The Promise of Refutation Texts for Science and Literacy Learning in the Primary Grades: A Descriptive Study of Extratextual Talk during the Read-Aloud

A Dissertation

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DEDICATION

This dissertation is dedicated to Marilyn K. Burger.

ABSTRACT

Knowledge supports all aspects of reading including decoding, fluency, and comprehension (Cervetti & Hiebert, 2015; Cervetti & Wright, 2020; Duke & Cartwright, 2021; Kintsch, 1988, 1988; McNamara & Kintsch, 1996; Priebe et al., 2012). Early knowledge predicts reading growth, and science knowledge and reading have a mutually beneficial relationship throughout elementary school (Hwang, 2020; Hwang et al., 2023). Evidence also shows that students benefit when content learning and literacy instruction are integrated (Hwang et al., 2022). For these reasons, educators must focus on building students' knowledge in topics like science and social studies as early as possible. This is especially true for language minority students and students from economically disadvantaged homes (Morgan et al., 2016).

Children’s science misconceptions are widely documented (Carey, 2000; Chi & Roscoe, 2002; Kuhn & Pearsall, 2000; Vosniadou & Ioannides, 1998). If not directly addressed, they can persist and interfere with knowledge building (Kendeou & van den Broek, 2005; Vosniadou, 2013). Through instruction students can revise their knowledge to align with scientific findings. This is a process known as knowledge revision (Kendeou et al., 2014). Knowledge revision has been supported with the use of refutation texts with older students (Kendeou & O’Brien, 2014; Kim & Kendeou, 2021). No empirical studies have looked at the use of refutation texts with primary students.

This study, part of a larger study called RAISE Learning (**R**ead-**a**loud **I**nstruction for **S**cienc**e** **L**earning), examines how Kindergarten and first grade teachers use two genres of informational science text in read aloud sessions with small groups of students. One text is a standard informational text, the other is a refutation text. Both texts cover the same information about birds, however the refutation text was designed to activate common misconceptions about birds, explicitly refute them, and provide further facts to support children in building an accurate knowledge network about birds (Guzzetti et al., 1993). From transcripts of 15 video recorded read-aloud sessions with two text conditions, seven with refutation text and eight with standard informational text, student and teacher extratextual talk was analyzed with qualitative and quantitative techniques.

Results showed that teacher questioning was the most common form of extratextual talk across both read-aloud conditions. Some types of teacher questioning were productive while others were less conducive to learning. A paired-sample Wilcoxen test revealed that teachers asked more questions with higher levels of abstraction and students produced more inferential talk in the refutation text condition. Descriptive statistics indicated that teachers' talk patterns varied widely by amount and type. Qualitative themes included high levels of student interest, lack of teacher comfort with the science topic, presence of student misconceptions, and the persistence of initiation-response-feedback (IRF) classroom discourse structure. Teacher interview analysis highlighted a spectrum of beliefs about student capacity, the purpose of the read aloud, the use of informational text, and what misconceptions arose during the read aloud sessions.

This study supports the literature concerning how teachers can best leverage the read aloud to engage students with science texts and knowledge revision in the early grades. The findings from this study have implications for the integration of science and literacy with refutation texts in primary grades, teacher professional learning on the use of discussion to

support engagement and knowledge acquisition, and policy to emphasize the use of informational text in the primary grades during the literacy block.

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LIST OF ABBREVIATIONS

C-I	Construction-Integration model
ELA	English Language Arts
FTA	Framework Theory approach
KReC	Knowledge Revision Components (KReC) framework
MDK-C	Multidimensional Knowledge in Text Comprehension (MDK-C) framework
RT	Refutation text
SIT	Standard informational text

CHAPTER ONE

INTRODUCTION

Einstein said, “Education is not the learning of facts, but the training of the mind to think.” Training the mind to think critically, as science does, invites students to challenge assumptions, use evidence to support claims, and verify that evidence. To become scientifically literate, one must also be literate. Literacy is a basic human necessity that requires more than the ability to lift words off a page, but the capacity to learn from and think critically about the meaning of those words. The beautiful thing about knowledge of science and reading proficiency is that they can be mutually enhancing (Hwang, McMaster, et al., 2023).

Knowledge about the world contributes to all aspects of reading including decoding, fluency, and comprehension (Cervetti & Hiebert, 2015; Cervetti & Wright, 2020; Duke & Cartwright, 2021; Kintsch, 1988; McNamara & Kintsch, 1996; Perfetti & Stafura, 2014; Priebe et al., 2012). Building students’ world knowledge as early as possible in a child’s education is an issue of equity. Children come to school with a range of science knowledge. (Morgan et al., 2016). Unless teachers focus on building all students’ science knowledge early on, inequities will persist for students who are not afforded opportunities to learn about science before entering school (Morgan et al., 2016; Osborne et al., 2003). Additionally, there is evidence of a positive bidirectional relation between science knowledge and reading. The more science knowledge students have in kindergarten, the better they do on reading comprehension tests in grade one. That enhanced reading performance in grade one leads to science achievement in grade two, and so on. This has been found to be true for both monolingual and multilingual children (Hwang, McMaster, et al., 2023). Science knowledge in young children can also support overall learning competencies (Gelman, 2009) that support overall school achievement (Patrick et al., 2009), and eventually future career opportunities (DeJarnette, 2012; Mantzicopoulos & Patrick, 2011)**.**

The Problem

One problem concerning early science instruction is the fact that science and social studies get short shrift in the elementary school day schedule. By some estimates science instruction claims only 2.5 hours a week of a typical elementary classroom (Connor et al., 2017; Hwang et al., 2020) and has declined by as much as 75 minutes per week (Connor et al., 2017). In contrast, time devoted to the English Language Arts (ELA) block has grown to about 11.5 hours per week in the past decades in part due to a concern about flat reading achievement scores (Hwang et al., 2020). The long literacy block would not be problematic if content such as science was commonly integrated into the block, however that is not often the case in primary classrooms (Dejarnette, 2016). The primary classroom is mostly consumed with code-based instruction and reading strategy instruction, not on content instruction that would increase world knowledge and science domain knowledge (Connor et al., 2017). Despite its importance to outcomes in school and life, building science knowledge is not a priority in many primary classrooms in part because many educators operate with an outdated paradigm of literacy learning in which instruction follows a sequence of *first* code-based instruction and *then* meaning-based or content-based instruction (Duke & Cartwright, 2021; Moats & Tolman, 2019). Therefore, teachers may not share the same level of urgency to teach content to their students as they do to teach code-based skills such as phonemic awareness and phonics (Aukerman, 2022; McMurrer, 2008). Students need to build knowledge and develop language early in school just as much as they need explicit phonics instruction (Dickinson et al., 2019; Language and Reading

Research Consortium, 2015; Wagner et al., 2015). This is true especially for students who begin schooling with less print exposure and less general knowledge (Cunningham & Stanovich, 1991; Stanovich & Cunningham, 1993). Research investigating early general knowledge suggests that reading difficulties in later elementary may be caused by weak general knowledge (Hwang, 2020).

Another obstacle is that primary teachers do not expose their students to the amount of expository text that would help them build the knowledge networks they will need for reading comprehension and for science achievement (Conradi Smith et al., 2022; Mantzicopoulos & Patrick, 2011). Common Core State Standards (CCSS) has encouraged educators to infuse "domain-specific nonfiction titles" into literacy instruction as a first and critical step toward building children's domain knowledge and, ultimately, their reading comprehension (National Governors Association, 2010). However, this recommendation is routinely disregarded. Studies across decades have shown that a low amount of classroom time is spent reading aloud or using informational texts, especially in the primary grades (Conradi Smith et al., 2022; Duke, 2000; Håland et al., 2021; Jacobs et al., 2000; Lickteig & Russell, 1993). Duke's seminal study (2000) describes text use in U.S. first grade classrooms, and she determined that an average of 3.6 minutes per day were spent on instructional activities with informational texts, and that number was as low as 1.9 minutes in low socioeconomic status (SES) schools. Unfortunately, typical classroom practice continues to neglect the use of informational texts. Conradi-Smith and colleagues (2022) found that 93.7% of read-aloud titles selected by teachers are narrative. Researchers speculate that informational texts, and particularly science texts, are infrequently used because of their perceived lack of friendliness, and the lack of comfort or familiarity among teachers with the topics covered in these texts. It is true that informational texts are more difficult for most readers to comprehend, but for this very reason students need more exposure to them earlier (Mantzicopoulos & Patrick, 2011; Patrick et al., 2009). Research has shown the amount of print exposure is predictive of vocabulary; content knowledge as print is an efficient and effective means of conveying information about the world (Cunningham & Stanovich, 1991; Hwang et al., 2022; Stanovich & Cunningham, 1993) and to that end there has been a push to bring science and social studies content into the ELA block to promote knowledge development (Hwang et al., 2020, 2022). The use of expository science texts is a win-win for both science learning and literacy (Hwang, McMaster, et al., 2023; Sinatra & Broughton, 2011).

Another reason for starting early with science instruction is that children come to school with misconceptions about the natural world (Vosniadou & Brewer, 1992). Misconceptions in science can prevent the accrual of accurate science knowledge. Research has shown that when learners hold inaccurate ideas about science topics, those inaccuracies interfere with reading comprehension and with accurate observations of natural phenomena (Chinn & Malhotra, 2002; Kendeou & van den Broek, 2007). Considering the fact that students learn about science through science texts (Neuman & Kaefer, 2018), and misconceptions can interfere with acquiring new and accurate information, it’s important to think about how knowledge gets revised. Knowledge revision is the process of incorporating new information and restructuring one’s knowledge to align it with accurate scientific findings (Kendeou et al., 2014). According to models of how knowledge revision occurs and how children’s science misconceptions are resolved, we know that the process is slow and would persist without instruction (Assaraf & Orion, 2005; Kendeou & O’Brien, 2014; Vosniadou, 2013).

Potential Solutions

A type of expository text called refutation texts have been shown to be beneficial with knowledge revision and promoting accurate science knowledge (Cervetti & Wright, 2020; Guzzetti et al., 1993a; Kendeou & O'Brien, 2014; Sinatra & Broughton, 2011; Tippett, 2010). Refutation texts are a type of text that directly state a common scientific misconception and then provide accurate information about the topic. While refutation texts have been used with older students with positive effect, their use and promise with primary-aged students has not been fully leveraged (Guzzetti et al., 1993a; Sinatra & Broughton, 2011; Tippett, 2010).

Because primary-aged students do not have the decoding skills to read refutation texts on their own yet, the interactive read-aloud, a common practice in the primary years, is one way that students can be exposed to refutation texts. The use of refutational texts by primary-grade teachers during an interactive read aloud may have beneficial effects over standard informational texts for students' language development and science learning (Cervetti & Wright, 2020).

An interactive read aloud is one of several book reading methods whereby the teacher simultaneously reads, discusses, and makes meaning of the text with students (Greene Brabham & Lynch-Brown, 2002; Wright, 2019; Yopp & Yopp, 2006). A number of studies have linked interactive read alouds with positive student outcomes such as vocabulary gains (Greene Brabham & Lynch-Brown, 2002; Wasik et al., 2016; Wright, 2019). Researcher Wasik and her colleagues noted common practices that foster dialogism and adult-child interaction including reading and re-reading texts, explicitly defining words, encouraging dialogue about book-related vocabulary through questions and discussion, re-telling, using props, and engaging children in post-reading activities. Learning is more than exposure to information. When a read aloud is dialogic and led by a teacher with a range of pedagogical strategies to draw students into sustained conversations and stretch their linguistic and cognitive abilities, it will produce greater academic gains (Lennox, 2013; Varelas & Pappas, 2006a). Despite this finding, the interactive read aloud in primary grades is used less than one would think. One study found that kindergarten teachers on average use the interactive read aloud with narrative text 8.36 minutes per year and fewer than 1.7 minutes per year with expository text (Wright & Neuman, 2014).

Informational texts are an efficient and effective means of relaying content, academic language, and vocabulary to children, however they are grossly underused by teachers in the primary grades for read-alouds (Donovan & Smolkin, 2001; Mantzicopoulos & Patrick, 2011). When teachers use informational texts, evidence suggests that their pedagogy is elevated to promote better student outcomes such as student talk and higher order thinking (Duke, 2004; Lennox, 2013; Pentimonti et al., 2010; Price et al., 2012; Romance & Vitale, 2012; Vitale & Romance, 2011; Wright & Gotwals, 2017; Yopp & Yopp, 2006). Researchers Torr and Clugston (1999) found that adults asked more questions requiring an explanation from students, engaged in more interactions requiring inferential reasoning, and used more sophisticated language (e.g., conditional clauses such as if-then) when reading informational texts compared to narrative texts. In one study of Greek preschool teachers, researchers found that teachers adopted an interactive style in the presentation of information books and a performance style while reading narrative texts (Moschovaki & Meadows, 2005). Similarly, Price et al. (2012) found that preschool teachers used a significantly greater number of extratextual utterances during the informational text read aloud than the narrative text read aloud. Teachers also tend to make higher cognitive demands from students during discussions when using informational texts (Price et al, 2012;

Moschvaki & Meadows, 2005). Genre has been found to mediate students' responses to read alouds as well. Moschvaki & Meadows (2005) found that students made more comments relating informational texts to personal experience than they did for narrative texts. The authors' interpretation is that students are actively involved in relating what they hear in the read aloud to what they already know and are assimilating the new knowledge into their existing knowledge network.

Not only does the dearth of science informational text use in the early years lower opportunities for young children to build accurate science knowledge, it also denies children chances to become interested and engaged with science topics early. Children not only come to school with misconceptions about science topics, but they also have stereotypical ideas of what science is and who are scientists. Students tend to think of science as the domain of white males, as too difficult, as uninteresting, and/or as unconnected to daily life (Andre et al., 1999; Baker, 2016). However, when students participate in science-focused literacy activities, such as a read aloud, their science interest grows and their ideas about science and their connection to it change (Patrick et al., 2009). For example, when kindergarten children who participated in science and literacy activities were interviewed about what science is, children made statements that were consistent with the practice of science such as, "people do science to help them know about things that live in shells, like snails, crabs, and turtles." Students not engaged in science activities made statements such as "Science is like when you have potions and stuff and they turn into different things" (Mantzicopoulos & Patrick, 2011, p. 274). Continuing to neglect the use of science texts as part of read alouds in the early grades will perpetuate the inequities in achievement in school by economic, racial, and gender factors. Engaging young children in science through read alouds and information texts such as a refutation text, has the potential to fuel long-term interest and motivation for studying science.

Contribution of the Study

The topic of my study addresses some important points in the current discussion about the best use of the literacy block to promote more equitable reading and school achievement. The "science of reading," a term now ubiquitous in schools, usually equates to prioritizing phonics and phonemic awareness instruction and has dominated educators' attention and efforts to improve reading instruction (Shanahan, 2020). The cost of these efforts and this attention has been at the expense of practices that promote building knowledge and interest in topics such as science (Hattan & Lupo, 2020; Silverman et al., 2020). Both code-based and meaning-based instruction are critical for primary students (Cervetti & Hiebert, 2015). Primary teachers will benefit from new understandings and insights about how to use a variety of texts and instructional practices to build accurate science knowledge during the literacy block. Furthermore, the focus of my study contributes to teacher practice and understanding of a little-used genre of text, the refutation text, and its potential for generating student interest and knowledge in science topics.

The effect of refutation texts as a tool for knowledge revision and interest in a science topic has not been studied in the primary grades, except for a single study identified in a meta-analysis (Tippett, 2010). The role teachers can play in their use of this kind of text to bring about interest in, and knowledge about science topics during the ELA block is nonexistent in the literature as well. While researchers and educators do know that bringing expository text to primary-aged students is important for enhancing vocabulary, language, and knowledge on academic topics, they do not know what the practice might look like using refutation texts. There is also a lot to learn about how the text type will affect engagement among students. In what ways might the genre of refutation text affect teacher knowledge? It is possible that more extensive use and familiarity with refutation text among teachers may generate their interest in teaching science topics, in students' misconceptions in science, and in the concepts of early knowledge building and knowledge revision. The introduction of the refutation text into the genre repertoire of the elementary non-science teacher has potential to bring about important awareness to teachers about what children know, how they know it, and how they can revise what they know.

Overview of the Present Study

As little is known about how primary teachers use refutation text during read aloud to promote science learning in their students, the purpose of the present study is to examine the extratextual talk that happens with two types of read alouds-a standard informational text and a refutation text. Also, through my study I aim to understand teacher's perceptions of refutation text and how their students experience them during a read aloud event. Data for this study were collected as part of the **R**ead-**A**loud **I**nstruction for **S**cienc**e** Learning (RAISE) project (Dr. HyeJin Hwang and Dr. Paniyoto Kendou, Principal Investigators) with funding from the American Psychological Association. Further details about the RAISE project, my participants, and methodology are outlined in Chapter Three.

In this chapter I discussed why science education is important because of the habits of mind science builds and because our democratic society benefits when we have a scientifically-literate populace. I pointed out how science knowledge contributes to learning to read proficiently and that building students' science knowledge and world knowledge at the onset of school is critical for creating equitable conditions for all students regardless of their access to opportunities before entering school. Current trends in early elementary classrooms show that science and social studies get short shrift while there is an overabundance of skills and strategies instruction with little inclusion of informational text. Because children come to school with science misconceptions and disparate levels of science knowledge, it is never too early to incorporate science instruction into the early elementary classroom. The literacy block is an ideal way to integrate science learning using informational text, especially refutation texts. While there is evidence that refutation texts improve science learning among older students, they have yet to be used in early elementary classrooms. This study investigates how refutation texts are leveraged during read aloud sessions with kindergarten and first grade students to learn about science and begin to reconcile student misconceptions about birds.

In the next chapter I describe the conceptual framing of my study. I also outline what is empirically known about the topics related to my investigation: reading comprehension, the role of knowledge and science knowledge within reading comprehension. I also review the research that examines the nature of children's science misconceptions, the role of inaccurate knowledge in learning, and how knowledge is revised. Finally, I discuss interactive read alouds and how they can be used to generate knowledge and interest in science.

CHAPTER TWO

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

In this chapter I provide the theoretical frameworks that inform the way I approach and answer the questions of my research study on primary teachers' read-aloud practices with two kinds of expository texts. I review research on topics that intersect with and lend insight to the topic of the study. These topics include the role that knowledge plays in comprehension and the evolving understanding of how knowledge is defined and operationalized in reading. I consider recent evidence for the role of science knowledge and its relationship to reading comprehension and reading performance in school. This leads me to lay out what is known about how and why children come to school with misconceptions about common science topics and how these misconceptions interfere with acquiring more and accurate knowledge about the very topics students require for their success with reading and school. I turn to the literature that discusses how knowledge is revised during reading and the use of refutation texts to support the knowledge revision process. Because my study concerns primary-aged students who do not yet read for themselves, I explore research on one of the most common ways children are exposed to texts, the teacher read aloud. Evidence and understanding is growing about the importance of boosting content knowledge in children as early as possible and not waiting until students are already behind in reading. My study fills an important gap in the literature about how teachers currently use their read alouds to enhance their students' science knowledge and revise misconceptions that interfere with that process.

Two Theoretical Frameworks: Sociocultural and Cognitive

To understand the complexity of how children learn about science topics through read alouds, one must understand how that learning is mediated by language, culture, and interpersonal interactions. Additionally, a cognitive framework that explains how reading comprehension occurs within an individual lends support to understanding why and how science knowledge is part and parcel of becoming a competent reader.

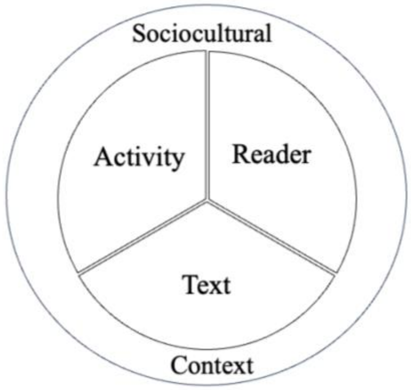
Reading is a Sociocultural Activity

Being read to at school is a social and cultural experience. This study describes the nature of read-aloud practices in primary grade classrooms with two kinds of science texts. Think of kindergarten students, especially emergent bilingual students, sitting at the rug with their classmates listening to a book their teacher has chosen, read in a language that might not be their own, about a topic that may or may not be in their realm of knowledge or experience, by a teacher whose culture may or may not be familiar to them. This experience is a deeply social and cultural one but it is also an individual and cognitive one. Before children can read for themselves, reading happens through others, often a teacher. Reading can be defined as a process whereby meaning is simultaneously extracted and constructed through social interaction and involvement with written language (Snow, 2002). This process consists of three elements including the reader, the text, and the activity. Each of these elements occurs within a sociocultural context. This context both shapes and is shaped by the reader who interacts with the other elements (Snow, 2002). A sociocultural perspective recognizes that reading involves being introduced to the world of symbols, including written language, by a more knowledgeable other (Vygotsky, 1978). The symbolic world consists of "conceptually organized, rule-bound belief systems about what exists, about how to get to goals, about what is valued (Bruner, 1985).” My study explores how teachers support students with text to understand new science topics (birds in particular) and possibly revise their misconceptions about a science topic. Snow’s heuristic is useful here because it outlines that reading text is both an individual cognitive activity and an activity guided by social and cultural processes.

Science knowledge is also a byproduct of culture and is socially constructed. Scientific knowledge is both “symbolic in nature and also socially negotiated (Driver et al., 1994), p. 5). The process of children revising their naive notions of the natural world, such as “the earth is flat,” is an inherently cultural process led by teachers, peers, adults, and texts. The naive theories children hold about the world are the result of both their individual experiences with nature, but also their interaction with adults and the culture at large (Carey, 2000; Driver et al., 1994; Duit & Treagust, 2003; Guzzetti et al., 1993a; Vosniadou & Ioannides, 1998a). Knowledge revision in science occurs through interaction and activity within the symbol system of the culture, including texts, dialogue, classroom instruction, etc. The cultural tools available to children through the classroom, including scientific theories, texts, language, and mental processes, help to gradually evolve children’s inaccurate theories into ones that are more scientifically aligned (Driver et al., 1994). Figure 1 illustrates how reading is both an individual and cultural phenomenon. In this figure the “activity” in this study, is the reader’s engagement with the text through the teacher and a child’s classmates.

Figure 1

A Heuristic for Thinking about Reading Comprehension



*Note. This diagram from "*Snow, C. (2002). *Reading for understanding: Toward as R & D program in reading comprehension*. Rand Corporation.

