social distancing guidelines and other practices to avoid viral exposure to the participants and other workers when physical contact with the subjects is made during the study.

- The study must be stopped if a participant or an investigator should test positive for COVID-19 within 14 days of the research interaction. This must be reported to the IRB as an "adverse event."
- The MTSU's "Return-to-work" questionnaire found in Pipeline must be filled by the investigators on the day of the research interaction prior to physical contact.
- PPE must be worn if the participant would be within 6 feet from the each other or with an investigator.
- Physical surfaces that will come in contact with the participants must be sanitized between use
- **FA's Responsibility:** The FA is given the administrative authority to make emergency changes to protect the wellbeing of the participants and student researchers during the COVID-19 pandemic. However, the FA must notify the IRB after such changes have been made. The IRB will audit the changes at a later date and the FA will be instructed to carryout remedial measures if needed.

Data Management & Storage:

All research-related records (signed consent forms, investigator training and etc.) must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application.

The data must be stored for at least three (3) years after the study is closed. Additional Tennessee State data retention requirement may apply (*refer "Quick Links" for MTSU policy 129 below*). The data may be destroyed in a manner that maintains confidentiality and anonymity of the research subjects.

The MTSU IRB reserves the right to modify/update the approval criteria or change/cancel the terms listed in this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

- Post-approval Responsibilities: http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php
- Expedited Procedures: https://mtsu.edu/irb/ExpeditedProcedures.php
- MTSU Policy 129: Records retention & Disposal: https://www.mtsu.edu/policies/general/129.php