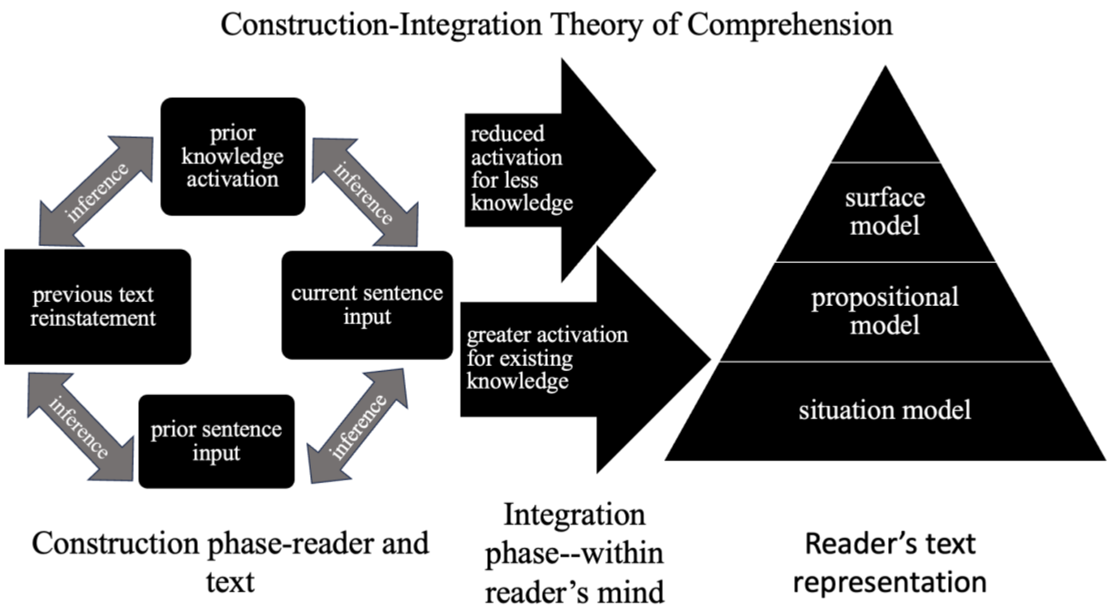
Reading Comprehension and the Construction-Integration Framework

Knowledge, while a product of social construction, also resides in the individual and is called upon while reading text. Therefore, in addition to a sociocultural approach, I employ a cognitive framework to understand how knowledge is involved with the mental processes of reading comprehension. Reading comprehension at the individual level is complex and multifaceted. Many skills and processes must be learned and orchestrated by the reader to understand and learn from text. First, readers must successfully orchestrate the lower-level processes of reading comprehension. These are the decoding and fluency skills sometimes referred to as the code-based skills (Paris, 2005). Code-based skills enable readers to decipher words by identifying their phonographic, orthographic, and semantic representations. The code-based skills are constrained, meaning there is a finite amount to learn and they take relatively little developmental time to learn with proper instruction (Paris, 2005).When a reader uses these skills with ease and proficiency, the reader is afforded the mental bandwidth to attend to the higher-level processing skills involved in comprehending text sometimes referred to as the meaning-based skills (Paris, 2005; Perfetti & Stafura, 2014).

The higher-level processes of reading involve a reader's ability to generate inferences, connect text content with relevant knowledge, identify text structure and genre, appreciate author intent, and learn from text (Graesser, 2015). The framework for the higher-level processes involved in reading comprehension used in my study is the Construction-Integration (C-I) model of reading comprehension (Kintsch, 1988). In this model, Kintsch describes how the higher-level comprehension processes happen in two phases in the reader's mind. The first phase is construction and refers to the activation of the information in the text and all its components. There are four sources of activation in this phase including the current text input (arguments and propositions), prior sentences, prior text, and background knowledge. The second phase is integration and refers to the spreading of activation across the networks of knowledge within the reader's mind. There is greater activation for concepts that have existing networks and reduced activation where there are fewer networks. Those concepts within the text that are not activated are let go due to the limits of working memory (Kendeou & O'Brien, 2017). The integration phase is iterative and only the concepts activated during the construction phase of processing remain in the reader's memory. The more knowledge that is activated during the construction phase of reading, the more robust the representation of the text will be for the reader. Figure 2 is an illustration of the process Kintsch describes. From this interaction, other processes activate including inference making (McNamara & Magliano, 2009). Inference making, the "glue" that holds the text together for the reader, is the process whereby readers fill-in information that is not explicitly stated in the text. Inferences are facilitated by the reader's background knowledge (van den Broek, 1994). This process of integration continues iteratively, giving rise to comprehension. This final product of the construction and integration processes forms the reader's mental representation of the text (Kintsch & van Dijk, 1978). The C-I model specifies three levels of text representation from least to most robust: the surface model, the propositional model, and the situation model. Of the three models, the situation model has the most enduring level of memory trace and is akin to directly experiencing the situation the discourse describes. The mediating factor for which text representation the reader creates is the reader's prior knowledge (Cervetti & Wright, 2020). Because my study concerns fortifying knowledge, particularly science knowledge, not necessarily as an end but to enable better reading performance for children, this cognitive framework supports my study's focus on how instruction can best build knowledge in the youngest readers.

Figure 2

A Graphic Representation of Kintsch's Construction-Integration Model of Comprehension



Review of Empirical Literature

In the previous section I laid out the theoretical frameworks that situate my approach to the research questions of my study. In this next section I review three areas of empirical literature that concern how educators can best support science knowledge building in their students. Therefore, I start the review with literature that looks at the role of knowledge in reading as well as ways the field has sought to define and conceptualize knowledge beyond a monolithic construct. Secondly, after establishing the degree to which knowledge matters for reading, I review what the literature says about the nature of inaccurate knowledge and approaches to understand how and why knowledge is revised. Finally, I turn to instructional interventions and review literature that speaks to how refutation texts support knowledge revision in science, how teachers use texts during read alouds to build content knowledge in students who cannot yet read on their own, and how teachers support students to construct science knowledge aligned with current scientific thought.

The Role of Knowledge in Comprehension and Why Building Knowledge Early is Important

The C-I model of reading comprehension provides a clear rationale for educators to build readers' knowledge networks as early as possible. The more knowledge a reader has related to the text, the more activation occurs while reading the text, the more robust text representation is created, and the more learning occurs (McNamara & Magliano, 2009). Additionally, knowledge helps readers with the lower-level processes of comprehension as well, such as word recognition and fluency (Duke & Cartwright, 2021; Priebe et al., 2012). The relationship between reading comprehension and knowledge is reciprocal. Many empirical studies have shown that knowledge is a significant factor in reading comprehension (Cervetti & Wright, 2020). However, given the infinite nature of knowledge, it is important to define knowledge to be more precise about how it contributes to reading comprehension. Doing so can also guide both research investigations concerning knowledge and instructional practices aimed at improving reading engagement and performance for elementary students.

Kinds of Knowledge and Evidence for Knowledge in Comprehension

The last four decades have produced a large body of empirical studies examining the role of knowledge in comprehension. Cervetti and Wright (2020) review the empirical literature of knowledge and comprehension. They cluster the definitions of knowledge into three categories including topic knowledge, domain knowledge, and general world knowledge.

Topic knowledge is defined as knowledge that is closely related to the topic of a text, and domain knowledge is defined as the broader discipline or context to which the text topic belongs (Cervetti & Wright, 2020.) For example, knowledge about the Civil Rights Movement in the United States is topic knowledge, and this topic relates to the domain knowledge of history. Many studies document topic knowledge's contribution to reading comprehension for students across multiple ages. One such study about baseball topic knowledge showed how participants with low reading ability and high topic knowledge on baseball outperformed high reading ability students with low topic knowledge on a comprehension measure (Recht & Leslie, 1988). Researchers McNamara and Kintsch investigated how high-prior-topic knowledge participants and low-prior-topic-knowledge participants performed on a variety of measures with high- and low-coherence texts about the Vietnam War. Findings revealed that participants with high-prior-topic knowledge performed better on tasks which measured deep comprehension after reading a low-coherence text, whereas those with low-prior-topic knowledge fared better with a high-coherence text. The finding suggests that when high prior knowledge readers have to "work the text" and create their own inferences, rather than the text "handing" those inferences to them, readers form a richer representation of the text (McNamara & Kintsch, 1996). According to this and other studies examining topic knowledge's influence on comprehension, studies show that not only does topic knowledge support text recall, but also supports bridging inferences (Cervetti & Wright, 2020; Pearson et al., 1979; Taft & Leslie, 1985). O'Reilly and colleagues investigated the ecology topic knowledge of high school students by having them define and relate a series of words which were critical to the topic. Researchers determined that once a certain threshold of topic knowledge was achieved, the relationship between that knowledge and comprehension was correlated, which suggests that knowledge facilitates comprehension (O'Reilly et al., 2019).

Domain knowledge, referring to a disciplinary area such as biology, has been shown to benefit reading comprehension, but in a more variable fashion. Perhaps this is due in part to how the researchers qualify domain knowledge in relation to the topic of the text; for example, in one study domain knowledge is defined as knowledge about spiders (Pearson et al., 1979). This definition is used to assess their ability to comprehend and make inferences with an expository text about spiders. While prior knowledge about spiders did have a significant effect on tasks that required inferences, it did not statistically influence performance on tasks related to explicitly stated information. This study suggests that comprehension requiring integration of background knowledge and textual information is especially facilitated by robust background knowledge. Another study on domain knowledge- also a baseball study- looked at how participants with domain knowledge about baseball performed on several comprehension tasks on a text about something specific within the domain of baseball, namely the retirement of a player. Researchers found that high topic and high domain knowledge were virtually indistinguishable in their effects on comprehension tasks, and both high topic and domain knowledge outperformed low knowledge participants' performance on recall and inferential statements (Stahl et al., 1991). Notably, in a recent study, domain knowledge, particularly *science* domain knowledge, was found to have a positive and bidirectional relationship with reading performance with elementary school students (Hwang, McMaster, et al., 2023). Researchers speculate about why science knowledge may have this effect on comprehension. Kim et al., wrote that "the acquisition of domain specific words may help instantiate a general schema (i.e. ecosystems) that provides mental hooks for hanging and organizing newly learned concepts in academic subjects (J. S. Kim et al., 2021, p. 20). Similarly, Nueman and Keifer write that the domain of science is inherently well structured. They speculate that when science's "taxonomic categories are made explicit, they help children develop a more coherent conceptual framework through which knowledge is encoded, organized and remembered" and "may also provide more fluent access to information and help to link prior knowledge with new information" (Neuman & Kaefer, 2018, p. 16). Nonetheless, researchers' definition of domain knowledge vs. topic knowledge is not consistent. Without consistency, it is hard to pinpoint what aspect of knowledge supports comprehension and therefore harder to build out interventions that will have the desired effect.

General knowledge refers to knowledge associated with the breadth of school-type subjects such as social studies, science, and the arts (Hwang & Duke 2020; Cervetti & Wright, 2020; Hwang, 2020). Readers with more general knowledge have an intricate and strong network of knowledge that can be leveraged easily for activation during reading (Hwang, 2020). Empirical studies include one investigation of the fourth-grade slump that examined readers' comprehension by reader world knowledge, text genre, and text cohesion (McNamara et al., 2011). This study found complex interactions between general knowledge, text genre, and text cohesion. Researchers found that general knowledge enhanced reading comprehension, especially in the case of science texts, thereby creating a bootstrapping effect (McNamara et al., 2011). Multiple recent studies show the predictive power of early general knowledge on reading growth and achievement in school (Duncan et al., 2020; Grissmer et al., 2010; Hwang, 2020).

Smith and colleagues did a critical review of research that looked at the effects of the background knowledge of primary-aged children. This review included studies with a definition of knowledge as “general” and knowledge directly related to target text (domain or topic). Their overall conclusion was that background knowledge has a variety of effects on reading comprehension depending on a number of factors such as the coherence and cohesion of the text, reader misconceptions about a given text topic, and overall reading skill (Smith et al., 2021). Interestingly, the Smith et al. study did not categorize knowledge beyond the term background knowledge and perhaps this is why the results were mixed. Nonetheless, findings across the studies discussed above support the idea that a network of knowledge structures leads to flexible and efficient activation when interacting with text, which in turn leads to learning from text.

The Dimensional Nature of Knowledge

Even in this brief review of empirical studies investigating the relationship between knowledge and comprehension, one can see a lack of consistency in how knowledge is operationalized and investigated. While my study is broadly concerned with increasing student science knowledge, but specifically about increasing topic knowledge about birds, I am also concerned with how inaccurate knowledge interferes with that process. Therefore, having a framework to think about knowledge in a more dimensional fashion is useful. Researchers McCarthy and McNamara (2021) put forth a framework for gaining clarity called the Multidimensional Knowledge in Text Comprehension (MDK-C) framework (McCarthy & McNamara, 2021). The framework introduces a construct of knowledge with four intersecting dimensions all existing on a continuum including amount, accuracy, specificity, and coherence. Amount refers to how many concepts a reader knows relevant to the text content. To go beyond categorization of “high” and “low” knowledge readers (McNamara & Kintsch, 1996), one study sought to determine exactly how much knowledge was necessary to influence comprehension. In this statistical study researchers found a knowledge threshold whereby students who scored greater than 59% on a vocabulary-type test on ecology demonstrated a strong relationship between their knowledge and their comprehension performance (O'Reilly et al., 2019). Those scoring below that threshold showed no significant relationship between their knowledge and performance on the comprehension task. Interestingly, besides revealing a knowledge threshold, the study showed that some of the pre-test items were more important than others in their predictive power with the comprehension task. This finding suggests that another aspect of knowledge other than amount was at play. The MDK-C framework allows for an interpretation of this finding by introducing other aspects of knowledge including accuracy or quality of knowledge. Accuracy refers to the degree to which a reader's knowledge is correct or incorrect. Accuracy is of particular importance to my study because the extant literature tells us that young children enter schooling with naive and inaccurate information about science which can interfere with building knowledge networks that are critical to reading comprehension (Vosniadou, 2002; Vosniadou & Ioannides, 1998). The empirical literature shows that inaccurate knowledge interferes, slows, or impedes reading comprehension (Driver et al., 1994; Kendeou & van den Broek, 2005). For example, in a study using a think-aloud methodology with college students, students who held misconceptions in physics made significantly more incorrect inferences than those who demonstrated accurate knowledge and understanding on an assessment of the physics concept while reading a text on the subject (Kendeou & van den Broek, 2007). Another aspect of the MDK-C framework is coherence. This valuation of knowledge matters because, as I discussed in the C-I model, the interconnectedness and organization of accurate knowledge is likely to draw more activation while reading than disconnected or incoherent knowledge. More activation leads to a stronger memory trace. The fourth aspect of the MDK-C framework, specificity, helps to frame my study to understand how specific knowledge about birds (topic knowledge) is affected by text type during a read aloud. For this study, the MDK-C framework affords a consideration of more than just one dimension of knowledge, especially the amount *and* accuracy of knowledge and how these can be influenced *by* text and how they influence *if* text is understood and learned from.

To summarize the first section of this review, I have highlighted literature that talks about the role that knowledge plays in reading comprehension, provided evidence that knowledge affects comprehension, defined different types of knowledge, and introduced a framework for discussing the multidimensional nature of knowledge. By establishing the criticality of knowledge, I have surfaced the idea that inaccurate knowledge is worthy of further attention and understanding. Therefore, I will talk about what insights the literature has on the topic of inaccurate knowledge.

Inaccurate Knowledge and Knowledge Revision

Inaccurate knowledge is important to understand because it can interfere with reading and learning from text. Perhaps it is best not to think of children as entering school with little science knowledge, but instead to think of children as entering school with science knowledge that is incongruent with current scientific thinking. *Lack* of knowledge and *inaccurate* knowledge are not the same phenomena and require different interventional approaches. In this next section, I look at how the field has understood inaccurate knowledge and misconceptions in science. I discuss how researchers from two different bodies of literature, the reading comprehension literature, and the science education literature, conceptualize revising inaccurate knowledge.

The nature of inaccuracy in the case of learning science for primary students is debated and nuanced (McCarthy & McNamara, 2021). The reason that knowledge misconceptions in science among young children matter is that these misconceptions interfere with building accurate knowledge, and accurate knowledge is exactly what students need to start forming the knowledge networks that will help them be successful with reading and in school (Hwang, McMaster, et al., 2023; Kendeou & van den Broek, 2005). Additionally, interest in and learning science cultivate higher order thinking skills which are both necessary for achievement in science but also in school and life more broadly (Kuhn & Pearsall, 2000). Understanding the nature of children's science misconceptions can help educators create interventions that revise these misconceptions in an effective and efficient manner. The misconception literature shows us that misconceptions are complex by nature and are not simply about having the *wrong* information. Instead, misconceptions can involve social, affective, and cognitive factors as well as belief systems. Understanding the nature of misconceptions is essential before attempting to intervene (Ecker et al., 2022). Therefore, in the case of this study, to best ameliorate science misunderstandings among children, it is important to understand how children typically learn about science and scientific concepts and the nature of their misconceptions.

The Nature of Misconceptions in Science

Most researchers agree that children come to school with knowledge, interest, and preconceived notions about the natural world and they are not tabulae rasae (Carey, 2000; Duit & Treagust, 2003; Hannust & Kikas, 2007; Kuhn et al., 1988; Linnenbrink & Pintrich, 2002; Malleus et al., 2016; Pine et al., 2001; Venkadasalam & Ganea, 2018; Vosniadou & Ioannides, 1998). Children construct their knowledge of the world on the basis of two information sources:

observations of the world and explanations given by other people (Hannust & Kikas, 2007; Vosniadou, 2002). These preconceived notions serve a function in children's lives as they have explanatory powers about how the world works, so that they can successfully interact and explain the world around them (Karmiloff-Smith, 1994; Pine et al., 2001). These are known as misconceptions (referred to also as naive theories, initial models, alternative frameworks, etc.), whereby a child's mental model about the natural world differs from a current scientific model (Carey, 2000, p. 2; Duit & Treagust, 2003; Malleus et al., 2016; Vosniadou & Ioannides, 1998a). The level of sophistication and nature of these preconceived notions is debated and evolving. Some researchers say that the preconceived notions children have are not full-blown models or theories, but simply fragmented knowledge or at best labile models that just need further refining with explicit instruction (Hannust & Kikas, 2007). Other researchers believe that children are theory-bound thinkers who have mental models, that these models are domain specific, that theories exist upon a continuum of sophistication, and that there is a longer, more iterative process involved in changing said theories (Carey, 2000; Duit & Treagust, 2003; Kuhn et al., 1988; Pine et al., 2001; Vosniadou & Brewer, 1992). There are many accounts of the nature of naive theories and how they change but to detail them further is beyond the scope of this paper (e.g.,(Carey, 2000; Chi, 2008; Chi & Roscoe, 2002; Chinn & Malhotra, 2002; Duit & Treagust, 2003; Hatano & Inagaki, 2003; Linnenbrink & Pintrich, 2002; Nussbaum & Sinatra, 2003; Pintrich et al., 1993; Posner et al., 1982).

What is most important to my study is the idea that regardless of the level of sophistication of these naive theories, they exist, and that children do not simply "not know" specific science topics. Instead, children come to school with *some* level of theory about the natural world and those theories, conscious or not, can interfere with acquiring knowledge in sync with current scientific thought. Here is an example that illustrates how a misconception interferes with how a child perceives information. When children aged six and seven are asked to balance a wooden beam of about 30 cm with a block of wood fixed to one end on a support, they are often unable to do so (Karmiloff-Smith, 1994; Pine et al., 2001). This is although children as young as four and five years old have lots of experience and expertise with balancing their bodies and objects on one another (e.g., play with blocks, walking on beams). Researchers interpret results from this experiment, which has been replicated numerous times, as evidence that children possess fixed ideas about how things balance (in this case the object must be placed on the support in the middle) and this belief interferes with a child's ability to problem solve, receive relevant proprioceptive feedback, and place the object to the side of the support so that it can balance. Furthermore, children resist changing the maxim, "all things balance in the middle " even after someone demonstrates the balance task (Karmiloff-Smith, 1994; Pine et al., 2001).

Misconceptions about Birds

Because my study is part of a larger study on children's knowledge and interest in the topic of birds, I will include some research on typical misconceptions children have about birds. Just as in other areas of science such as astronomy and physics, discussed earlier, children also hold misconceptions with biological phenomena such as birds. These misconceptions, like in other areas of science, can interfere with learning accurate information. Researchers found that children's misconceptions about birds formed patterns across age, gender, and abilities, and that typically these misconceptions resolved with age, and yet some misconceptions persisted (Prokop et al., 2007). Children's misconceptions about birds tend to resemble theories of previous generations of naturalists. The basis for classification of birds was driven by characteristics of habitat and locomotion and that their explanations for classification often reflected anthropomorphic and teleological reasoning (Prokop et al., 2007). Anthropomorphic reasoning is shown in children's statements that ascribe human attributes to birds, such as "the wood-pecker picks grubs from trees, because he is a doctor of trees (Prokop et al., 2007) p. 394)." In other words, the bird is trying to "cure" the tree of sickness by removing the bugs. Teleological statements are ones where children ascribe goal-like psychology to bird behavior, such as birds migrate to get warm, rather than birds migrate to find food to survive. In Prokop et al's study with students aged 7-15, the youngest students significantly misclassified animals that fly as birds, as well as birds that do not fly, suggesting that locomotion is a major cue when classifying animals. Science education researchers Chi and colleagues describe this as an ontological naivety in children, meaning that children's reasoning for categorizing concepts is flawed and needs revision (Chi, 2008; Chi & Roscoe, 2002). However, the grain size of knowledge involved in categorization is, according to Chi, the largest among three sizes of knowledge. This means that categorical mistakes reflect a more cohesive and robust knowledge network within the child's mind and take more time to change (Chi, 2008; Tippett, 2010). The point of presenting this information is that when children learn about birds in school, as they do in the larger RAISE Learning study (Hwang et al., 2024), children are not coming to this information as blank slates. Instead, children are learning the information through a theory of what makes a bird a bird and that theory most likely interferes with learning information about birds that is in line with current scientific thought.

Knowledge Revision

I have established that children come to school with science misconceptions and that these misconceptions are the result of an innate need to explain the physical world. Furthermore, these misconceptions interfere with acquiring new scientifically-accurate knowledge for a number of reasons- including the fact that misconceptions can impede students from making correct observations of phenomena because they tend to align observations with their misconceptions (e.g., bats are birds because they have wings (Chinn & Malhotra, 2002; Prokop et al., 2007) and that belief-confirming evidence is processed with less cognitive effort than incongruent evidence (Driver et al., 1994; Ecker et al., 2022; Pine et al., 2001; Venkadasalam & Ganea, 2018). Therefore, it is important to look at how misconceptions get revised and what the role of instruction is in that process of knowledge revision. One point of note is that researchers in both reading research and science education agree that knowledge revision is a slow process (Kendeou & O'Brien, 2014; Vosniadou, 2002, 2013). Therefore, starting science content instruction early will benefit children and lead to a number of positive outcomes including interest and achievement in science as well as accurate and robust knowledge of science topics (Morrison & Lederman, 2003; Tippett, 2010). Without instruction, misconceptions will persist. Instruction can restructure mental models and make way for new connections to build new and accurate models, but this is not an easy or short process (Carey, 2000).

Knowledge Revision During Reading: From the Reading Comprehension Lens

At a certain level, all learning is a process of continually revising knowledge, but how does it work? Two lines of inquiry can help answer the question of how incorrect knowledge/misconceptions get revised. The first line of inquiry is from research in reading processes and memory and the other is the research on conceptual change in science education. Both bodies of literature lend insight into how knowledge revision occurs and is supported through instruction. To start, I discuss the relevant research on knowledge revision in reading comprehension literature. Many reading comprehension models, including the C-I model, claim that comprehension requires a reader to continually update and revise information in memory with newly incoming information from the text (Kintsch, 1988). A reader relies on prior knowledge while reading to make sense of and learn from text, and that knowledge is stored in long-term memory (Kintsch, 1988). Basic assumptions in memory research assert that when a reader encodes new information from text, the information is processed with working memory (Kendeou & van den Broek, 2007). Working memory signals long term memory for information that resonates with the current text being processed including earlier text representations and general knowledge (Myers & O'Brien, 1998). This signaling process occurs in an autonomous and unconstrained manner, so even if the information in long term memory is incorrect, outdated, or incoherent, it is activated and brought to bear on encoding the new text via working memory (Kendeou & O'Brien, 2017). The degree to which the information helps or hinders comprehension depends on the accuracy, amount, and coherence of the information stored in long term memory (Kendeou & O'Brien, 2014; McCarthy & McNamara, 2021).

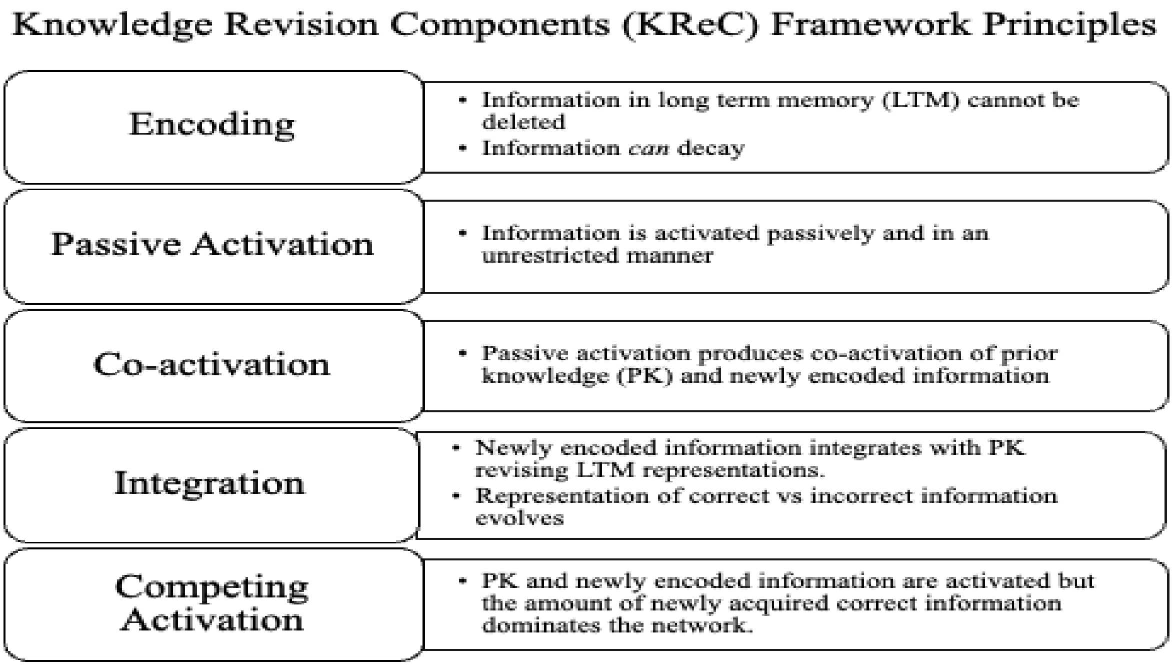
Research on narrative text comprehension provides evidence that readers engage in updating and revising knowledge to make sense of text. Experiments revealed that reading times were significantly slower for target sentences that required a reader to revise their knowledge about a character in a story, e.g. a character is introduced as a vegetarian and then sentences later, without qualification, that character eats a cheeseburger. Slowed reading times on targeted sentences generally indicate that the reader is working harder to make sense of the text and revising knowledge (O’Brien et al., 1998, 2004, 2010). Using the memory assumptions from above, the reading slows because the reader must sort through competing activation in memory, in the case of the vegetarian, the reader must sort how the character ordered a cheeseburger when they recently learned they were a vegetarian. Ongoing experiments with narrative and expository text show that information in long term memory, even when revised, gets summoned while reading. Therefore the outdated and updated information coexist and compete for activation (Kendeou & O’Brien, 2014). Researchers found that when experimental texts included causal sentences that supported the knowledge revision, interference from outdated information lessened in part because the causality statements supported an enriched and more connected network of knowledge (Kendeou et al., 2013). Therefore, the more robust the network of accurate knowledge, the less interference the incorrect knowledge poses.

Knowledge Revision Components Framework

Using the concepts just summarized, researchers Kendoeou and O'Brien outline in the Knowledge Revision Components (KReC) framework the following principles that form the basis of knowledge revision in the context of reading comprehension (Kendeou & O’Brien, 2014). Figure 3 illustrates the framework.

Figure 3

Principles of Knowledge Revision Components Framework, Kendeou & O'Brien, 2014



The first principle is *encoding* whereby information is encoded into long-term memory. It becomes a permanent part of long-term memory and therefore can be reactivated. The second principle is *passive activation*. Information in long-term memory becomes active and available via passive activation processes. The memory stores resonate or activate regardless of whether they facilitate or interfere with comprehension. The *co-activation* principle holds that previously acquired but no longer correct information and newly encoded information co-activate. This principle presents itself differently in narrative text research versus expository text research. Experimental research with expository texts shows that world knowledge (not just information specific to a narrative text as in the vegetarian example) revision is more likely when the outdated information (e.g., some people think vaccines cause autism) is explicitly stated in the text along with the updated/correct information (e.g., hundreds of studies conducted by scientists show that vaccines do not cause autism). This text condition facilitates co-activation in working memory and requires readers to slow and make sense of the conflicting information. This principle arose from research with science refutation texts (more on this later) (Kendeou & O'Brien, 2014)). *Integration,* the fourth principle, states that when newly encoded information is integrated with previously acquired information, the long-term memory representation is revised to consider the new information. Finally, the competing activation principle is the idea that the representation in long term memory is integrated and networked. Thus, when this newly created knowledge network containing both misinformation and correct information is passively activated for comprehension, there is a likelihood that the network has more "correct information real-estate" and this is what will be used to enhance comprehension and learn more accurate information further growing the "correct" network of knowledge. The KReC framework contends that knowledge revision is a slow, incremental, and laborious process.

Knowledge Revision in Science-the Framework Theory Approach

Knowledge revision in science education complements the KReC framework and addresses issues the KReC framework does not. Conceptual change is a "complex process, gradually occurring over an extended period of time, through which an individual revises their mental representations to align with the accepted scientific perspective (Broughton et al., 2013). Some researchers theorize that children's mental models undergo dramatic and wholesale shifts in a fashion similar to the process that the philosopher and science historian Thomas Kuhn described in his theory of paradigm shifts and science revolution (Carey, 2000; Duit & Treagust, 2003; Posner et al., 1982). While multiple theories about conceptual change in science learning exist, discussing them here is beyond the scope of this study (Carey, 2000; Chi, 2008; Duit &

Treagust, 2003; Kuhn & Pearsall, 2000; Malleus et al., 2016; Pine et al., 2001; Pintrich et al., 1993; Posner et al., 1982). The understanding most relevant to my study is that of Vosniadou and colleagues. Vosniadou and colleagues, like Kendeou et al., state that knowledge revision (also called conceptual change) is a slow and incremental process (Vosniadou, 2013; Vosniadou & Brewer, 1992; Vosniadou & Ioannides, 1998a; Vosniadou & Skopeliti, 2017). Vosnaidou and colleagues' theory of conceptual change, called the Framework Theory Approach (FTA), states that misconceptions in science topics are not faulty knowledge but productive knowledge that must undergo systemic change (Vosniadou, 2013). As stated earlier in this review, before instruction, children develop naive but relatively coherent explanatory theories in multiple domains, such as the shape of the earth, the nature of living things, and so on. Evidence for this is that children and adults with little exposure to science instruction answer questions about basic ideas in science in relatively consistent ways. These naive theories undergo two important kinds of changes to align with current scientific thinking. The first is that knowledge must be acquired to make new ontological commitments. This means that when children learn more about birds, for example, they alter how they categorize bird behavior from teleological (birds fly south because they are cold) and anthropomorphic (the bird eats bugs from the tree because the tree is sick and needs help) to adaptive for survival (due to evolution). These ontological commitments require new knowledge. Furthermore, for conceptual change to occur, children must also undergo epistemological shifts and achieve certain epistemic milestones[1]. The epistemological

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[1]Other researchers in the conceptual change literature discuss how true scientific thinking occurs when a thinker meets epistemological accomplishments. Kuhn and Pearsall discuss three. The first such accomplishment is attaining "theory of mind." Theory of mind is the idea that "assertions are understood as generating from human minds and are recognized as potentially discrepant from an external reality to which they can be compared (Kuhn & Pearsall, 2000), p.119)." Part and parcel of this theory-of-mind accomplishment is that a person can recognize that evidence can falsify a theory. To accomplish that, a person must know *how* one knows something. Did they come to their knowledge through imagination? Did they obtain the knowledge with their own eyes or hear it from a reliable

shifts require perspective taking (such as theory of mind, discussed earlier), an understanding of how knowledge is garnered, and an awareness of the difference between what constitutes evidence versus what constitutes a theory (a theory must undergo testing and evidence must be gathered). These epistemological shifts are gradual, domain specific, and somewhat dependent on developmental constraints but can be socially triggered (Vosniadou, 2013). The FTA argues that, like the KReC framework, misconceptions must be explicitly articulated and addressed by instruction. I address the instructional implications in more detail later in this review.

Instructional Interventions with Text for Science Learning

Thus far in the literature review, I have examined what research says about the cognitive processes involved in reading and gaining knowledge in science. I have discussed the role of knowledge, the nature of inaccurate knowledge and science misconceptions, and the cognitive processes involved in knowledge revision including science misconceptions. This next part of the literature review will discuss intervention approaches, first by introducing research and rationale for the expository text genre called refutation text. Then I return to the other theoretical framework that guides this study, the sociocultural one. Sociocultural theory claims that

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source? Preschool-aged children have little awareness of the sources of their knowledge. For example, children were unable to tell researchers how they just learned the contents of a drawer they were shown during an experiment (Kuhn et al., 1988; Kuhn & Pearsall, 2000). Once children know *how* they know something, they can participate in falsifying or validating a theory because they can tell the difference between knowledge that counts as evidence vs. knowledge that is theory. The final accomplishment in scientific thinking is once a person can distinguish the epistemological status between *theory* and *evidence;* something that thinkers of all ages struggle to do, not just young children. For example, when children are shown a picture of a boy that is first climbing a tree and then on the ground holding his knee, children will answer the question, "How do you know he fell?' with a theory-like answer "Because he was not holding on carefully" as opposed to an evidence-based answer such as "He was in the tree and now he is on the ground holding his knee which suggests he fell and hurt himself (Kuhn et al., 1988; Kuhn & Pearsall, 2000)." In other words, the children point to their theory as their source of knowledge not the evidence available to them. The implications here are that not until thinkers can distinguish what constitutes evidence from what constitutes theory, those beliefs and theories interfere and hinder someone's ability to acquire new knowledge that is accurate. These existing theories and beliefs act as a set of biases which interfere with knowledge building, in part because the naive theories promote the "cherry picking" of evidence that supports their theory (Pine et al., 2001).

language, thought, and knowledge are mutually developed within social and cultural activities. In the case of my study, this framework applies to the way primary students learn about science in their classroom with other students through text read aloud by their teachers. For this section, I use a wider lens and leave the individual behind to focus on the group. I include research on the current state of typical read-aloud practices in the primary grades and what kinds of read-aloud practices yield engagement and promote science learning. Finally, I indicate where my research study fills an important gap in the literature on knowledge revision and read-aloud practices with expository texts.

Refutation Texts

A considerable body of research has shown that refutation texts can be a tool for knowledge revision (Guzzetti et al., 1993; Sinatra & Broughton, 2011; Tippett, 2010). Before the KReC framework was proposed, early research on text structure and other interventions for knowledge revision was reviewed in a meta-analysis and concluded that refutation texts were the most effective intervention for conceptual change (Guzzetti et al., 1993). A refutation text is a text that explicitly states a misconception, or common theory, refutes it, and provides an explanation of the correct idea in line with current scientific thinking (Hynd, 2001). Below is an example of a first-grade version of a refutation text about birds. The italicized sentence is the misconception, and the bold sentence provides the refutation. The subsequent sentences provide further correct content about the concept.

> Birds are all around us, flying, singing, and nesting. Let's learn more
> about birds. *Some people think all animals that fly are birds. Do you?*
> **Well scientists agree that this is not true.** Many birds fly, as insects like

bees and ladybugs fly. Penguins and ostriches are birds and have wings. But they do not fly.

(Text adapted from the RAISE Learning text developed by H. Hwang, 2023)

As discussed earlier, the Knowledge Revision Components (KReC) framework (Kendeou & O'Brien, 2014) explains the online processes involved in knowledge revision and the role of the refutation text in that process. Knowledge revision can occur when the reader's prior and inaccurate knowledge is coactivated in memory with the accurate information being processed through text reading. A refutation text, with a statement like "some people think that all animals that fly are birds, but this is not true" ensures that the misconception will be activated in the reader's memory. As reading ensues, the misconception will be bound to the accurate idea in memory and exist in the same knowledge network. After the refutation sentence, the text's subsequent and accurate information will provide the reader with new information to fortify their knowledge network. The enhanced knowledge network is dominated by accurate ideas, such as "some birds do not fly, and some birds do not build nests, but they are still birds." The accurate ideas draw greater activation and enhance comprehension rather than hinder it. Thus the idea that knowledge coherence must also be considered as a factor when considering knowledge's relationship with comprehension (McCarthy & McNamara, 2021).

Tippet, in her review of the refutation text research, suggests that refutation texts are effective for knowledge revision and conceptual change for several reasons. First, the text structure invites metacognitive awareness, a condition that Vosnaidou calls out as a necessary factor for conceptual change to occur (Tippett, 2010; Vosniadou, 2013). Second, the structure of the text presents information in a coherent and plausible format, making it easier for readers to build robust networks of knowledge. And finally, a refutation text's efficacy depends to some degree on the nature of the misconception being "treated." This is where a discussion of the nature of the misconception as well as the dimensionality of knowledge is relevant. If the misconception is a full blown model (as in a theory as Vosnaidou suggests) then a single refutation text will have an incremental effect on nudging the reader towards a scientifically accurate conception (Chi, 2008; Ecker et al., 2022; Kendeou & O'Brien, 2014; Vosniadou, 2013). Or, according to the (MDK-C) framework, if the knowledge is coherent and robust but inaccurate, then the revision will take longer (McCarthy & McNamara, 2021). Chi (2008) would argue that categorical misconceptions (the rules for a given taxonomy like birds) also would respond in an incremental fashion. However, if the grain size of knowledge is simply a single idea or fragmented knowledge, refutation texts may have their biggest effect (Tippet, 2010).

Evidence that refutation texts facilitate coactivation, integration, and competing activation, as the KReC framework poses, comes from several studies. In one study, researchers (Kendeou & van den Broek, 2007) used both think aloud and reading time methodologies to investigate how undergraduates with misconceptions in physics process refutation texts. They found that undergraduates with misconceptions adjust their reading times when reading text that refutes their prior knowledge. Increased reading time indicates that the reader is working harder to make sense of the text because their prior knowledge and the statement being read is discrepant. Additionally, the researchers found that during think alouds readers with misconceptions engaged in conceptual change strategies while reading refutation text. These reading behaviors only took place with the refutation texts. Another investigation involving four separate experiments with undergraduates found that refutation texts reduced the disrupting effects of misconceptions, that a refutation plus causal explanation eliminated the disruptive effects of misconceptions on comprehension, and finally that the refutation plus explanation produced long term learning outcomes. From this investigation, researchers could claim that knowledge revision is a function of creating competition with incorrect information (Kendeou et al., 2014). In 2019, Kendeou and colleagues conducted another series of experiments. Researchers found evidence that after reading the refutation and explanation sections of the refutation that readers' think alouds revealed cognitive conflict and comprehension monitoring. The cognitive conflict reported accounts for the first two stages of knowledge revision, coactivation and integration. Think aloud analysis also revealed that readers experienced diminished conflict and comprehension monitoring when reading sentences that provided correct information (after the refutation section). This supports the occurrence of the third component of KReC, competing activation, whereby the more highly connected and correct information overtook the incorrect prior knowledge. Reading times and posttest data confirmed that refutation text structure facilitated coactivation and integration of the correct information. The posttest scores showed that knowledge revision had occurred with participants in the refutation condition. A study conducted by Ariasi and Mason (2011) using eye tracking methodology looked at reader's saccadic movements (how they track print) and their fixation times to gain insight into how readers allocate attention while reading. Participants read either a traditional expository text or a refutation text. They found that readers in the refutation text condition read the refutation passages more quickly than the standard text condition, but they spent significantly more time rereading the sentences containing the accurate explanations than the expository text group. The refutation condition group also reread the refutation sentences more frequently than the other participants. This finding suggests that readers in the refutation condition allocated more attentional resources to build coherence in their model of the text (Ariasi & Mason, 2011).

Research on the specifics of what kind of refutation texts are most effective has shown that refutation texts that include categorical information about the scientific topics can be an effective means to create conceptual change in readers (Skopeliti & Vosniadou, 2008). Recent evidence also supports that refutation texts support students' transfer of revised knowledge from refutation texts to a new related text. This research suggests that revised knowledge gained from a refutation text can be maintained and transferred to new contexts (J. Kim & Kendeou, 2021). For further evidence on the efficacy of refutation text to support the online processes of knowledge revision and learning outcomes, see reviews by Sinatra and Broughton (2011) and Tippet (2010). Yet, there is no research looking at the potential of refutation text used as a read aloud with primary-aged students for science knowledge revision. Table 1 overviews the studies conducted on refutation text as a tool for knowledge revision in elementary school

Table 1

Interventions with Refutation Texts for Science Learning for Elementary Students

Author/s	Participants	Area of science	Misconception	Text type	Teacher read aloud	Activities with refutation text	Major findings
Dole & Smith, 1989	103 5th graders	Physical science	Naive ideas about matter	Non-refutational expository text	No	Prior knowledge monitoring and integrating strategy (PKMI)/think sheets /Discussion/lab lecture	PKMI strategy more effective than traditional instruction
Dole & Smith, 1987	44 fifth graders	Life science	Naive conceptions of cells	Non-refutational expository text	No	PKMI strategy/think sheet /Discussion	More students in the PKMI group demonstrated scientifically accurate conceptions after instruction and fewer naive conceptions
Gordon &	23 5th graders	Life science	Wild animals	Narrative	No	Written	Narrative text

Author/s	Participants	Area of science	Misconception	Text type	Teacher read aloud	Activities with refutation text	Major findings
Rennie, 1987			are always ferocious	refutational text vs. expository refutational text		summary/concept map/research-led discussion	had a less potent effect than expository text on restructuring schema
Maria & McGinitie, 1987	44 5th graders	Life science	Animal behavior	Refutation text vs non-refutational expository text refutation	No	None	Text type was related to amount of new information included in recalls of text
Maria, 1987	112 5th graders	Physical science	Motion	Refutation vs.non-refutational expository texts	No	Activation / augmented activation	No differences on any measure
Maria, 1988	86 5th graders	Earth science	Seasonal change	Non-refutational vs refutational (two conditions of each-considerate and	No	Think sheet	Refutational-considerate text superior to inconsiderate text; think

Author/s	Participants	Area of science	Misconception	Text type	Teacher read aloud	Activities with refutation text	Major findings
				inconsiderate)			sheet effective only with refutational considerate text
Mason & Boldrin, 2008	94 5th graders	Physical science	Light	Refutation text vs expository text	No	None	Students who read refutational-text had higher posttest scores. High topic interest and more advanced beliefs about scientific knowledge also affected conceptual change. Students preferred refutational text.

Author/s	Participants	Area of science	Misconception	Text type	Teacher read aloud	Activities with refutation text	Major findings
Mason et al., 2019	91 4th and 5th graders	Physics	Energy	Refutation text vs standard text	No	None	Inhibition predicted conceptual learning after reading refutation texts not expository texts
Skopeliti, & Vosniadou, 2007	81 3rd graders	Earth science	Earth as sphere	Is refutation text containing categorical information more effective than refutation text containing noncategorical information?	No	None	Refutation text about categorizing the earth as a solar object rather than a physical object was more effective than text refuting flatness and up/down gravity
Skopeliti, & Vosniadou,	84 3rd graders	Earth sciences	Earth as sphere	Refutation text with	No	None	Refutation text

Author/s	Participants	Area of science	Misconception	Text type	Teacher read aloud	Activities with refutation text	Major findings
2007				categorical information vs refutation text without categorical information			containing categorical information was more effective than either refutation text with noncategorical information or non refutation text.
Tippet, 2004	40 3rd and 4th graders	Earth sciences	Seasons	Refutation text vs expository text	No	None	Refutation text was more effective than expository text. Changes resulting from reading a refutation text were more likely to be maintained.

To summarize, both the conceptual change literature in science education and the knowledge revision literature in reading comprehension demonstrate that refutation texts are an effective instructional intervention for supporting students to overcome misconceptions and enhance accurate knowledge in science. Most of this research has been done with students who read the texts themselves. In my study, teachers are reading texts aloud *to* students because most Kindergartners and first graders do not yet have the ability to read to themselves. While there is no research on read-aloud practices with refutation texts, I next review research on read-aloud practices with expository texts and highlight elements that produce optimal conditions for student science learning and engagement.

Current State of Read-aloud Practices for Informational Texts

An interactive read aloud, a common instructional practice in the primary grades, is when a teacher reads a book aloud to students and embeds various instructional activities including discussion, explicit vocabulary instruction, and possibly other linked activities such as writing (Conradi Smith et al., 2022; Greene Brabham & Lynch-Brown, 2002; Wright, 2019; Yopp & Yopp, 2012). Read aloud with informational text can support science learning and reading comprehension (Neuman & Kaefer, 2018; Wright, 2019). Educational policy has promoted an emphasis on texts in elementary science. Common Core State Standards (National Governors Association, 2010)) and the Next Generation Science Standards (National Research Council, 2013)) have called upon early elementary readers to engage with science informational texts and learn how to articulate their comprehension in the academic register. This policy has posed a challenge to teachers for several reasons. First, teachers have historically and currently preferred reading aloud narrative texts to children (Conradi Smith et al., 2022; Donovan & Smolkin, 2001;

Duke, 2000; Jacobs et al., 2000; Varelas & Pappas, 2006). Duke's seminal study (2000) describes text use in U.S. first grade classrooms, and she determined that a mean of 3.6 minutes per day were spent on instructional activities with informational texts, and that number was as low as 1.9 minutes in low SES schools. A recent study found that 93.7% of read-aloud titles selected by elementary teachers are narrative (Conradi Smith et al., 2022). The second challenge that science texts present for teachers and students is that they tend to be lexically dense and possibly dry and difficult to understand thereby requiring teachers to determine ways to make the texts comprehensible for their students (Conradi Smith et al., 2022). Third, teachers lack the disciplinary training and knowledge in science to support students' understanding of the texts (Conradi Smith et al., 2022; Oliveira, 2015; Pappas et al., 2002; Pine et al., 2001; Vosniadou & Brewer, 1992). It is precisely because science texts expose students to a high level of rigor that students need early practice with these texts (Karlsson et al., 2018).

Interventions that Promote Science and Reading Comprehension

In the early grades, the read aloud is a central instructional practice in a number of multi-component interventions that have shown to support science learning, language learning, and reading comprehension (Cabell & Hwang, 2020, 2023; Connor et al., 2017; J. S. Kim et al., 2021; Neuman & Kaefer, 2018). These interventions each use expository text read aloud as a central component of the interventions. While this literature review is not the place to detail the nature of each intervention, I pull out some key features of these interventions as they relate to what happens in the text read-aloud sessions themselves as this is germane to my study. Each of these interventions used high rigor expository science texts with primary-aged students. Each intervention focused on text-based discussion activities, most intervention incorporated concept mapping, and all included vocabulary instruction (Cabell & Hwang, 2020, 2023; Connor et al., 2017; J. S. Kim et al., 2021; Neuman & Kaefer, 2018). One intervention in particular called *SOLID Start* aimed at increasing students' science talk, defined as students' abilities to make claims, use science vocabulary, and support claims with evidence (Wright & Gotwals, 2017). Next, I drill down into what kinds of talk should happen during a read-aloud that supports science learning and engagement.

Read-aloud Practices for Optimal Science Learning and Talk

In the interventions mentioned above, text discussion is a key component. The research on extratextual talk can help clarify what the important features of an effective read-aloud session for science learning are. Extratextual talk is the talk that happens during a read-aloud session related to the text itself (A. Anderson et al., 2012). The term incorporates the kinds of talk that both teachers and students use. As mentioned earlier, science texts tend to be lexically dense and place a high demand on readers (or listeners) to comprehend the text and make meaning of the science that is covered within the text (Donovan & Smolkin, 2001). Teachers can mediate the density of these texts by leading discussions during text reading and in so doing support students to engage in science talk and thought as well as make meaning of texts read aloud (Gotwals et al., 2022; Oliveira, 2015; Pappas et al., 2002; Snow, 2010; Varelas & Pappas, 2006). There is evidence that when teachers engage elementary students in rich discussions, science learning and language learning benefit (Beck et al., 1982; Broughton et al., 2010; Gotwals et al., 2022). For example, critical evaluation of a science text using small group discussion formats such as "Question the Author" has been shown to increase knowledge and knowledge revision in science (Beck et al., 1982; Broughton et al., 2013). Outcomes also improve when teachers inform themselves of the kinds of misconceptions children bring to instruction, lead discussions about these theories, and strategically select refutation texts to read about the topic (Hatano & Inagaki, 2003; Pine et al., 2001; Vosniadou, 2013). When teachers elicit children's ideas about a topic and have children speak verbally about them, the misconceptions' interference may be lessened (Pine et al., 2001; Vosniadou, 2013). This idea is resonant with the KReC assumption that all prior knowledge is activated, incorrect or not, and when a refutation text explicitly names that incorrect knowledge, it is more likely to get coactivated with the correct knowledge. Additionally, discussions where students compare their theories to those of the scientific community encourage what Vosniadou calls "metaconceptual awareness" a necessary component of knowledge building and conceptual change (Vosniadou, 2013). For example, in the case of learning about the earth as round, students would detail their own theory of the earth with drawings and discussion and then compare it to the more accurate models and pictures of the earth with a variety of media (Venkadasalam & Ganea, 2018; Vosniadou, 2013). A number of studies show that when refutation text is used with small group and teacher-led discussions, the text's efficacy is enhanced (Broughton et al., 2013; Nussbaum et al., 2008). Read-aloud discussions like these afford students critical opportunities to practice the scientific register, an entry point into disciplinary literacy (Halliday, 1975). The scientific register is how students "talk like scientists" by using the vocabulary and epistemological habits of scientists, such as argumentation practices and supplying evidence for claims. In a study that examined student discourse in elementary science classrooms, Hoffman, the author, found that levels of interaction and the construction of meaning had a relationship–higher levels of interaction were associated with higher levels of meaning construction (Hoffman, 2012). Higher levels of interactions were defined as multiple Initiation Response Feedback (IRF) exchanges between teacher and students. Higher levels of meaning construction were defined as when the teacher built from and extended upon student interpretation to represent her own or accepted knowledge. One study found that science read alouds typically lasted for approximately 15 minutes and 48 seconds with 46% of the total time being spent on teacher-led discussion (Glass & Oliveira, 2014).

Given that discussion is used to build understanding of science texts, it is important to know what the literature says about how to best use that time. In a recent meta-analysis of 48 research studies about science talk, Gotwals et al. (2022) found three characteristics of high quality science talk. The first is talk that supports equitable student participation and engagement. This means that teacher talk is balanced with student talk and children have multiple opportunities to add to a discussion and talk with each other. The second characteristic is that students are invited and trained to use *habits of thought* associated with science such as questioning, exploration, critique, using evidence, and argumentation with the aim of deepening science knowledge. The third characteristic is when students use the language of science including the terminology and phrases of science. The studies included in the meta-analysis made claims for *how* these talk characteristics were accomplished, and while the number of these strategies is beyond the scope of my review, I highlight some that are relevant to supporting rich discussion during a read aloud. Teachers who fostered high quality talk promoted discussion by elaborating, restating, and clarifying children's ideas. They provided wait time, scaffolding, and asked follow-up questions to probe student ideas further. Teachers provided limited if any evaluation of children's ideas and instead used open ended questions such as "why," "how," and "what if." Multiple studies also focused on teacher moves that *shut down* talk. Examples of these shut-down moves included the overuse of closed and known-answer questions, teacher-heavy control of the flow of discussion, and the authoritative presentation of science concepts. Successful teachers focused on students' lived experiences and connected the science content with those experiences. Classrooms that employed norms, structures, and routines for a variety of modes of participation were successful at facilitating science talk as well as those that used student friendly definitions of science terms and used sentence stems to encourage use of technical terms and phrases. In other words, a plethora of sound teaching strategies were employed to guide students to talk about science in generative ways.

The bidirectional nature of student talk and teacher talk is also an important line of inquiry in studies concerning the quality of extratextual talk. Some of the studies included in the meta analysis discussed above address this issue specifically. ‘‘Children adjust their discourse to match the level of the adult’s conversation’’ (Zucker et al., 2010, p. 67) is a claim across a number of these studies (Donovan & Smolkin, 2001; Gjems, 2011; Glass & Oliveira, 2014; Menninga et al., 2017; Price et al., 2012; Zucker et al., 2010). With that notion in mind, researchers highlight three characteristics of teacher talk that contribute to the development of sophisticated language skills in students. These characteristics include syntactic complexity (Huttenlocher et al., 2004), varied vocabulary (Peterson & French, 2008), and extended discourse and cognitive and linguistic stimulation (Dickinson & McCabe, 2001). A recent study of first grade science lessons explored the relationship between teachers’ and students’ language use in real time. Researchers found that teachers and students were sensitive to each other’s use of complex and dense language. They also found that the use of open-ended questions was related to complex and dense student utterances (Menninga et al., 2017). However, according to Glass and Oliveira, teachers must be strategic on how they deploy sophisticated language for students during science text read alouds (Glass & Oliveira, 2014). They found that teachers engage in accommodation strategies along a continuum of simplification and sophistication to support their students to access science text and engage in the scientific register. This bidirectional process is related to the fact that teacher talk serves two important functions-content transmission and register acquisition- and that both need to occur for students to both understand difficult content and still have practice with the scientific register. Basically, teachers can simplify content so it is comprehensible, but they still need to prompt and scaffold for sophisticated science language acquisition.

Another way to define and evoke high quality talk during a read aloud is to focus on language and thought that is inferential in nature (Blank et al., 1978; van Kleeck et al., 2003; Zucker et al., 2010). Teachers can support students to identify information that is implicit in the text by asking inferential questions and using think-aloud techniques to model inference making and inferential language. This practice is especially important with science texts because the implicit information is not obvious to young children. For example, if the text states, “Bees need pollen for food. Scientists studying bees encourage people to plant native flowers in their yard to help bee populations stay healthy.” By asking students a question like, “Why would more flowers help bees?” The teacher can help students fill in the missing information about where bees get pollen for food (Hwang, Orcutt, et al., 2023). Several researchers have provided rubrics identifying features of inferential language to use and expect of children during discussions (Blank et al., 1978; van Kleeck et al., 2003). Student talk that uses more inferential language shows engagement and a higher level of cognitive load on students (Lennox, 2013). Interestingly, “teachers naturally adopt one of a relatively small set of approaches to reading with children, but they tend not to be aware of these patterns” (Dickinson & Smith, 1994, p. 118).

In summary, science read alouds combined with discussion are a critical way to cultivate science interest and knowledge in young children because children can make sense of science topics by talking. Discussion during a science read aloud gives students practice in developing disciplinary literacy skills in science and deepening their understanding of scientific concepts. Research has shown that the quality of talk that ensues during these read-aloud sessions matters and can vary. I examined research that provides evidence for the importance of talk during a read aloud and describes what kinds of talk best supports students to practice using the scientific register, using inferential language, and engaging in the kinds of epistemic habits of scientists, such as reasoning and using evidence to argue claims.

The Present Study

Researchers' understanding of the reciprocal relation between reading and science has grown in recent years. Science knowledge can support reading, enhance text memory, and support inference-making during reading (Cervetti, 2022; Hwang, McMaster, et al., 2023). Reading can support science knowledge and can be leveraged for learning about science throughout the school years (Cervetti, 2022; Hwang, McMaster, et al., 2023). How can this research be translated into classroom practices that promote science learning and interest in science topics? Evidence suggests that primary teachers do not use science expository texts with their students (Romance & Vitale, 2012). Evidence also shows that science instruction time is shrinking as other subjects, such as literacy, have grown to take on more of the daily schedule (Connor et al., 2017; Hwang et al., 2020). A win-win to this dilemma is to integrate science texts into the literacy block. However, many primary teachers report that they do not feel confident teaching science and may benefit from knowledge on how best to support science learning in their classrooms so that they do it more often, with more finesse, and with more sense of purpose (Pine et al., 2001). A common practice in classrooms to build language and knowledge with young children is through text and talk. The interactive read aloud has great potential to introduce children to science topics, generate interest, grow children's science knowledge, and provide opportunities to talk about science. Thus, my focus in this study is to examine the qualities of the interactive read aloud with two kinds of expository texts, one standard text and one refutation text.

My study's aim is to look at how teachers use two different kinds of informational text to generate student learning and interest in a science topic. When looking at how teachers use the read aloud for talk and knowledge building, empirical literature shows that several things are important to pay attention to. First, how does the teacher attend to conveying new science facts while addressing science misconceptions which are so common among young students? Second, how does the teacher generate talk among their students? What kinds of questions do they pose? What kinds of gestures do they use to engage students? How do they respond to student talk? What kinds of intonations do they use during the read aloud? What is the nature of the teacher's extra-textual talk? Does it change by style of book? And does a certain style of informational text influence the teacher's ways of reading? Does it impact their delivery of the material? Does the teacher know the importance of accuracy in science learning? Does this get conveyed through reading and discussion?

To increase understanding of the ways teachers can foster science learning, this study fills an important gap in the literature. Refutation texts have been effective for science learning among later elementary and adolescent learners, but they have not been explored in the primary setting. Investigating how these texts are used by teachers to convey science content and generate discussions among students will contribute new understanding on how educators can effectively use the read aloud to foster science learning and science talk in the primary classroom. Findings from this study can contribute to teacher practice by providing descriptions for ways to foster science reading engagement and knowledge revision for the youngest learners; additionally, findings generated from this study contribute to practice by emphasizing the importance of accurate science knowledge building for primary aged students and its relationship to reading comprehension and performance.

Research Questions

What, if any, are the differences between teachers' read alouds of a standard informational text compared to refutational texts of the same topic?

What are teachers' observations about their students' uptake of the information in these two kinds of texts?

What, if any, are the differences in student engagement with these two kinds of read-aloud texts?

Summary

The construction of knowledge happens through language and cultural activities such as reading. Knowledge is critical to being able to read and understand texts. Knowledge is a complex and multifaceted concept that research has sought to define and operationalize in terms of how it relates to reading and comprehension. There is evidence of a positive bidirectional relationship between science domain knowledge and reading performance. Therefore, cultivating science knowledge early in children is a worthwhile pursuit both for purposes of developing strong readers but also for cultivating interest and proficiency in the sciences. Because knowledge is not monolithic, but instead multifaceted, it is important to consider the role that accuracy plays in reading comprehension and learning new science topics. Research has shown that inaccurate knowledge interferes with reading comprehension and learning science that conforms to current thinking. Children possess inaccurate science knowledge, called misconceptions. These serve a function in children's lives as they have explanatory powers about how the world works so that they can successfully interact and explain the world around them. With instruction and time, these misconceptions can evolve and become aligned with current scientific thought. Two frameworks, one from the reading comprehension literature called KReC (Kendeou & O'Brien, 2014) and one from the science education literature called the Frameworks Theory Approach (Vosniadou, 2013) explain how knowledge revision works. Refutation texts are an effective tool to promote knowledge revision in science. The efficacy of refutation texts has been established with older students, but not yet with primary students. However, research shows that science texts read aloud are at the heart of multiple interventions that have been successful in improving both science knowledge and literacy outcomes. Because discussions are an integral component of science read alouds, my study benefits from the literature that investigates the nature of those discussions, referred to as extratextual talk. The quality and quantity of extratextual talk matters greatly to the sense students make of science topics. My study looks at how teachers use two kinds of science texts, a refutation text, and a traditional expository text, to promote discussion and learn accurate information about birds.

The next chapter I discuss the methods I use to address the research questions of this dissertation study.

CHAPTER THREE

METHODS

In my review of the literature, I looked at the critical role that knowledge plays in text comprehension. Since knowledge is such a large and ambiguous construct, I also discussed recent efforts in the literature to further define and dimensionalize knowledge. By operationalizing two more specific notions of knowledge, including science domain knowledge and accuracy of knowledge, I argued that developing both dimensions of knowledge is a priority for readers in early elementary school. Two instructional tools support students to learn about science and develop accurate science knowledge: the read aloud and refutation texts. Much has been written about what practices best leverage a read aloud for science learning and engagement, namely using high-rigor texts, posing open-ended questions, connecting background knowledge and personal experience to the topics of the texts, defining key vocabulary, and discussion. The study of discussions, called extratextual talk, has described and provided evidence for a number of conditions that make extratextual talk productive and positive for student outcomes such as oral language development and science knowledge (Gotwals et al., 2022). Some of the features defining high quality talk include the following: equitable participation in talk; teacher use of complex language and vocabulary balanced with reasonable language accommodation strategies; and the expectation of and support for student use of the scientific register (Glass & Oliveira, 2014; Gotwals et al., 2022; Hoffman, 2012; Menninga et al., 2017; Rogoff, 1990; Snow, 2010). The research on extratextual talk provides valuable insights about the learning that can happen during a read aloud with a science text. However, there is evidence that children come to school with inaccurate science knowledge and that inaccurate knowledge interferes with learning. Refutation texts have proven to be an effective tool to resolve knowledge inaccuracies and support learning accurate information with older students (Kendeou & van den Broek, 2007). However, there is no research that examines the use of refutation texts read aloud to students paired with the use of discussion. As momentum grows for practitioners to integrate science instruction into the literacy block, practitioners and researchers alike will benefit from the knowledge of how these texts can be best used during a read aloud for science learning, for promoting science talk, and for students to create a robust network of accurate science knowledge. My study is a mixed methods study aimed at describing how teachers use the science read aloud with standard text and refutational texts.

Research Questions

What, if any, are the differences between teachers' read alouds of a standard informational text compared to refutational texts of the same topic?

What are teachers' observations about their students' uptake of the information in these two kinds of texts?

What, if any, are the differences in student engagement with these two kinds of read aloud texts?

Context of the Larger Study

This study is part of a larger study called RAISE (**R**ead **A**loud **I**nstruction for **S**cience) Learning. The purpose of RAISE Learning is to investigate the effects of interactive read alouds of refutation text to support knowledge revision in primary-aged students. Findings from this study provide empirical data on the effect of refutation texts delivered as interactive read alouds on the knowledge revision of K-2 students. Additionally, the study investigated the moderating effects of inhibition and topic interest with each effect. The larger RAISE study was funded by the American Psychological Association Division 15 (Educational Psychology). The present study, nested in the larger study, looked at the characteristics of teacher read-aloud styles by text type and by teacher. Through qualitative and quantitative methods, I created descriptions of read-aloud session by text type and by teacher. I also analyzed teacher interview data from four participants about their experiences with the text types and the read aloud.

Setting

This study took place in an elementary school in a small district in a large Midwestern metropolitan area during summer school. The district has five schools, an early learning center, and approximately 3,400 PreK- Grade 12 learners. Summer school was open and free to all students in the district. The district has many multilingual learners, students who qualify for free or reduced-price lunch, and students from diverse racial backgrounds. The district has an English learner population of 41.7%, a free and reduced-price meals population of 77.8%, and a racially diverse population including 27.3% Black of African American, 48.1% Hispanic or Latino, and 14.6% white.

Participants

The study's participants were teachers and students of a small suburban district over the summer school session. I conducted the study in one of the districts' three elementary schools. Many of the students and teachers were based in other schools in the district during the regular school year.

Teachers

Study participants were eight teachers who taught during summer school. All of the teachers taught in the district during the regular academic year and all were licensed teachers. Six of the eight teacher participants were women. Three of the teachers held master's degrees, two of the teachers self-identified as African American, two as Hispanic, and four as White/Caucasian. Their experience teaching ranged from 0 years (that teacher had only done student teaching) to over 25 years. The mean number of years of teaching experience was 8.5 years. Table 2 shows the teacher demographics.

Students

86 end-of-year kindergarten and first grade students participated in this study. The average student age was 6.72 years. 41% of the student participants were female. 48.41% were eligible for English language service and 79.76% qualified for free and reduced-price meals. Two students' data were missing.

Procedure and Materials

Texts

Two types of texts had been developed by RAISE Learning's principal investigator, HyeJin Hwang: a refutation text and a standard text (Hwang, 2023a, 2023b). These texts have similar readability and word counts and contain the same information about birds. The texts address multiple Next Generation Science Standards (NGSS) and Common Core State Standards in English Language Arts for kindergarten and grade one students. One text was written in the refutational style, the other text is written in a standard informational style. The texts have many photographs to engage young learners. Many young children struggle to correctly identify and categorize birds. The refutation text directly addresses this and other common misconceptions children have about birds (e.g., all birds fly, all birds have nests, etc.), refutes them, and provides accurate information about what classified a bird as a bird: feathers. The standard expository text relays the same information, without the rhetorical style of the refutation text.

Professional Learning

Before the study began, we provided teachers with a one-hour professional learning session. This session's objectives were as follows:

- Consider important ideas that connect reading and science instruction.
- Explore how to use read-aloud instruction to support young students' science knowledge.
- Anticipate what activities will take place in your classroom and when for the RAISE Learning project.

Teachers were given information about research-based ways to support conversation, support inference making, to teach vocabulary, and to support comprehension monitoring. Teachers received two texts but did not know the style of either text, however they knew that both texts were about the same topic of birds. We also did not directly discuss refutation texts with teachers although they were mentioned as a genre of expository text in the professional learning session.

Logistics

Teachers were given the two kinds of texts the day before they were expected to do the read-aloud session. Teachers were not given explicit instructions on how to do the read aloud, they were simply asked to read the texts in whatever manner they saw fit. Teachers did two read-aloud sessions in one day. Teachers read the standard informational text to a small group of their students, and the refutational texts to another small group of their students in a successive fashion. While one group of students was participating in the read-aloud sessions, the non-participating group was taken to the library to do some activities by graduate students. This enabled the teacher to conduct the read aloud session with a small group of students (3-5 students).

All students were assessed with the Cubed Narrative Language Measure (NLM) for kindergarten and first grade to establish a baseline for language comprehension. Students were grouped to establish an even distribution of language comprehension skills for each read-aloud session. On any given day during the study, three teachers did the read-aloud sessions at the same time. The order in which the teacher read the two types of texts alternated by day, meaning on one day the teachers read the standard text first and the refutational text second and on the next day they used the opposite order.

Data Collection

Read-Aloud Sessions

Video recordings were made during the read-aloud sessions for each small group for each teacher, resulting in 15 recordings of approximately 15-25 minutes each. For one of the teachers, we were unable to record the read-aloud session with the refutation text due to technical difficulties. Table 2 shows demographic data for the participating teachers.

Table 2

Summary of Teacher Demographic Information

Gender	Race/ethnicity	Years of experience	Education level
Female	Caucasian/white	0	A few courses short of bachelor's degree

Female	Caucasian/white	10	Bachelor's degree
Female	Caucasian/white	25	Master's plus additional course work
Female	Caucasian/white	25	Master's plus additional course work
Female	Hispanic	1	Bachelor's degree
Female	Latina	9+	Bachelor's degree
Male	African American/Black	8	Master's degree plus additional course work
Male	African American/Black	1	Bachelor's degree

Teacher Interviews

To answer the research questions:

- "What are teachers' reflections on the two conditions of read-aloud sessions (standard informational text and refutation text)?
- What did teachers notice about their students' response to the read-aloud conditions? and,
- What do teachers say about the purpose of the read-aloud in general?

I conducted four teacher interviews. The purpose was to gather information about what teachers noticed during the read-aloud sessions and what their beliefs were about the purpose of read-aloud instruction for their students. These interviews followed a standardized open-ended approach. The order and content of the questions were predetermined (Patton, 2014). Interview questions are included in Appendix A. I interviewed two teachers who had fewer than five years of experience and two teachers with more than nine years of experience. Three of the teachers were women and one was a man. Three of these interviews were conducted via videoconferencing and one was conducted in person.

The larger study of RAISE Learning collected additional data on the following topics: student interest in birds, student knowledge about birds, and inhibition. These measures were not included in my analyses of the video recordings and teacher interviews.

Transcription of Video Recordings

The goal of transcription was to capture as much of the context and specifics of the read-aloud session as possible. I transcribed what teachers said, their gestures, expressions, and their tone of voice. I captured what students said as much as possible along with their gestures, expressions, and body language if possible. Oftentimes students were difficult to hear and spoke in unison, so their words were not transcribed with as much precision as the teachers' communications.

For ease and purposes of analysis, I created the transcript by utterance, as that is the unit of analysis for this study. I chose this unit of analysis because I needed a consistent and precise unit to evaluate and compare the different approaches used in the read alouds among teachers and text types. Another reason I chose the utterance as the unit of analysis was because the other variables, such as the number of students in each group, the language abilities of the students, the text, and the settings of the read alouds were controlled and I wanted to make sure I had as precise a measure as possible to compare across teachers and texts. Other mixed-methods studies investigating extra-textual talk have used the utterance defined as I have above as a unit of analysis (A. Anderson et al., 2012; B. E. Anderson, 2021; Halliday & Matthiessen, 2013; Miller et al., 2016; Price et al., 2009; van Kleeck et al., 1997, 2003; Zucker et al., 2010, 2021). An utterance is defined as a unit of speech by one speaker bound by a conversational turn and one main clause. A conversational unit has one main clause (subject-predicate) but may have a dependent clause (Halliday & Matthiessen, 2013). Each independent clause got a line break. These types of utterances were transcribed as questions:

what is a bird? *question word at beginning of utterance*

is that a bird? *inversion of subject-verb*

that's a bird,, right? *tag question at end*

bird? *word with rising contour at the end*

Gestures, tone of voice, and other context clues are indicated with each utterance if notable in italics. Text read aloud is indicated with curly brackets { }. If the teacher is the speaker, the line starts with "T:". If the speaker is a student/s, the line starts with "S:" I did not distinguish between students when transcribing comments.

Qualitative Data Analytics for Read-Aloud Transcriptions

Coding Procedure

Coding was done in Dedoose, a software for qualitative and quantitative analysis. I generated provisional codes (Miles et al., 2014; Saldana, 2021) after reviewing the transcripts multiple times. These codes were informed by the empirical literature on knowledge revision, students' engagement in the scientific register, dialogic reading, and extratextual teacher talk. I decided on my initial codes from observing the read-aloud sessions. Once provisional codes were developed and applied, I used analytic memos and iterative pattern coding to refine the codes further, I conducted this process multiple times. Inter-rater reliability sessions with a graduate student supported the iterative coding process and helped to evolve and clarify codes, their descriptions, and their applications. The process involved training a graduate student on the contextual nature of applying codes to the transcript. For example, to code properly, the coder had to consider where in the transcript the utterance occurred in relation to the discussion among participants and the content of the text. In other words, the context of the utterance determined much of how something was coded. Therefore, to code properly, one had to know what text had been read, what discussion had been had, and what comments had been made to determine the appropriate code to apply. Through working together and discussion, the graduate student used the final codebook on two transcripts. Not all codes were tested, only the ones deemed most important for analysis. I did four Cohen’s kappa tests on a subset of codes using multiple transcripts and Excel. Cohen's kappa is a widely used and respected measure to evaluate inter-rater agreement based on the actual coding behavior of each rater as compared to the rate of agreement expected by chance (Cohen, 1960). Coders established a Cohen’s kappa value of 1.0 for inter-rater reliability for coding of the general categories of teacher extratextual talk (text commentary, responses to students, teacher questioning, and management). Coders established a Cohen’s kappa value of 0.877 for inter-rater reliability for the teacher levels of abstraction codes (Levels 1-4) and a Cohen’s kappa value of 0.813 for inter-rater reliability for coding student production amounts (high production and low production), and quality of student talk (inferential, literal, and association). A description of these codes will be presented below. An inter-rater reliability kappa score between .75-1.0 is considered an excellent agreement score (Fleiss, 1971).

Teacher Codes

To answer the first research question, **"What, if any, are the differences between teachers' read alouds of a standard informational text compared to refutational texts of the same topic?"** I went through the following process of coding utterances.

After multiple rounds of coding, I determined that the following four categories of teacher extratextual talk facilitated the deepest analysis: TEACHER QUESTIONS (TQ); COMMENTS ABOUT THE TEXT (TC); and, RESPONSES TO STUDENTS (RS) in the form of statements**.** I also coded READING TEXT (RT) when the teacher read the text as it was written, and management statements (MGT). Extratextual talk is all of the teacher talk outside of reading the text during the read-aloud session. By examining the general categories of extratextual talk, I was able to home in on what kinds of talk was most frequent and thus able to analyze each category with more depth.

TEACHER QUESTIONS (TQ) was the most common category of extratextual talk. I created additional codes for teacher questions to do a finer grain analysis of the questions that teachers posed; I looked at both the form and the content of questions teachers posed. I created child codes for teacher questions that addressed trends in the types and purposes of the questions. I coded questions related to the content of the text for levels of abstraction. In addition to questions pertaining to the topic of the text, questions served other purposes within the read aloud such as, emphasis of information; conveying enthusiasm and affect for the topic of the text; correcting students; and conveying procedural commands. The TQ parent code had five child codes including LEVELS OF ABSTRACTION which had four categories, TURN TAKING question, REPAIR question, TAG question, and CLOSED question.

Content Questions and Levels of Abstraction

For questions of content related to the text, I created four additional codes to determine the LEVELS OF ABSTRACTION (LOA) because I was interested in the level of rigor teachers posed to their students. The LOA codes were the focus of the analysis of content-based questions. I was interested in how teachers engaged students in thinking about the topic of birds, how they encouraged students to "think like scientists" and use the skills of description, inference, reasoning, hypotheses, application of their own knowledge and experience, new vocabulary words, and synthesis to discuss the topic of birds. The idea of a cognitive load that teachers placed on students during discussions expressed itself in coding questions on a scale of the level of abstraction demanded by the question. The empirical literature I discussed in Chapter Two highlighted that when teachers ask questions with a higher cognitive load, students follow suit and tend to be more engaged in discussions (Menninga et al., 2017; Zucker et al., 2010). The empirical literature also states that if teachers focus on students' background knowledge and personal experiences with the scientific phenomena, students will talk more, make more connections with the topic, and possibly share any misconceptions they have about the topic (Varelas & Pappas, 2006b; Vosniadou, 2013).

Level 1 questions were characterized by requiring students to match their perception of print or spoken words by labeling, counting, repeating, imitating, identifying objects or words in print. Examples of Level 1 questions were: "What color are these eggs?" or "Can you say rachis?" Level one questions place a low cognitive demand on students.

Level 2 questions required selective analysis of perception. They also placed a relatively low cognitive load on students. These questions required students to describe information just relayed, imitate/act out information relayed, describe perceptual qualities of objects/print, and recall information from a single page.

A Level 3 question required a student to reorder or infer about perception. Level 3 questions asked students to draw an inference from something not explicitly stated in text, explain, or infer animal behavior, evaluate or judge non-perceptual qualities of objects/ideas/text as a whole, draw text-to-life connections/comparisons, compare similarities/differences of objects, animals, animal features, summarize/synthesize information across more than one page, or formulate a generalization about bird features or behaviors. An example of a Level 3 question is: “What did you learn about birds after reading the entire text?” I coded this as Level 3 because it asked the student to synthesize what they learned from the entire text.

One of the descriptors of a Level 3 question that posed a concern for coding was the descriptor, “draw text-to-life connection/comparison.” Teachers asked students to make connections about the content of the book to their daily lives by asking questions such as, “Have you seen other kinds of animal nests?” or “Do you have eggs in your refrigerator?” Although they required students to connect the text with personal experiences, I questioned the level of cognitive demand these questions posed. Sometimes teachers asked questions that required inferences, for example “What do you think penguins eat?” after reading about how penguins do not fly and live near water.

Level 4 questions asked students to reason about perception; predict/hypothesize about subsequent events/conditions; define a word's meaning; define the function/purpose of an object or print unit or animal feature; explain conditions that cause alternate outcomes or a solution; identify causes of occurrence/events; identify direct or indirect effects; distinguish between fact and fiction; provide factual background information beyond the text; provide reasoning about an idea or hypothesis.

I coded these as level 4 questions because they required a student to provide factual or personal experience with the topic beyond the text. Some of the phrasing of these questions was as follows:

> "Student D, what would you say if your tiny little two-year-old brother or sister came up to you and said 'Student D what's a bird?'"
> "What do you know about birds already?"
> "How would you describe birds?"
> "What do you know about birds?"
> "Do you know anything about birds?"
> "What is a bird?"

I adapted the LOA rubric from studies that examined extratextual talk of preschool children in shared book reading settings (van Kleeck et al., 1997, 2003; Zucker et al., 2010). The LOA was originally intended for narrative texts, so I adapted the rubric for primary students and for informational text.

Turn-Taking Questions

The form and purpose of the question mattered in the context of the read aloud so I analyzed the intent and purpose of the question within the context of the read aloud. When teachers posed a topic-based question for a particular student to give each student a turn with a particular question, I gave these questions an additional code, called TURN-TAKING QUESTION (TTQ). An example of a turn-taking question was, "What did you learn about birds, student X?" or sometimes it may just look like this in the transcript, "Student Y, what about you?" Excerpts coded as TTQ were also coded for their level of abstraction (LOA) and if they were closed or open questions.

Tag Questions

A tag question (TAG) is a statement that is delivered as a question, or when a teacher's voice rises in pitch at the end of a statement. For example, "But that doesn't mean the bird is gold, right?" is a tag question because within the context of the lesson, the teacher did not wait for a response and instead kept talking. Most tag questions were also coded as CLOSED questions because they bid for a "yes" or "no" response, or a one-word, known-answer response if they bid for a response at all. Tag questions presented a dilemma with coding because the intent of the question was different from the content of the question's meaning. However, if the intent of the question was to make a statement, but the teacher did so in the form of a question to seek affirmation, the question was coded as a tag (TAG) question. These were oftentimes not genuine questions that expected a response from students, except for "yes" response.

Repair Questions

If the intent of the question was to serve as conversational repair, a technique to acknowledge a speaker and close out a conversation whereby generally the teacher simply repeats what the child says with the signature lift of voice pitch then this type of question was coded as repair (REPAIR). A repair question generally occurred in response to a child statement. For example, a student responded to the teacher's question, "What do you know about birds?" with the response, "They fly." The teacher responded with, "They fly?" The teacher repeated what the child said with an increase in pitch to indicate a question to acknowledge and wrap up the conversational exchange. Sometimes repair questions seemed to indicate an affirmation to the student. However, at times the repair question came across as an ambiguous response, for example ”really, they fly?” And sometimes it seemed to be a correction of the student's response, as in “Are you sure they fly?” This ambiguity presented a dilemma for coding.

Closed Questions

Finally, I coded questions for how they were phrased. I coded questions worded in such a way that the respondent can answer with a one-word known answer or “yes” or “no” as closed (CLOSED). All question types, including those with the following codes, Levels 1-4, REPAIR, TTQ, TAG were further considered for the CLOSED code. I did not do inter-rater reliability testing for the CLOSED code. The coding scheme for teacher questions is detailed in Table 3.

Table 3

Teacher Question Codes and Child Codes

Code	Content (C) or Form (F)	Code description	Examples
Questions to Students (TQ)	C/F	An utterance in the form of a question to students about the text or topic of birds	What are birds? Do you know that birds fly?
Closed questions (CLOSED) Form-related	F	The phrasing of the question is such that respondents choose from a predefined set of responses, typically one-word answers such as “yes/no”, “true/false”, or a set of known responses.	Do you know anything about birds? (closed) What do you know about birds? (open) Is this the rachis or the barb?
Tag question (TAG) Form-related	F	A statement that takes on the form of a question. statement that ends in a ? rather than a period. Generally the teacher does not expect an answer or need one.	This is cool, right? Are you ready to learn more?

Code	Content (C) or Form (F)	Code description	Examples
Turn taking questions (TTQ) Form-related	F/C	Turn taking question-interrogative that give a child the floor to speak to the question at hand about the text	Emiliano? (what do you know about birds?) Last but not least, Ariana?
Repair Questions (REPAIR) Form-related	F	Restating what children say with a question at the end. Asking a question back to a student's comment. such as you think so?	Child says: Feathers. Teacher says: Feathers? Child says: I have two. Teacher says: You have two? Child says: I think that is a bird. Teacher says: You think so?
Levels of linguistic complexity (LOA)			
Level 1-Matching Perception	C	-Label objects, or print -Locate/notice objects or print -Identify sounds -Imitate/repeat a simple sentence/word -Count objects	What color are these eggs? Can you say rachis? What is this called (pointing to a bird)? How many eggs are in the nest?
Level 2—Selective Analysis of Perception	C	-Describe information just relayed -Imitate/act out information relayed -Describe perceptual qualities of objects/print -Recall information from single page	Which egg is the hummingbird's egg? Do oystercatchers build nests? Which one is the rachis?

Code	Content (C) or Form (F)	Code description	Examples
Level 3—Reorder/ Infer about Perception	C	-Draw an inference from something not explicitly stated in text -Explain/infer animal behavior -Evaluate or judge non-perceptual qualities of objects/ideas/text as a whole -Compare similarities/differences of objects, animals, animal features -Summarize/synthesize information across more than one page -Formulate a generalization about bird features or behaviors -Draw text-to-life connection/comparison	What did you learn about birds from this book? Are bees and ladybugs birds? Are ants and rabbits birds, how so? Are all these feathers the same or different? Where would a birds' tail feathers be?
Level 4- Reasoning about Perception	C	-Predict/hypothesize about subsequent events/conditions -Define a word's meaning -Define the function/purpose of an object or print unit or animal feature -Explain conditions that cause alternate outcomes or a solution -Identify causes of occurrence/event -Identify direct or indirect effects -Distinguish between fact and fiction -Provide factual background information beyond the text about topic and connect it to text	Why does the hummingbird sip nectar? What makes a bird a bird? What do you think unique means (from context)? Why do you think that feather is from a different bird than this feather? If a bird had only one of these feathers, would it help it fly?

Code	Content (C) or Form (F)	Code description	Examples
		-Provide reasoning about an idea or hypothesis	

Note. Coding categories for the levels of abstraction were adapted from (van Kleeck et al., 1997, 2003; Zucker et al., 2010).

Text Commentary

The research literature I discussed in Chapter Two repeatedly stated that science text and more generally expository text was more difficult to read and understand than narrative texts. The literature also claimed that the teacher plays a key role in supporting students sense-making of these texts by using accommodation strategies to make the texts more comprehensible (Glass & Oliveira, 2014). With the empirical research on how students revise knowledge and how students make sense of informational texts, I created six child codes to the parent code of TEXT COMMENTARY (TC) to analyze teachers' attempts to make sense of the text for their students. I was interested in if and how teachers modeled learning new information, how they generated enthusiasm for the topic of birds, how they modeled being surprised by new ideas, how they synthesized information for children to emphasize key points, and how they modeled their own comprehension.

One child code of TC was CONTENT REPHRASING, RESTATING, NARRATION (CRN). I coded instances when teachers narrated photographs from the text as CRN, when teachers reviewed key vocabulary from the text, or when they restated or slightly rephrased key ideas from the text. These utterances gave children a kind of "double dose" of the language and ideas in the text and sometimes a simplification of the language in the text. I applied the CRN code most frequently to utterances that narrated the photographs of the text.

Here are excerpts that received the CRN code:

> "And these little pieces coming off from the rachis, they are called barbs."
> "So take a look at the nine different feathers."
> "This is a purple martin."
> "Like if you used a big magnifying glass to look at it really closely."
> "The small one is the hummingbird eggs."
> "Barbs are the little lines in the feather."
> "Unique means that it's different, all different kinds."

One dimension of CRN concerns emphasis on information in the text**.** I coded an utterance as CRN when teachers emphasized pertinent information while reading the text by using a louder and more authoritative voice with certain phrases. Below is an example of this, where the bold text indicates that the teacher slowed and said things with emphasis, again the curly brackets indicate the text:

Teacher H-RT

T: {scientists agree that **this is not true you**}
T: {penguins and ostriches are birds and they have wings but they **do not fly.}**
T: Some people agree let's see let's see.
T: {Well scientists agree that that is **not true!}**

The emphasis of certain words happens repeatedly throughout the text:

T: they **don't fly** and they d**on't build nests**. hmmm
T: Well scientists agree that this is **not true. All birds have beaks**.

T: Feathers. {It is feathers That make a bird a bird.}
T: {Feathers are the special things for birds because only birds have feathers.}
T: only birds……

Another child code of text commentary was SYNTHESIS (CS). I created this code to characterize teacher utterances that included an explanation, an elaboration, an interpretation, an emphasis of correct information from multiple pages, and an emphasis of correct information to target known/common misconceptions.

I created two final child codes called LITERACY CONNECTION (CL); and META comments (CM). Meta comments were comments about the process of learning or metacognition.

For the category of TC, coders achieved an inter-rater reliability Cohen's kappa score of 1.0. Coders achieved an inter-rater reliability Cohen's kappa score of 0.82 on the distinction between the CS child code and CNA child code; both scores indicate excellent agreement (Cohen, 1960; Fleiss, 1971). I did not do inter-rater reliability testing for the other sub-categories of responses to students because I did not include those subcategories in my statistical analysis of text influence or teacher influence on any particular outcome See Table 4 for each of the child codes for TEXT COMMENTARY, descriptions of the codes, and examples.

Table 4

Summary of Teacher Declarative/imperative Utterances about Text Codes from Most Frequent to Least

Teacher declarative/imperative utterances about the text codes	Code description	Example
Emphasis/re-phrasing/restating (CRN)	This includes defining certain vocabulary terms, stating the text in a slightly different way with a certain emphasis, or even verbatim. It also can include emphasis of correct information by restatement	So NOT all birds can fly. Hmm. T: {northern Cardinals use their beaks to crack seeds to eat} T: the Red Birds, they use their beaks to crack seeds open.
Affective language (CRN)	Statement that indicates an emotional response, e.g. enthusiasm, wonder, excitement, awe, interest,	That's so cool!

Background knowledge or personal experience (CBKE)	Connecting text content to personal or collective	I saw a cardinal on my deck this morning. We learned about beaks yesterday.
Synthesis-Elaboration/Explanation (SYNTH)	Bringing in outside information to explain or elaborate information in the text. Could include linking to outside texts, knowledge, etc.	
Connecting text content to literacy (CL)	Connects activity/feature to ELA discipline	This is a non-fiction text. This book does not have an author listed.
Metacomments (CM)		You're smart just like scientists. We are learning new words We will see if you can learn anything new about birds from this book. Hmm I didn't know that before this book.

Responses to Students

Teacher responses to students' comments or questions was another frequently occurring utterance type. These utterances were not in the form of a question. For this category, coders achieved complete agreement. I did not do inter-rater reliability testing for the sub-categories of responses to students because I did not include those subcategories in my statistical analysis of text influence or teacher influence on any particular outcome. There were patterns in this kind of talk and I created six child codes to further analyze the patterns. The codes for responses to students are summarized in Table 5. These talk patterns, in order of frequency included POSITIVE FEEDBACK ON ACCURACY (RFA), RESTATING RESPONSES (RR),

AFFECTIVE RESPONSES (RA), EXPANDING RESPONSES (RE), CORRECTING RESPONSES (RC), OTHER RESPONSES (RO).

Table 5

Summary of Teacher Declarative/Imperative Utterances Codes in Response to Students Statements or Questions

Teacher declarative/imperative utterances in response to students codes	Code description	Example
Positive feedback on accuracy (RFA)	An indication that the child is on the right or accurate track	Student says: all birds fly. Teacher says: You're right all birds fly.
Restating responses (RR)	A verbatim restatement of child comment	Student says: a blue one Teacher says: a blue one
Affective responses (RA)	A positive and enthusiastic word is included	Wow you know a lot about birds!
Expanding responses (RE)	An expansion of the child comment by providing more grammar, or context, or information	Student says: a blue one Teacher says: So you saw a blue feather.
Correcting responses (RC)	An indication to the student that they are not correct in their statement	Student says: Ducks don't fly Teacher says: Ducks CAN fly.
Other (RO)	Not worth categorizing because of the random nature of comments	

Each transcript was coded temporally including talk that happened before reading (BR), during reading (DR), and after reading the text (AR). I also marked the time that students engaged in an activity whereby the teacher passed out feathers to students and discussed the feathers (FA).

Student Codes

To address the research question, **"What, if any, are the differences in student engagement with these two kinds of read-aloud texts?"** I examined the level of student engagement and thinking during the read aloud by coding child utterances for length of utterance, content of utterance, and abstraction of utterance (see Table 6). Student talk was difficult to capture on the transcript during the lesson because students sometimes spoke quietly, were inaudible, or spoke in an overlapping manner. I captured student talk a bit differently than I did teacher talk. Rather than using the utterance as the transcription guide, I grouped student talk into two codes, LOW PRODUCTION (LP) and HIGH PRODUCTION (HP). LP student talk was two or fewer morphemes. HP talk was three or more morphemes. I did not count inflectional morphemes such as "s" for pluralization as a separate morpheme. I made this decision because most often students did not speak in full sentences. Pat phrases such as *I don't know*, were coded as low production. In the cases where student speech was overlapping, I coded the student who produced the most morphemes (Zucker et al., 2010).

In addition to considering the *quantity* of student talk, I also considered the *quality* of student talk during the read-aloud sessions. I grouped student talk into five categories including, LITERAL (LIT), INFERENTIAL (INF), ASSOCIATION (ASSN), YES/NO (Y/N), and NO LEVEL OF ABSTRACTION (NOLA). I adapted Blank's and van Kleeck's levels of abstraction into five categories: literal, association, abstract responses, yes or no, and no discernable level of abstraction. (Blank et al., 1978; Price et al., 2009, 2012; van Kleeck et al., 1997, 2003). I coded student talk as LIT when the student utterance matched perception or demonstrated selective analysis of perception. I coded student talk as INF when the student demonstrated a reordering, inferring, or reasoning about perception. I coded student talk as ASSN when the student provided their background knowledge that was recalled by a teacher question, when looking at a picture in the text, or when hearing the text read aloud. I coded student talk as YN when the child gave a yes or no response. I coded student talk as NOLA when I could not determine the level of abstraction.

This process of coding student talk was painstaking as it required me to look at the context of each instance as I had to consider what stimuli was present to determine the level of abstraction for what the student said. For example, if a student provided information about what they know about birds before the reading of the text in response to a question from the teacher, I coded that as an ASSN.

Below are some examples of the kinds of associations children offered. These were usually in response to a teacher question either about what they knew of birds or if they had certain experiences with birds.

They swing and tweet.
They fly.
They are a species of animals
Ostriches can run up to 20 miles an hour actually
I've seen a feather before
I've seen a house finch
I've seen a cardinal like a million times
I haven't seen a house finch
Yeah in my fridge *child is referring to eggs*
I only saw the finches in the winter

If a student described something with a simile using their background knowledge and what they were learning about in the text, I would typically code it as an inferential comment. Here are some examples:

> That feather looks like a tree—*the child is looking at a picture of a feather*
> The one looks like an eye—t*he child is looking at a picture of a feather*
> They almost look like little pebbles—*the child is looking at a picture of bird eggs*
> Echidna's are like porcupines
> They're kind of like a porcupine—*the child is looking at a picture of an echidna*
> leaves have that too — *the child is looking at a picture of a feather*
> It looks like a platypus—*the child is looking at a picture of an echidna*
> Why does it look like a platypus snout?—*the child is looking at a picture of an echidna*
> They feel like a pedal—*the child is touching a feather*

Below are other examples of inferential comments from children during the read-aloud sessions that I coded as inferential comments because they required inferential reasoning from the child. Each excerpt provides the context of the student comment.

> The teacher is reading about hummingbirds drinking nectar and there is a picture of a hummingbird doing so. There is no question from the teacher, the child just volunteers their thoughts. The child says, "Butterflies drink up nectar."
>
> The teacher reads from the text and shows a picture of a robin with blue eggs. The student says, "Hey guess what? I saw robin's nest and it was cracked open so the baby already hatched and the shell was on the ground."
>
> The text shows a picture of a hummingbird sipping nectar with its beak and the teacher reads the caption that says that hummingbirds sip nectar from flowers.
> T: Why do you think birds sip the nectar from flowers?
> S: Like bees

In the example below the comment underlined would be coded as literal, because that exact idea was just provided in the text, virtually verbatim. However, the comment in bold was coded as inferential because the child had to use what they know along with what they just learned to create a new thought.

T: How do feathers help birds survive?
T: What do you think?
S1: Because because in the winter it's cold and their feathers are warm and it can help them be warm.
T: Oh I like that, oh I like that.
T: Anyone else have any other ideas of how feathers help birds survive, Student O?"
S2: **They can fly away from things that want to eat them**
T: They can fly away. What are those things called that want to eat them?
S: **Predators!**

Below are three exchanges from different teachers and different read-aloud sessions.

Each student response was coded as inferential.

T: what do you think they eat?
S: Ahh, worms?
T: they might eat worms, too.

T: Some other people think that animals that lay eggs are birds. Do you?
S: Yeah, like a fish, a fish!

T: Do cats have feathers?
S: No, they have fur.

Table 6

Summary of Student Utterance Codes

Quantity of student talk		
Code	Code description	Examples
Low Production (LP)	Student produced two morphemes or fewer	yes/no That one. I don't know.
High production (HP)	Student produced three or more morphemes	The penguin and the ostrich Yes because it's red and yellow.
Quality of student talk		
Code	Code description	Examples
Level of abstraction: Literal (LITERAL)	Utterance that matches perception OR demonstrates selective analysis of perception	That feather is brown. I found the rachis.
Level of abstraction: Inferential (INFERENTIAL)	Utterance that demonstrates reordering/inferring about perception. OR reasoning about perception.	Birds need lots of feathers to fly. Birds that can't fly have broken wings.
ASSOCIATION (ASSN)	Utterance that refer to background knowledge that were brought to mind by the text or solicited by the teacher	I have many cardinals on my deck. An ostrich can run fast.

Note. Coding categories for levels of abstraction and length of utterance adapted from (Blank et al., 1978; van Kleeck et al., 1997, 2003; Zucker et al., 2010).

Teacher Interview Analysis

Teacher interviews were primarily conducted on Zoom and one was conducted in person. The format of the interviews was semi-structured, meaning I had planned questions, but sometimes went "off script." The main purpose of the teacher interview was to provide a source of data triangulation and insight into the read-aloud experiences with the two texts to enhance credibility and trustworthiness (Patton, 2015). I used an In Vivo analysis approach with the teacher interview transcripts (Saldana, 2021). From this analysis I identified key themes characterizing each teacher's beliefs about the purpose of a read aloud, their role in supporting students to build accurate science knowledge, and their role in supporting student engagement and talk. These key themes are identified and discussed in the results section.

Text Differences

I collected the most important extratextual talk measures and compared them for each teacher between the SIT and the RT to see if there were key differences in the ways teachers conducted their read-aloud sessions. Because my sample size was small and I had identical measures for each text, I used the Wilcoxen paired sample statistical test (Wilcoxen, 1945). For two measures that were close to significance, I did a Cohen's *d* test to calculate effect size (Cohen, 1960). I had no data for teacher G for the RT, so I used the median score for each measure to maintain G's participation in the statistical analysis.

Inventory of Read-Aloud Practices

The empirical literature on read alouds, especially read alouds about science, names a number of the practices noted below in Table 7 as effective teaching strategies for informational texts (Cabell & Hwang, 2020; Connor et al., 2017; Hwang et al., 2022; K. McMaster et al., 2019; Neuman & Kaefer, 2018; Wright, 2019; Wright & Gotwals, 2017; Zucker et al., 2021). If one of the following instructional strategies was used at least once, I counted it as present in the list of strategies.

Table 7

Evidence-Based Practices for Read-Alouds

Effective Read-Aloud Instructional Practice Inventory
Asked Students for Background Knowledge Before Reading
Provided a Vocabulary Preview
Asked Students What They Learned After Reading
Passed Out Feathers for Observation Activity
Used Traditional Student Talk Structure (Teacher Calls on Individual Students One at a Time)
Demonstrated Hypertext Strategy (Used Song, Gesture, Call-and-Response, etc.)
Translanguaging (Used Spanish and English to Teach Content and Engage Students)
Created Semantic Maps
Organized Student-o-Student Talk Structures
Used Charts To Keep Track Of Ideas (KW, etc.)
Explicitly Stated or Modeled Metacognitive Strategy, e.g., “Learning Something Different from What We knew from The Text”
Referenced Other Shared Texts During Read Aloud
Referenced Literacy Practices, e.g., Book Genre, Decoding, Vocabulary, Comprehension Strategies, etc.
Engaged in Science Disciplinary Talk
Generated Questions that Promoted Inferential Reasoning

Quantitative Analysis

I wanted to understand the nature of the read-aloud talk by teacher and by text type both qualitatively and quantitatively. Using the frequency of application of qualitative codes, I generated descriptive statistics. Dedoose has a feature that counts each code application. I exported these counts into Excel to calculate the overall talk frequencies in each category. I calculated the mean, median, percentages, and standard deviations of each category using Excel formulas (AVERAGE, MEDIAN, STDEV.S). I was also able to calculate the number of words spoken for students and teachers using three formulas in Excel (LEN, TRIM, SUBSTITUTE).

Researcher Positionality

My experience as an elementary teacher, a school-based literacy coach, and university-based literacy coach inspired me to pursue this dissertation. These professional experiences have afforded me the opportunity to grasp the vast and complex work that educators face to reshape literacy instruction so that students, especially students who have been marginalized by traditional practices, can thrive. My ambition, and why I have engaged in this research, has been to create new knowledge and understanding about reading instruction to collaborate with in-service educators to implement innovative solutions to improve student outcomes. The focus and purpose of this work is about creating conditions for all learners to achieve educational success. It is because I aspire to work with in-service teachers in schools with large populations of language and racial minority students and disrupt status quo teaching methods, that my positionality as a researcher is important to discuss openly. My background is different from those I wish to benefit most from the work. As a white, middle-class woman living and working in a highly racialized society, I believe that race, culture, and gender play a central role in how people live and experience the world and that I have been afforded, simply by the color of my skin, privileges and advantages. I believe that my social and professional positions, roles, and identities are intricately linked and embedded in the process and outcomes of my research and in order not to do harm to Black, Indigenous, and People of Color and to produce meaningful research and to disrupt the kind of reading instruction I aspire to disrupt, I am committed to engage in what educational researcher and scholar Milner describes as a framework to work through the seen, unseen, and unforeseen dangers of educational research (Milner, 2007). This work includes researching the self, researching the self in relation to others, and engaging in reflection and representation of research findings.

Limitations of the Method

One limitation of this study is the setting in which the research took place. The study took place during summer school. While the summer school setting was beneficial in some ways such as the small number of students in classrooms, it did present some disadvantages. The participant teachers did not always teach their usual grade level during summer school. Student absenteeism was more of an issue during summer school than the regular school year.

A second potential limitation was that teachers were not provided with professional learning about the refutation text type and knowledge revision. Therefore, if teachers attended to knowledge revision during their read-aloud session or attended to the differences in text features, this was purely happenstance. As mentioned in the procedures section of this chapter, teachers were provided with a one-hour professional learning session on best practices for read alouds.

Thirdly, some teachers said that the refutations in the refutation passage were worded awkwardly. This led some teachers to read that passage slightly differently. For example, the text says, "some other people think animals that have beaks are birds. Do you? Well, scientists agree that this is not true."

Fourth, the student responses were somewhat difficult to decipher and, due to overlapping speech and quiet voices, it was difficult to capture student talk as well as I would have liked. I also did not develop a method for tracking the relationship between teacher statement and student responses or which student/s responded to which statements.

Finally, teachers received the texts only the night before, and as one teacher said, she likes to prepare for her read alouds with more time. Perhaps this lack of preparation altered the teacher's usual read-aloud style and practice.

Summary

In this mixed-methods study I used qualitative analysis and statistics to describe how teachers enacted a read aloud with a standard informational text and with a refutation text about birds to a small group of their primary-aged students. Mixed methods are also used to describe student engagement with these two kinds of read-aloud texts. Finally, I used qualitative analysis with transcripts of teacher interviews about their read-aloud practices, their beliefs about the purpose of the read aloud, and their reflections on the read aloud with the researcher-developed standard and informational texts about birds.

A total of 15 videotaped recordings of read aloud sessions were transcribed by utterance. I used a codebook informed by the transcriptions and literature on extratextual talk, knowledge revision, and reading comprehension that I had developed and applied to each utterance. Through qualitative and quantitative analysis, I identified key themes of the nature of extratextual talk by teacher and by text type. My intent was to illustrate key trends and differences by teacher and text type through descriptive statistics.

Little is known about how primary teachers use the read aloud to promote knowledge revision in science, and nothing is yet known about how teachers might leverage the refutation-text style to promote science learning and knowledge revision. My study fills a gap in knowledge about how primary teachers can best leverage the read aloud, refutation texts, and extratextual talk to promote science learning, engagement, and knowledge revision.

CHAPTER FOUR

FINDINGS

I had three goals with this study. They included a) providing a description of how teachers use two different kinds of informational texts, a standard informational text and a refutation text, in two separate read-aloud sessions with small groups of students, b), describing how students respond to the texts and read-aloud sessions, and c), a describing how teachers reflect on the sessions and the use of the read aloud in general. To realize these goals, I transcribed 15 video recordings and conducted four teacher-participant interviews. To code the read-aloud transcripts, I created a codebook based on the empirical literature on extratextual talk, science learning, and knowledge building and revision. Through memos, discussions with other researchers, pattern coding, and iterative coding, I coded each transcript. The frequency of code applications and the inductive nature of the coding resulted in the qualitative and quantitative findings I present to address the following research questions:

1. What, if any, are the differences between teachers' read alouds of a standard informational text compared to refutational texts of the same topic?
2. What are teachers' observations about their students' uptake of the information in these two kinds of texts?
3. What, if any, are the differences in student engagement with these two kinds of read aloud texts?

The presentation of findings includes: a) descriptive findings regarding the extratextual talk of the read-aloud sessions by teacher and by text type, b) statistical analysis of extratextual talk differences by text type, c) a qualitative examination of extratextual talk trends across teachers and texts, and d) trends from interviews with teachers about the purpose of read alouds with expository texts and how they reflected on their read-aloud sessions with two different types of expository texts.

Descriptive Findings

The refutation text (RT) that I focused on in this study contained a total of 454 words including all the captions. Without the captions, there were a total of 410 words. The text contained two cover illustrations front and back along with 50 photographs. The standard informational text (SIT) included 456 words including captions. Without captions there were a total of 410 words. The SIT also contained 49 photographs with two cover illustrations. Both texts were written at similar levels of readability. Teachers read the entire text in each read-aloud session. Teachers read the captions with some degree of variability.

Transcript Coding

I coded a total of 15 transcripts. Eight teachers did two read-aloud sessions, one read aloud with the SIT and one with the RT. One teacher's video recording for their RT read-aloud session did not occur, therefore that teacher has one transcript of their SIT read-aloud session only. Across all transcripts, I coded 4,536 excerpts. These excerpts included the teacher reading the text and extratextual talk of students and teachers.

Length of Read-Aloud Sessions

Table 8 reports the time for each read-aloud session in minutes by teacher. Each teacher read the entirety of each text, a total of 16 pages, with a small group of students. The student group size ranged from three students to five students. The read alouds with the RT lasted on average slightly longer than with the SIT (RT M=18.25 minutes, SD=5.17 minutes and SIT M=16.69 minutes, SD= 2.42 minutes)

Table 8

Duration of Read-Aloud Sessions by Text Type and by Teacher

Teacher	Duration in Minutes		Number of Students in Read-aloud Session	
	SIT	RT	SIT	RT
A	15.93	23.33	3	6
B	15.00	17.73	4	6
C	20.85	19.50	4	5
D	21.13	17.61	5	6
E	19.82	25.61	4	3
F	12.88	11.88	4	5
G	15.02	-	3	6
H	12.90	12.10	5	6
Mean	16.69	18.25	4	5.37
Median	15.48	17.73	4	6
SD	3.42	5.17	.76	1.06

Note. SIT-standard informational text and RT-refutation text.

Table 9 shows the amount and type of teacher extratextual talk in each reading session. The amounts reflect frequency counts of teacher utterance codes. As I outlined in the previous chapter, I coded each utterance into the following general categories: reading text (RT); questions to students (TQ); comments about the text (TC); and responses to students in the form of statements (RS). By examining the general categories of extratextual talk, I was able to narrow in on what kinds of talk was most frequent and thus able to analyze more deeply. Table 9 shows that teacher questioning was the most common type of extratextual talk in both kinds of texts except for Teacher G and Teacher H, whose most common form of extratextual talk was text commentary. Teacher H's read-aloud style was the most distinct from the other teachers, something I will discuss later. The percentages for means and medians for each category of teacher extratextual talk indicate moderate variability across teachers' extratextual talk patterns. The range of text commentary averages was 17.30% - 51.72%. The range of teacher questioning averages was 28.45%-50.55%. In Table 9 and in the subsequent tables that display frequency percentages for all teachers and text types, the non-bolded lines are for the standard informational text sessions and the bolded lines are for the refutation text sessions.

Table 9

Extratextual Talk by Major Category: Teacher Questions (TC), Responses to Students (RS), Text Commentary (TC), and Management (Mgt) by Teacher and Text Type

	Teacher Extratextual Talk Type Percent of Total				
Teacher/text	TQ %	RS %	TC %	Mgt %	Total Counts
A-SIT	37.69	21.61	35.18	5.53	199
A-RT	**33.83**	**23.88**	**24.88**	**17.41**	**201**
B-SIT	42.26	21.43	32.14	4.17	168
B-RT	**41.26**	**21.68**	**23.08**	**13.99**	**143**
C-SIT	38.11	28.28	26.64	6.97	244
C-RT	**39.46**	**21.08**	**17.30**	**22.16**	**185**

	Teacher Extratextual Talk Type Percent of Total				
Teacher/text	TQ %	RS %	TC %	Mgt %	Total Counts
D-SIT	53.92	16.04	23.89	6.14	293
D-RT	**56.35**	**13.10**	**28.57**	**1.98**	**252**
E-SIT	34.77	19.53	35.55	10.16	256
E-RT	**40.00**	**30.67**	**26.67**	**2.67**	**300**
F-SIT	50.55	19.78	19.78	9.89	91
F-RT	**45.56**	**18.89**	**20.00**	**15.56**	**90**
G-SIT	30.00	26.36	33.64	10.00	110
G-RT	**-**	**-**	**-**	**-**	**-**
H-SIT	28.45	14.66	51.72	5.17	116
H-RT	**30.19**	**18.87**	**46.23**	**4.72**	**106**
Mean	40.16	21.06	29.68	9.10	184
Median	39.46	21.08	26.67	6.97	185

Note. TQ-teacher questions, RS-responses to students, TC-text commentary, Mgt-management.

Types of Teacher Questions

Teacher questions were the most common form of extratextual talk and required further analysis. The average amount of teacher talk devoted to questioning students was 40.16% (Mdn=39.46%). The range of averages for this measure was 28.45% to 50.55%. As discussed in the previous chapter I also coded each question for level of abstraction if it was content related. Content questions (questions coded for LOA) comprised a mean of 63.79% of the questions teachers asked students during the read-aloud sessions.

Level 1 questions, as discussed in more detail in the previous chapter, were characterized by questions that required students to match their perception of print or spoken words. Level 1 questions were asked an average of 11.62% of the time (Mdn= 11.33%). The number of Level 1 questions asked varied across teachers. The average frequency percentage ranged from .85% to 29.415%. The raw score standard deviation for number of Level 1 questions per session and teacher was 6.97.

Level 2 questions required selective analysis of perception. They also place a relatively low cognitive load on students. Level 2 questions were asked an average of 18.19% of the time (Mdn=19.72%). Here is a scenario that included some Level 2 questions. A teacher read from the text: “All birds lay eggs as other animals like frogs, fish, and snakes lay eggs.” Directly after reading that line, the teacher asked, “Do all birds lay eggs?” and then, “What other animals lay eggs?” These questions often produced low production responses that were literal or yes/no. Sometimes Level 2 questions were open-ended questions such as “What do you notice about your feather?” The open-ended Level 2 questions produced longer responses but were most often still literal responses. The average frequency percentage ranged from 6.12% to 29.79%, suggesting variability among teachers and among all the question levels. The raw score standard deviation for number of Level 2 questions per session and teacher was 11.31.

When I combined Level 1 and Level 2 questions, both literal, they comprised an average of 29.81% (Mdn= 31.91%) of the total number of questions asked of students. This kind of questioning was akin to quizzing students on the content of the text being read and was used in part as an engagement strategy. The questions tended to be a mix of open and closed questions and, as one might expect, these types of questions generated literal and low-production responses. When I combined these literal questions into one category and looked only at the raw frequency counts per teacher, there was even more variability among teachers (M=22, Mdn=18.50, SD=17.36).

A Level 3 question required a student to reorder or infer about perception and the code description is discussed in detail in Chapter Three. Level 3 questions were present in the transcripts an average of 15.43% of the time (Mdn= 14.86%). Teachers showed the least variability with Level 3 questions in their read-aloud sessions. The range of averages was 4.55%-29.86%.

The most common kind of Level 3 question came at the end of the read aloud when teachers asked students to sum up their knowledge from the text by asking "What did you learn about birds today?" Level 3 questions had the least amount of variability among teachers (SD=7.99).

Level 4 questions asked students to reason about perception. The description of this code is discussed in more detail in Chapter Three. Level 4 questions were present for an average of 18.56% (Mdn= 16.91%) of the questions asked by teachers during the read-aloud sessions. The variability was of the highest among the leveled question types (SD=16.64) highlighting that Level 4 questions had the greatest variability among teachers. An example of a Level 4 question is, "How do feathers help birds survive?" The most common type of Level 4 question posed by teachers usually came before the reading and asked students about their bird background knowledge. Some of the phrasing of these questions was as follows:

> "Student D, what would you say if your tiny little two-year-old brother or sister came up to you and said, 'Student D what's a bird?'"
> "What do you know about birds already?"
> "How would you describe birds?"
> "What do you know about birds?"
> "Do you know anything about birds?"
> "What is a bird?"

Level 4 questions were also posed during the text reading. These questions placed the highest cognitive load on students and asked for inferential or associative thinking. Generally, students responded in kind, meaning their responses indicated inferential thought. Table 10 shows some exemplars of level 4 questions and the subsequent student responses:

Table 10

Exemplar Level 4 Questions and Student Responses

Level 4 Questions	Student Responses
I want to hear from someone why they think the feathers are from the same bird.	I do think it’s the same bird, but I just recognized something. This one doesn't have the same mark and this one has black and brown
Why do you think the barbs are soft?	To keep birds warm
Why do you think the ostrich cannot fly?	They're on the ground a long time
Why do you think you can't fly if you have one feather?	It's cause you don't have enough feathers
With feathers by the fan what do you think would happen?	They fly away. Let me see, let me see, let me see!
Why do you think birds sip the nectars from the flower?	Because they like the juice of it

Here is an exchange of a series of level four questions between teacher and students:

T: what do birds use their feathers for?
S: to fly?
T: yes, to fly, why would they want to fly?
S: to get some food
T: to get some food
T: that helps them survive.
T: what else?
S: and to get back to the nest quicker
T: to get back to the nest quicker.
T: why would they want to get back to the nest quicker?
S: because of their babies/babies/
S: or if something is coming to eat their eggs,
T: something, I don't know
T: so, to protect their babies, to protect them from predators

When I combined Level 3 and Level 4 questions, both inferential, I found that teachers asked these types of questions an average of 33.99% (Mdn= 31.77%). Therefore, most of the topic questions asked for some kind of inferential reasoning (M=33.99%, Mdn=31.79%). The raw frequency counts had the highest variability when combining Level 3 and Level 4 questions (SD=21.95) compared to the combined raw frequency counts of Levels 1 and Level 2 questions (SD=17.36). In these combined questions analysis, shown in Table 13, the variability between teachers was more apparent in the raw combined frequency counts of Level 3 and Level 4 questions (M=29.63, Mdn=21, SD=21.95) compared to the percentages of Level 3 and Level 4 questions.

Closed questions (CLOSED) are phrased in such a way that there is either a one-word known-answer response, or a yes/no response. The range between teachers was 33.75% at the lowest percentage to 77.91% at the highest. Teachers asked a relatively high percentage of their questions as closed (M=58.99%, Mdn=64.29%) The closed-question category included all content questions, tag questions, turn-taking questions, and repair questions. Level 4 questions, ostensibly the type of question with the most cognitive load because of the level of abstraction it posed to students, were frequently posed as closed questions. The phrasing of the questions mattered in terms of the kinds of engagement and responses that ensued. While an open-ended Level 4 question did not guarantee a longer, more rigorous response, students were *less* likely to respond with a one-word answer than they would to a closed question. In fact, a mean of 36.44% with a median of 37.79 % of questions posed by teachers were closed.

I coded excerpts TURN-TAKING QUESTION (TTQ) when teachers directed a question at a particular student. An example of a turn-taking question was, “What did you learn about birds, student X?" or sometimes it may just look like this in the transcript, "Student Y, what about you?" These questions were also coded for their level of abstraction. The higher percentage of questions coded as TTQ, the more often the teachers sought responses from individual students. Teacher E (RT condition), for example, asked turn-taking questions a mean of 26.53% of the time, whereas Teacher H (RT condition) *never* asked a TTQ. Those two numbers reflect a different participation pattern between the two read-aloud sessions.

Tag questions occurred an average of 10.15% of the time (Mdn=9.30%). A tag question is a statement that is delivered as a question, or when a teacher's voice rises in pitch at the end of a statement. For example, "But that doesn't mean the bird is gold, right?" is a tag question because within the context of the lesson, the teacher did not wait for a response and instead kept talking. Teachers used tag questions in a variety of ways. Sometimes tag questions conveyed managerial commands, such as, "How about I hang on to those feathers?" Other times tag questions were used to convey or emphasize some information about the text, such as "Wow, all birds have feathers, cool, huh?" or "Did you know that birds use their tail feathers to steer?" Tag questions were also used to correct a child, such as in the example, "Do you really think that all birds fly?" Occasionally tag questions generated an acknowledgement from students in the form of a "yes" or "no" or nodding of the head. Most tag questions were also coded as closed questions because they bid for a "yes" or "no" response, or a one word, known-answer response. The frequency with which teachers used tag questions varied (M=9.40, Mdn=8.00, SD=8.44), for example, 19.77% of one teacher's questions were tag questions while another teacher never used them. Tag questions presented a dilemma with coding because I had to discern the intent of the question from the content of the question. Sometimes the teacher posed a tag question as a correction of a student, as emphasizing certain information, or as a behavioral command or correction.

Below is an excerpt demonstrating how a teacher used two tag questions, shown underlined, as well as questions about the content where she expected an answer. The excerpt from below is between one teacher and multiple students. The teacher used the interrogative form to scaffold information for children as they make sense of animal categories.

Teacher D-SIT
T: this is called the rockhopper penguin
T: do they have wings?
S: no
T: look real close
T: do they have wings?
S: yes
S: no
S: *one boy shaking head no*
T: do they fly?
T: no, they swim
T: oh my gosh, then we have an ostrich
T: do ostriches have wings?
S: no
S: yes
S: no
T: yes they have wings
T: do ostriches fly?
S: no
S: yeah
S: *boy is furrowing brow-shakes his head no*
S: they just run away
T: so these guys don't fly and these guys do?
T: is a bee a bird?
S: NO
S: no
T: a bee isn't a bird.
T: is a ladybug a bird?
S: no
T: but they fly?
T: that’s crazy!

The underlined questions above show how the teacher used the question as a rhetorical device, a kind of “think-aloud” for her students whereby she lays out the logic of her thinking through of what is a bird and what is not a bird. Mixed in between the underlined examples are questions that she expected students to answer. In these instances when she expects an answer, it is as if students were on “auto pilot” and respond somewhat randomly perhaps because they are not sure if the question is genuine, or they are not sure of their role in the whole enterprise, or perhaps they just do not know the answer.

Repair questions represented an average of 10.03% of all questions teachers asked students (Mdn=9.30%). Teacher F (SIT condition) asked the highest percentage of repair questions at 29.79% and Teacher H (RT condition) was the lowest, 0%. A repair question generally occurred in response to a child statement. For example, a student responded to the teacher’s question, “What do you know about birds?” with the response, “They fly.” The teacher responded with, “They fly?” The teacher repeated what the child said with an increase in pitch to indicate a question to acknowledge and wrap up the conversational exchange.

Sometimes repair questions seemed to indicate an affirmation to the student. However, at times the repair question came across as an ambiguous response, for example ”Really, they fly?” And, sometimes it seemed to be a correction of the student's response, as in “Are you sure they fly?” Also, this pedagogical style could be confusing for children trying to form an accurate science concept, especially when considering the use of other forms of questions such as the tag question discussed earlier. I think of the many multilingual learners trying to make sense of what their teachers are saying, perhaps asking themselves, “Is she asking me a question, is she telling me some information, does she know the answer? Am I correct in my statement? Am I incorrect?" The excerpt below shows an exchange between the teacher and several students. In this excerpt I coded the underlined utterances as repair questions, meaning a question was used to close out a conversational turn. These teacher utterances are potentially ambiguous for the child.

Teacher A-SIT

T: now tell me one thing you learned about the birds today?
S: they can fly
T: <u>they can fly?</u>
S: they can chirp and they can lay eggs
T: yeah they can lay eggs.
T: do all birds lay eggs?
S: yeah
S: some
T: yeah they all lay eggs.
T: Student J, what is one thing you learned about the birds today?
S: birds can fly
T: yeah they can fly.
T: how do they fly?
S: with their feathers
<u>T: they fly with their feathers?</u>

In the first underlined teacher utterance, the teacher repeated what the student said, with the addition of the raise in pitch at the end. This raise in pitch could be perceived by the student as a correction, or it could be perceived as an affirmation. The response was ambiguous and not explicit. Similarly, in the second underlined teacher utterance, the teacher expands upon the student response and adds the raised pitch thereby creating ambiguity and potential confusion for the child about the accuracy of their statement.

Teachers used questions in a variety of ways with a variety of purposes. Below is an excerpt that shows how one teacher used questions to convey information.

Teacher G-SIT

T: {so here's an interesting fact about birds all birds lay eggs as other animals like frogs, fish, and snakes lay eggs}
S: huh? *girl is staring at screen with interest*
T: did you know that snakes lay eggs?
S: no
T: did you know that fish lay eggs?
S: *girl shakes her head no*
T: have you ever heard of fish eggs before?
T: have you heard about frog eggs?
S: *the girl shakes her head again no*
S: no, none of them *another student says*
T: now you know because they're right over here

The utterances above in Teacher G’s class were a way to comment on the content of the text. Specifically, in this case the teacher is simply emphasizing that other types of animals lay eggs, something he perceived that the children did not know. The style of this commentary was interrogative, but the intent of the question was to make a point about the content.

Table 11 shows the percentages of the various types of teacher questions. The non-bolded lines are for the standard informational text sessions and the bolded lines are for the refutation text sessions.

Table 11

Questions by Type, Teacher, and Text Shown in Percentages of Total Questions Asked (RT Results are Bolded)

	Types of questions teachers asked in percentages							
Teacher/ Text	Level 1	Level 2	Level 3	Level 4	Tag	Repair	Closed	TTQ
A-SIT	11.83	21.51	9.68	13.98	8.60	15.05	38.71	12.90
A-RT	**5.00**	**23.75**	**18.75**	**20.00**	**6.25**	**5.00**	**33.75**	**20.00**
B-SIT	8.33	14.29	11.90	11.90	16.67	21.43	64.29	11.90
B-RT	**4.35**	**20.29**	**13.04**	**15.94**	**17.39**	**15.94**	**72.46**	**8.70**

Teacher/ Text	Types of questions teachers asked in percentages							
	Level 1	Level 2	Level 3	Level 4	Tag	Repair	Closed	TTQ
C-SIT	6.36	11.82	15.45	21.82	14.55	15.45	64.55	10.91
C-RT	**13.64**	**7.95**	**4.55**	**43.18**	**3.41**	**7.95**	**50.00**	**18.18**
D-SIT	11.05	27.33	19.19	9.88	19.77	2.91	77.91	8.14
D-RT	**18.54**	**22.52**	**13.91**	**17.88**	**9.27**	**8.61**	**76.16**	**9.27**
E-SIT	0.85	9.32	16.10	34.75	9.32	3.39	38.98	23.73
E-RT	**2.04**	**6.12**	**14.29**	**40.14**	**6.12**	**4.76**	**35.37**	**26.53**
F-SIT	12.77	19.15	29.79	4.26	2.13	29.79	74.47	2.13
F-RT	**8.51**	**29.79**	**10.64**	**23.40**	**0.00**	**14.89**	**55.32**	**12.77**
G-SIT	15.91	27.27	13.64	6.82	6.82	2.27	52.27	27.27
G-RT	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
H-SIT	29.41	8.82	17.65	5.88	20.59	2.94	73.53	8.82
H-RT	**25.71**	**22.86**	**22.86**	**8.57**	**11.43**	**0.00**	**77.14**	**0.00**
Mean	11.62	18.19	15.43	18.56	10.15	10.03	58.99	13.42
Median	11.33	19.72	14.86	16.91	9.30	8.28	61.64	12.34

Table 12 shows the literal level questions teachers posed to students (Level 1 and Level 2). The frequency counts in the first three columns along with the mean, median, and standard deviation show the degree of variability across teachers. The final column shows the percentage of lower-level questions of the total number of questions asked by each teacher.

Table 12

Frequency Counts and Percentages of Literal Questions Asked (Levels 1 and 2)

Frequency of literal questions asked by teachers				
Teacher/Text	Level 1 Questions	Level 2 Questions	Sum of L1 and L2 Questions	% of total Questions
A-SIT	11	20	31	33.33
A_RT	**4**	**19**	**23**	**28.75**
B-SIT	7	12	19	22.62
B-RT	**3**	**14**	**17**	**24.64**
C-SIT	7	13	20	18.18
C-RT	**12**	**7**	**19**	**21.59**
D-SIT	19	47	66	38.37
D-RT	**28**	**34**	**62**	**41.06**
E-SIT	1	11	12	10.17
E-RT	**3**	**9**	**12**	**8.16**
F-SIT	6	9	15	31.91
F-RT	**4**	**14**	**18**	**38.30**
G-SIT	7	12	19	43.18
G-RT	**-**	**-**	**-**	**-**
H-SIT	10	3	13	38.24
H-RT	**9**	**8**	**17**	**48.57**
Mean	8.73	15.47	22.00	29.81
Median	7.00	12.00	18.50	31.91
SD	6.97	11.31	17.36	-

Table 13 shows the inferential level questions teachers posed to students (Level 3 and Level 4). The frequency counts in the first three columns along with the mean, median, and standard deviation show the degree of variability across teachers. The final column shows the percentage of higher-level questions of the total number of questions asked by each teacher.

Table 13

Frequency Counts and Percentages of Inferential Questions Asked (Levels 3 and 4)

	Frequency of Inferential Questions Asked by Teachers			
Teacher/Text	Level 3 Questions	Level 4 Questions	Sum of L3 and L4 Questions	% of Total Questions
A-SIT	9	13	22	23.66
A_RT	**15**	**16**	**31**	**38.75**
B-SIT	10	10	20	23.81
B-RT	**9**	**11**	**20**	**28.99**
C-SIT	17	24	41	37.27
C-RT	**4**	**38**	**42**	**47.73**
D-SIT	33	17	50	29.07
D-RT	**21**	**27**	**48**	**31.79**
E-SIT	19	41	60	50.85
E-RT	**21**	**59**	**80**	**54.42**
F-SIT	14	2	16	34.04
F-RT	**5**	**11**	**16**	**34.04**
G-SIT	6	3	9	20.45
G-RT	**-**	**-**	**-**	**-**
H-SIT	6	2	8	23.53
H-RT	**8**	**3**	**11**	**31.43**
Mean	13.13	18.47	29.63	33.99
Median	10.00	13.00	21.00	31.79

Teacher/Text	Frequency of Inferential Questions Asked by Teachers: Level 3 Questions	Level 4 Questions	Sum of L3 and L4 Questions	% of Total Questions
SD	7.99	16.64	21.95	-

Table 14 shows the frequency counts of questions that are questions in form only, meaning that they serve a purpose other than asking students questions about the content of the text with an expected in-kind reply (non-content). These types of questions were described in detail earlier (e.g., tag, repair, managerial). In the case of Teacher B, nearly half of their questions were not content based. The percentage of non-content-based questions to students is notable especially for students who are learning English and new to the culture of school because the "grammar of the discussion" adds an additional burden to the child as they must decipher the intent and purposes of the questions *along with* trying to understand the content being presented. These types of questions comprised an average of 22.79% of all questions asked, (Mdn= 20.00%).

Table 14

Frequency Counts and Percentages of Non-Content Questions Asked

	Types of Non-Content Questions Asked by Teachers				
Teacher/Text	Management (M)	Tag (T)	Repair (R)	Sum of M,T,R	% of Total Questions
A-SIT	6	8	14	28	30.11
A_RT	**1**	**5**	**4**	**10**	**12.50**
B-SIT	3	14	18	35	41.67
B-RT	**3**	**12**	**11**	**26**	**37.68**

	Types of Non-Content Questions Asked by Teachers				
Teacher/Text	Management (M)	Tag (T)	Repair (R)	Sum of M,T,R	% of Total Questions
C-SIT	4	16	17	37	33.64
C-RT	**1**	**3**	**7**	**11**	**12.50**
D-SIT	3	34	5	42	24.42
D-RT	**0**	**14**	**13**	**27**	**17.88**
E-SIT	3	11	4	18	15.25
E-RT	**0**	**9**	**7**	**16**	**10.88**
F-SIT	0	1	14	15	31.91
F-RT	**0**	**0**	**7**	**7**	**14.89**
G-SIT	0	3	1	4	9.09
G-RT	**-**	**-**	**-**	**-**	**-**
H-SIT	2	7	1	10	29.41
H-RT	**3**	**4**	**0**	**7**	**20.00**
Mean	1.93	9.40	8.20	18.31	22.79
Median	2.00	8.00	7.00	15.50	20.00
SD	1.83	8.44	5.93	12.71	-

Table 15 shows the percentages of closed questions teachers posed to students. Each excerpt that I coded as a question, I also considered whether it was a closed question. Closed questions set up a one-word answer from students, and therefore could suppress the quantity of student talk that ensues during the read aloud. Table 15 shows variability among teachers and shows that some teachers used many closed questions when speaking to students. In fact, of the 15 read-aloud sessions, teachers used mostly closed questions in ten sessions. The average was 58.99% (Mdn=64.29%) and the range for the average amount of closed questions was 35.37% to 77.91%.

Table 15

Percent of Closed Questions Teachers Asked in RT and SIT Text Conditions

Teacher/Text	% of total questions coded as closed
A-SIT	38.71
A_RT	33.75
B-SIT	64.29
B-RT	72.46
C-SIT	64.55
C-RT	50.00
D-SIT	77.91
D-RT	76.16
E-SIT	38.98
E-RT	35.37
F-SIT	74.47
F-RT	55.32
G-SIT	52.27
G-RT	-

H-SIT	73.53
H-SIT	77.14
Mean	58.99
Median	64.29

Text Commentary

Second to questioning students, teachers' commentary (TC) on the text was the most common form of extratextual talk (M=29.68%, Mdn=26.67%). The empirical literature on knowledge revision and best practices for read aloud with informational texts informed the creation of four child codes. These codes highlighted if and how teachers modeled learning new information; expressed enthusiasm for the topic of birds; showed surprise and delight in new ideas; synthesized information for children to emphasize key points; and articulated aloud their own comprehension. The child codes within the parent code of TEXT COMMENTARY showed the most variability across teachers.

The first and most commonly occurring type of text commentary, I called CONTENT REPHRASING, RESTATING, NARRATION (CRN). This code comprised 63.83% of the total Text Commentary category. Details on how this code was applied are available in the Chapter Three. These utterances gave children a kind of "double dose" of the language and ideas in the text and sometimes a simplification of the language in the text. I applied the CRN code most frequently to utterances that narrated the photographs of the text.

Here are some excerpts that received the CRN code:

"And these little pieces coming off from the rachis, they are called barbs."
"So take a look at the nine different feathers."

“This is a purple martin.”
“Like if you used a big magnifying glass to look at it really closely.”
“The small one is the hummingbird eggs.”
“Barbs are the little lines in the feather.”
“Unique means that it's different, all different kinds.”

Below is an example of an excerpt coded as CRN, where the bold text indicates that the teacher slowed and said things with emphasis, again the curly brackets indicate the text. The following excerpts are from different points of the read aloud session.

Teacher H-RT

T: {scientists agree that **this is not true you**}
T: {penguins and ostriches are birds and they have wings but they **do not fly.}**
T: some people agree let's see let's see.
T: {Well scientists agree that that is **not true!}**

The emphasis of certain words happens repeatedly throughout the text:

T: they **don't fly** and they d**on't build nests**. hmmm
T: well scientists agree that this is **not true. All birds have beaks**.

T: feathers. {It is feathers that make a bird a bird.}
T: {Feathers are the special things for birds because only birds have feathers.}
T: only birds……

Finally, more often with the refutation text, teachers included phrases that provided a scaffold for knowledge revision. This happened with phrases that suggested to students that they should think about what they know and then compare that to what they will learn from the text. Here is a sampling of such phrases across most of the teachers while reading the refutation text. I coded these types of phrases as CRN because they provided a framing and narration structure for the information in the text.

“Let's read about it.”
“Let's see if we can get an answer.”
“Let's read a bit more to find out...”

“So we're going to try to learn facts about birds today, okay well we're going to see if we can learn something new in our story today about birds .”
“We're going to read and learn and we'll see if we can learn anything new about birds or if all of the information you already know is in this book.”
“Let’s see if we can learn some new facts and some new interesting ideas.”
“Let's see if there's information in here that you already know and …”

Below is an example of a full exchange between student and teacher in which the teacher used a knowledge revision framing phrase with a student around their misconception:

Teacher D-RT

T: Do all birds fly?
S: *Some students are shaking their heads yes, some students are shaking their heads no*
T: You don't think so?
T: No, you don't think so?
S: All birds can fly
T: So, you think all birds can fly?
T: Let's read and find out….

Another form of text commentary was when teachers modeled learning something new from the text. Below are some examples of phrases teachers used to think aloud and model knowledge revision:

“I had no idea..”
“I wonder if they’re birds too...”
“When I thought of chickens as a kid I was thinking, hmmm they're always on the ground. I don't think they can fly… but they can.”
“It's exciting to learn.”
“I did not know that!”
“Hmmm, interesting some birds don’t fly...”

When teachers showed enthusiasm and affect for the text, I coded these excerpts with the code AFFECTIVE RESPONSE TO CONTENT (CA). This code occurred an average of 10.71% of the time (Mdn=7.5%). The range of frequency averages for this category was 0 to 37.04%. The following excerpts illustrate this code:

“Oh I love birds!”
“Look at all these colorful feathers!”
“Oh my gosh look at the purple martins!”
“Oh my gosh, some birds do NOT build nests!”

Another child code of text commentary was SYNTHESIS (CS). For an utterance to receive the CS code, the teacher had to show a deeper level of thought, understanding, or appreciation for the content of the text. I coded text commentary excerpts as SYNTHESIS an average of 9.44 % of the time. The frequency counts for the SYNTHESIS code (M=5.60, Mdn=3, SD=5.99) demonstrate that teachers made these types of comments about the text the least. This code was applied to excerpts that included an explanation, an elaboration, an emphasis of correct information from multiple pages, and an emphasis of correct information to target known/common misconceptions. In the excerpt below, the teacher explained how birds stay warm with their feathers by comparing them to the way a boy stuck his arms inside his shirt to stay warm during the lesson.

Teacher A-SIT

T: so here you have a {fluffed pigeon in cold weather}
T: you see how Student G?
T: he’s trying to warm up.
T: he has been putting his arms into his sleeves the entire lesson
T: that's what the pigeon is also trying to do.
T: he's trying to warm up.

In another example, this same teacher conveys an idea that seems to confuse students, that we eat birds’ eggs.

Teacher A-SIT

T: when we make scrambled eggs or an omelet
T: those are bird eggs./
T: chickens are birds,
T: that's why we have birds’ eggs in our house/

In these two excerpts, teachers synthesize the information that has been presented in a way that drives home the point about what makes a bird a bird.

Teacher E-SYNTHESIZING STATEMENT-RT

T: so no matter what we learned about eggs
T: we learned about beaks
T: we learned about all those things and
T: some birds had ‘em and
T: some birds didn't but
T: all birds have feathers and
T: only birds have feathers
T: so feathers are the thing that make all birds special

Teacher A-SYNTHESIZING STATEMENT-RT

T: even though they share some qualities with other animals
T: some of other animals have beaks
T: some other animals make nests
T: some other animals can fly
T: feathers are the special thing about birds

Teachers referenced their own or collective background knowledge and experiences to illustrate a certain idea or fact from the text. I coded these kinds of comments with the code CONNECTING TO BK/PE (CBKPE).” This code was the least commonly occurring among the text commentary codes. Frequency counts for this code among teachers were variable and accounted for 10.26% of the total text commentary count.

> “When I think of birds this is what I think of.”
> “I saw cardinals on my deck this morning.”
> “Probably why you don't want to put your fingers anywhere near a beak, it will hurt!”
> “I have a down jacket made up of feathers and it keeps me warm.”
> “You have probably seen penguins at the zoo.”

Table 16 shows the frequency counts by teacher and by text for the text commentary codes. The table also shows what percentage each child code is of the total text commentary counts.

Table 16

Text Commentary Frequency Counts and Child Code Percentages by Type, Teacher, and Text. RT Results are Bolded.

	Number of parent code applications	Child code percentages			
Teacher/text	# TC				
type	Utterances	% CRN	% CA	% CS	% CBKPE
A-SIT	70	77.14	2.86	17.14	7.14
A-RT	**50**	**74.00**	**0.00**	**18.00**	**10.00**
B-SIT	54	50.00	37.04	5.56	1.85
B-RT	**33**	**63.64**	**3.03**	**15.15**	**15.15**
C-SIT	65	72.31	0.00	20.00	23.08
C-RT	**32**	**75.00**	**3.13**	**9.38**	**28.13**
D-SIT	70	67.14	15.71	2.86	22.86
D-RT	**72**	**61.11**	**16.67**	**12.50**	**11.11**
E-SIT	91	38.46	7.69	0.00	1.10
E-RT	**80**	**65.00**	**7.50**	**25.00**	**12.50**
F-SIT	18	83.33	5.56	0.00	5.56
F-RT	**18**	**72.22**	**16.67**	**0.00**	**11.11**
G-SIT	37	40.54	0.00	0.00	0.00
G-RT	**-**	**-**	**-**	**-**	**-**
H-SIT	60	80.00	18.33	1.67	6.67
H-RT	**49**	**63.27**	**26.53**	**14.29**	**0.00**

	Number of parent code applications	Child code percentages			
Teacher/text type	# TC Utterances	% CRN	% CA	% CS	% CBKPE
Mean	53.27	65.54	10.71	9.44	10.42
Median	54.00	67.14	7.50	9.38	10.00
SD	22.16	-	-	-	-

Note. TC-text commentary, CRN-content rephrasing, restating, narration, CA-affective response to content, CS-synthesis, CBKPE-connecting content to background knowledge or personal experience (of self or collective).

Responses to Students

Teacher responses to a student or students in the form of a statement, not a question, was the least common form of extratextual talk (M=21.06%, Mdn=21.08%). These patterns, in order of frequency included POSITIVE FEEDBACK ON ACCURACY (RFA), RESTATING RESPONSES (RR), AFFECTIVE RESPONSES (RA), EXPANDING RESPONSES (RE), CORRECTING RESPONSES (RC), OTHER RESPONSES (RO). The patterns of this type of extratextual talk show the tenor of the read-aloud sessions, whereby mostly students were encouraged, affirmed, acknowledged, and sometimes corrected. However, the fact that this category of extratextual talk was the least common, shows that teachers controlled most of the talk that occurred during the read-aloud sessions.

The most common kind of response to students was when teachers gave students positive feedback about their comments. This type of response occurred 41.09% of the total count of responses. Some excerpts with this code include:

> "Yes, birds use their feathers, very good."
> "Yeah, you're noticing a pattern, we call that a pattern."

"They ARE still birds."
"I don't know if our book said that but you already knew that about them which is pretty cool."
"Yep, you found it, the rachis."

Another common form of response to a student was to simply restate exactly what the child said. This occurred 19.52% of the time. This code was like the code called REPAIR, but the teacher did not raise their pitch at the end of the statement. This type of response was a means of acknowledging and affirming what the child said.

Teachers expanded slightly on what the child said 15.95% of the time usually to make the comment more clear or complete. Three excerpts from different read-aloud sessions with the expansion code are included below with the expansive comment underlined:

S: seahorses lay eggs
T: <u>yes, we learned that seahorses put them in the father's pouch</u>

S: crocodiles
T: crocodiles lay eggs

Or in this exchange:

T: what else flies?
S: a butterfly
T: <u>a butterfly flies</u>

Affective responses to children's talk occurred a mean of 17.15% of the time. These were enthusiastic and affirming exchanges when teachers complimented children on their thinking. Examples include:

"Nice job you guys!"
"I really like how student X is examining her feather."
"Wow, wow, you guys have a lot of knowledge about birds already."
"You're as smart as scientists."

Corrections occurred an average 14.94% of the time. If a child said something that was incorrect the teacher corrected them explicitly. This happened in a couple of different ways. At times the teacher just presented some information, and the child simply made an error, as in this example:

T: you guys know what that bird is?
T: It's a big pink bird.
T: you might see it at the zoo.
T: Student C?
S: I think it's a turkey.
T: Not quite

Another example of a correction was when children got confused between a hedgehog and an echidna and the teacher corrected them on that error. For example, a teacher said, “It looks like a hedgehog but it's not a hedgehog.”

Sometimes this response was used to correct a broader concept, such as a misconception about which birds fly, as many children expressed their belief that ducks and chickens did not fly. Here’s an exchange between a student and teacher about ducks, the underlined text shows the teacher’s correction:

T: penguins and the ostrich, they can't fly.
S: duck can't fly too?
T: what two birds can't fly?
S: penguins?
T: penguins and
S: ducks?
T: ducks can fly
S: no
T: yeah

The final category, comprising 12.90% of the total, were miscellaneous responses to students, coded as RO. These were not worth categorizing further but still contributed to the overall total count of responses to students. A few examples of these include:

"Oh you used that bird word that's hard for me."
"That happens sometimes."
"People see those eggs in random places."

Table 17 shows the frequency counts by teacher and by text for the responses to students codes.

The table also shows what percentage each subcategory is of the total student-response counts.

Table 17

Responses to Students Parent Code Frequencies and Child Code Frequency Percentages by Teacher and Text

	Number of parent code applications	Child code percentages					
Tchr/Txt	RS #	% RFA	% RR	% RE	% RA	% RC	% RO
A-SIT	43	55.81	46.51	25.58	0.00	2.33	13.95
A-RT	**48**	**37.50**	**20.83**	**14.58**	**10.42**	**20.83**	**14.58**
B-SIT	36	50.00	13.89	5.56	13.89	16.67	19.44
B-RT	**31**	**64.52**	**12.90**	**6.45**	**12.90**	**6.45**	**12.90**
C-SIT	69	31.88	15.94	11.59	2.90	31.88	11.59
C-RT	**39**	**38.46**	**17.95**	**28.21**	**23.08**	**20.51**	**5.13**
D-SIT	47	29.79	14.89	17.02	29.79	19.15	12.77
D-RT	**33**	**45.45**	**18.18**	**9.09**	**21.21**	**24.24**	**6.06**
E-SIT	50	38.00	24.00	16.00	28.00	6.00	6.00
E-RT	**92**	**42.39**	**17.39**	**30.43**	**17.39**	**14.13**	**5.43**
F-SIT	18	33.33	38.89	11.11	16.67	5.56	16.67
F-RT	**17**	**47.06**	**35.29**	**11.76**	**23.53**	**0.00**	**17.65**
G-SIT	29	48.28	10.34	3.45	10.34	0.00	34.48
G-RT	**-**	**-**	**-**	**-**	**-**	**-**	**-**
H-SIT	20	10.00	0.00	0.00	45.00	5.00	45.00
H-RT	**17**	**47.06**	**5.88**	**5.88**	**35.29**	**23.53**	**5.88**
Mean	67	41.30	19.53	13.11	19.36	0.13085	15.17
Median	36	42.39	17.39	11.59	17.39	0.1413	12.90

SD	20.64	-	-	-	-	-	-

Note. RFA-positive feedback on accuracy, RR-restating student's response, RA-affective responses, RE-expanding responses, RC-correcting responses, RO-other types of responses.

Student Talk

Rather than using the definition of utterance as I did for teachers' talk, I grouped student talk into two codes, LOW PRODUCTION (LP) and HIGH PRODUCTION (HP). LP student talk was two or fewer morphemes. HP talk was three or more morphemes. I grouped student talk into five categories including, LITERAL (LIT), INFERENTIAL (INF), ASSOCIATION (ASSN), YES/NO (Y/N), and NO LEVEL OF ABSTRACTION (NOLA). This is explained in more depth in the methods chapter.

Quantity of Student Talk

A mean of 56.33% of student talk was high production and 43.67% was low production. The average number of student words uttered compared to the average number of teacher words uttered was 392:1254. Students produced on average 36.44% of the words that teachers produced. Keep in mind that the average number of students per group was five. Therefore, if you divide the average number of words students spoke by five (the average number of students per session), the average number of words each student spoke across all the sessions was 78.4 words per session. The length of each utterance across all teachers and all texts was an average of 4.74 words (Mdn=3.00 and SD=6.53). The variability in these percentages and ratios could be explained by one talkative student in each group and this happened frequently. If a child told a personal story during the lesson, which did happen, the student talk percentages and teacher: student talk ratio changed considerably. The numbers do not consider participation patterns, equity of talk among the group, or other factors.

The table presents the quantity of dialogue exchanged between teachers and students during read-aloud sessions, measured by the total number of words spoken and instances categorized as either low participation (LP) or high participation (HP), as shown in Table 18.

Table 18

Amount of Student Extratextual Talk in Relation to Teacher Extratextual Talk and Student Production Percentages by Teacher and Text

Teacher/Text	Number of student words	Number of teacher words	Number of student words as % of teacher words	% HP	% LP
A SIT	257	1231	20.88	56.16	43.84
A RT	**388**	**1272**	**30.50**	**56.47**	**43.53**
B-SIT	387	1094	35.37	71.60	28.40
B-RT	658	1133	58.08	78.49	21.51
C-SIT	506	1572	32.19	42.31	57.69
C-RT	**577**	**1297**	**44.49**	**55.46**	**44.54**
D-SIT	513	1853	27.68	28.05	71.95
D-RT	**313**	**1652**	**18.95**	**34.58**	**65.42**
E-SIT	153	2032	7.53	67.65	32.35
E-RT	**584**	**2395**	**24.38**	**56.03**	**43.97**
F-SIT	303	579	52.33	73.08	26.92
F-RT	**232**	**545**	**42.57**	**52.94**	**47.06**
G-SIT	324	759	42.69	75.56	24.44
G-RT	**-**	**-**	**-**	**-**	**-**
H-SIT	497	570	87.19	51.11	48.89

Teacher/Text	Number of student words	Number of teacher words	Number of student words as % of teacher words	% HP	% LP
H-RT	**181**	**833**	**21.73**	**45.45**	**54.55**
Mean	391.53	1254.47	36.44	56.33	43.67
Median	387.00	1231.00	32.19	56.03	43.97
SD	156.93	561.69	-	-	-

Note. HP-high production student utterance and LP-low production student utterance.

Quality of Student Talk

I examined the quality of student talk. To do so I created five codes to differentiate the types of talk noted above; more details were provided in the methodology chapter. The variability of these frequencies is the greatest among teachers in the categories of inferential comments and yes/no comments. The quality of talk categories of yes/no on the one end, and inferential on the other end suggest a continuum of response rigor, the lowest of which is yes/no and the highest of which is inferential. Table 19 shows the quality of student talk in percentages of the total amount of student talk by teacher and by text type.

Table 19

Quality of Student Talk by Teacher and Text Type in Percentages of Total Coded Student Talk

	Types of Student Talk				
Tchr/Txt	% LIT	% YN	% INF	% NOLA	% ASSN
A-SIT	64.38	12.33	9.59	6.85	6.85
A-RT	**52.94**	**14.12**	**18.82**	**5.88**	**8.24**
B-SIT	40.24	9.76	13.41	13.41	23.17
B-RT	**39.56**	**8.79**	**21.98**	**5.49**	**24.18**

	Types of Student Talk				
Tchr/Txt	% LIT	% YN	% INF	% NOLA	% ASSN
C-SIT	52.71	17.83	20.16	5.43	3.88
C-RT	**42.02**	**7.56**	**25.21**	**10.08**	**15.13**
D-SIT	44.44	37.04	7.41	2.47	8.64
D-RT	**54.63**	**25.93**	**8.33**	**1.85**	**9.26**
E-SIT	27.27	6.06	42.42	6.06	18.18
E-RT	**27.35**	**19.66**	**26.50**	**11.97**	**14.53**
F-SIT	46.15	7.69	19.23	3.85	23.08
F-RT	**58.00**	**16.00**	**8.00**	**4.00**	**14.00**
G-SIT	60.87	6.52	8.70	8.70	15.22
G-RT	**-**	**-**	**-**	**-**	**-**
H-SIT	71.74	4.35	2.17	4.35	17.39
H-RT	**47.73**	**18.18**	**18.18**	**6.82**	**9.09**
Mean	48.67	14.12	16.67	6.48	14.05
Median	47.73	12.33	18.18	5.88	14.53

Note. LIT-literal utterance, Y/N-yes or no utterance, INF-inferential utterance, NOLA-no level of abstraction of utterance could be determined, ASSN-association utterance.

Text Differences

I collected extratextual talk measures I deemed important by virtue of what they indicated about the tenor of the read aloud, such as the quantity and quality of students' talk, or the rigor of teachers' questions. I compared them for each teacher between the SIT and the RT to see if there were key differences in the ways teachers conducted their read-aloud sessions. I used a paired-sample Wilcoxen test to measure for any statistically significant differences between the two text conditions (Wilcoxen, 1945). The Wilcoxen test is a non-parametric alternative to a paired t-test for data that are not normally distributed. The test is designed to compare two related samples for which the measurement is ordinal and can be ranked. In the case of this study, the frequencies of certain codes were the outcome measures that were ranked and then compared to see if the text could be correlated to the codes' frequencies. In each comparison, the only variable was the text. The teacher was constant and student groups were controlled for language comprehension scores and grade level. The V value is the sum of ranks assigned to the absolute differences between the two groups. I found no significant differences in extratextual talk measures between the RT and the SIT conditions. However, the RT did produce a nearly significant result with student inference production (p=0.0584) and the number of inferential questions teachers asked (p=0.09349) while not significant did have the second highest p value. The effect size for the RT condition on student inferential talk was moderate (Cohen's *d* = 0.694) and for the frequency of inferential questions, the effect size was small (Cohen's *d* =0.0279). The Wilcoxen test results are shown in Table 20.

Table 20

Paired-Sample Wilcoxen Test Results for Extratextual Talk Measures for RT and SIT Text Conditions Across Eight Teachers

Extratextual talk variable	V=	p-value (p >.001)	Cohen's *d* effect size (*r*=)
Number of student words produced	14.5	0.674	
High production	8.5	0.207	
Low production	15	0.7422	
Inferential	4	0.0584	0.6943

Association	15	0.7256	
Literal	19	0.9453	
Yes-No	12	0.7995	
Teacher Questions	20	0.8438	
Question Levels 1-2	18.5	0.4974	
Question Levels 3-4	2	0.09349	0.2792
Text Commentary	20.5	0.3096	

Note. V-the sum of ranks assigned to the absolute differences between the two groups.

Inventory of Read-Aloud Practices Across Eight Teachers

Across the eight teachers, I observed common practices during the read-aloud sessions that are not captured in the findings I have reported thus far. These practices are listed in Table 21. Using the empirical literature on effective read aloud teaching strategies, especially about science, I looked for the presence of these evidence-based strategies in the read-aloud sessions (Cabell & Hwang, 2020; Connor et al., 2017; Hwang et al., 2022; K. McMaster et al., 2019; Neuman & Kaefer, 2018; Wright, 2019; Wright & Gotwals, 2017; Zucker et al., 2021). Most teachers began the read aloud by asking students about their bird background knowledge in a round-robin fashion. Most teachers used real feathers provided by the research team as part of their read aloud. Teachers passed the feathers out before or after the read aloud to let students examine and talk about the feathers with one another. Two teachers did a vocabulary preview activity, and one of those teachers presented that activity with a semantic map. Half of the teachers asked students what they had learned about birds after reading the text. All of the teachers controlled student participation and talk, usually by calling on students one by one. There were no instances of student-to-student talk participation structures. Half of the teachers used hypertext strategies for their students. I define hypertext strategies as those that involve gesture, song, and call-and-response techniques to present the material and to engage students in participation in the lesson. One teacher used hypertext strategies often, for example, when learning about nests, she had students "make a nest" and pretend to be a bird and make a nest. She also had students chorally repeat key phrases of the text such as this:

T: penguins and ostriches–they do not fly
T: go like this –te*acher makes an "x" with her arms and shakes her head*
T: go like this —*still showing the x and the gesture*
T: say-they do not fly
S: they do not fly-*only one student says*
T: Oh let's say it together
S: *one child is desperate to say something else unrelated to the command*
S: THEY DO NOT FLY -*all students say in unison with the gestures*

None of the teachers used graphic organizers for ideas in the text such as a KWL (what I know, what I wonder, what I learned) chart or other type of thought and concept tracker. Five of the eight teachers used explicit metacognitive strategies that involved statements such as, "Hmm, let's read to find out if what you know is different from what the text says." All the teachers asked questions that required inferential thinking about the text. Two of the eight teachers referenced other texts (or a video) that they had read or watched together about a topic that arose during reading the SIT or the RT read aloud. For example, a student began talking about seahorses laying eggs as an example of another species of animal that lays eggs, and this is how the teacher responded:

T: oh because we watched that video, is that right?
S: yes uh-huh
T: but do this but does the seahorse lay their eggs in a nest
S: No
T: where do they lay eggs?
S: in the ocean.
T: do you remember the video?

Two of eight teachers used disciplinary science talk at least once. This means that teachers referred to scientists or the domain of science explicitly in their extratextual talk. Four of the eight teachers referenced disciplinary literacy practices during the read alouds such as "learning new words," identifying the genre of the text as teacher B said, "This is a non-fiction text and that means it's real true information." Or teachers highlighted the decoding of words on the page as in this example, "I read the letters "b" and "o" so I said *bold* instead of bald. Letters make differences don't they, they make different sounds." Table 21 shows the inventory of practices that I observed or did not observe across the 15 read-aloud sessions.

Table 21

Evidence-Based Read-aloud Practices Observed During RT and SIT Conditions

Read-aloud instructional practice	Number of teachers who demonstrated practice at least once N=8
Asked students for background knowledge before reading	6/8
Provided a vocabulary preview	2/8
Asked students what they learned after reading	4/8
Hands-on activity paired with reading (feathers observation)	7/8
Used traditional student talk structure (teacher calls on individual students one at a time)	8/8
Demonstrated hypertext strategy (used song, gesture, call-and response, etc.)	4/8
Translanguaging (used Spanish and English to teach content and engage students)	1/8
Created semantic maps for vocabulary	1/8
Organized student to student talk structures	0/8
Used charts to keep track of ideas (e.g. KWL)	0/8

Read-aloud instructional practice	Number of teachers who demonstrated practice at least once N=8
Explicitly stated or modeled metacognitive strategy, e.g. “learning something different from what we knew from the text”	5/8
Referenced other shared texts during read aloud	2/8
Referenced literacy practices, e.g. book genre, decoding, vocabulary, comprehension strategies, etc.	3/8
Engaged in science disciplinary talk	2/8
Generated questions that promoted inferential reasoning	8/8

Qualitative Trends

While the frequency counts for extratextual talk revealed patterns and gave insights into differences across teachers, texts, and students, a qualitative review of the transcripts illuminated aspects of the read-aloud sessions that would have been lost using only quantitative methods. In this next section of the Findings Chapter, I share key themes in the transcripts and occasionally weave in data from the teacher interviews. I discuss teacher interviews at the end of the findings chapter.

Students Were Engaged in the Topic and Showed Inferential Thought

“Students are always excited to learn about science.” Teacher H said in her interview with me. She reported that in the beginning of the year when students declare their “hopes and dreams” for their school year, often children say, “I hope to learn a lot in science.” She went on to say, “They all really love science, they are very interested.”

There were many examples from student extratextual talk that illustrated their enthusiasm for the topic of science and, in this case, birds. A quick search on the word “overlapping speech” on the transcripts revealed at least 50 instances where students were so excited to talk about what they were learning that I had to transcribe, "overlapping speech," or "the child gasps," or "various responses from each child," or "COOL" or "Awesome!" or "What?!"

Here are some responses from questions teachers asked during the read aloud.

S: "OMG!" she exclaims while raising her hand enthusiastically…

T: so, have you seen these birds in your yard?
S: *lots of responses somewhat indecipherable because they are all talking over each other excitably*

Another teacher said, "throughout the lesson a lot of them were raising their hands" and added, "it's just a time where they're all really thinking and talking through a lot of things that are going through their brains otherwise."

Students showed fascination with the material and showed inferential reasoning many times. One boy during the lesson was so captivated by a photograph of snakes coiled around a clutch of eggs and he asked the teacher many times about the phenomenon. Below is the excerpt from the transcript:

S: Snakes can make eggs? t*he boy interrupts her*
S: The snakes.
T: chickens are birds,
T: that's why we have birds eggs in our house/
S: Does snakes make eggs -*the boy interrupts the teacher again*
T: {here's an interesting fact about birds all birds lay eggs as other animals like frogs, fish, and snakes lay eggs}
T: now you just had a question -*she calls on the boy who has been interrupting her*
T: do snakes lay eggs?
S: um yes
T: Yeah we just read…/
S: how did they lay them? -*he interrupts her again*
T: they lay the eggs
S: from what? t*he boy's brow is scrunched because he's slightly confused by snakes laying eggs and her not answering*

Students also showed fascination patterns across the read-aloud sessions. These topics garnered lots of interest across the read aloud sessions:

Golden eggs
Snakes lay eggs
Ostriches don't fly
That we eat chicken eggs
Not all birds fly
Bald eagles have feathers on their heads
The father penguin just watches the eggs and does not hunt

The reasons why these topics were fascinating to children is interesting to consider. A fascination with the golden egg could be related to the folktale, the others, however, appear more about misconceptions or misunderstandings.

Students Showed a Wide Range of Knowledge about Birds

Before reading the text, six out of the eight teachers asked students what they knew about birds. The responses to this question exposed a wide range of knowledge about and language to convey their understanding of birds.

In the excerpt below, a second-grade child showed a somewhat encyclopedic knowledge:

S: That's the species of animals they are. Birds are animals with feathers that fly and have beaks.
T: that's awesome.
T: can you say that again?
S: birds they're animals that can fly. I added also they have feathers 'cause kids get that confused with sidewinders which can also fly.
T: Ok, so you're telling me that birds are animals that have feathers and that can……
S: fly..
T: fly
T: is there anything else you can tell me about birds
S: They also have beaks and some birds are nocturnal. They're only awake during the night
T: are all birds nocturnal?
<u>S: no not all birds and there are loads of types of birds I think by the way I think most people would say that northern cardinals are the most beautiful.</u>

These examples from other classes show the range of knowledge about birds, the range of facility with language, and the range of comfort with using oral language:

T: Student X tell me what you know about birds.
S: they usually make nests when they have little baby eggs

T: what do you know about birds?
S: *student G makes wings with his arms and pretends he's flying and he says "they fly"*
T: they can fly?
S: *Student G shakes his head yes*

T: What do you know about birds?
S: they live in the trees

T: What else do we know about birds Student T?
S: eat
T: they eat?
S: yes
T: what do they eat?
S: worms

T: Student C, what else do you say about birds?
S: birds fly around sometimes when it's raining and there's mud the worms come up and the birds fly down and get the worms and fly away.

The most common occurring answer from students was that birds fly. The excerpts I've pulled from the transcripts illustrate the wide range of science background knowledge and English language facility children come to school with. This finding is supported in the empirical literature as well (Morgan et al., 2016) and is one reason why it is an equitable practice to bring this kind of content learning into the classroom as early as possible.

Misconceptions About Birds Were Present and Persisted

In my literature review I discussed how students come to school with misconceptions and these misconceptions can interfere with learning new information. The misconceptions about categorizing animals like birds has been studied before. As in Prokop et al.'s study, students aged

7-15, the youngest students, significantly misclassified animals that fly as birds, as well as birds that do not fly, suggesting that locomotion is a major cue when classifying animals. Science education researchers Chi and colleagues describe this as an ontological naivety in children, meaning that children's reasoning for categorizing concepts is flawed and needs revision (Chi, 2008; Chi & Roscoe, 2002). However, the grain size of knowledge involved in categorization is, according to Chi, the largest among three sizes of knowledge. This means that categorical mistakes reflect a more cohesive and robust knowledge network within the child's mind and take more time to change (Chi, 2008; Tippett, 2010). This phenomenon was present in the comments that students made during the read aloud.

Teacher C-RT

T: {In fact some birds do not fly}
T: WHAT? *Scrunches up face and turns to look at students.*
S: some birds can't fly??
T: oo if it flies is it a bird?
S: yes *one child says…*
S: no *another child says.*
T: no?
T: what else can fly?
S: anything!
T: not anything – I can't fly.
S: some things.
T: some things like what?
S: bees or lady bugs or bats?
T: bats
T: bats fly and they're not birds.
T: that's a good example.

Teacher E-RT

T: think of a bird that might not be able to fly, Student C ?
T: it says, *in fact, some birds do not fly*?
T: have you guys heard of that before?
T: do you know of any animals or any birds that don't fly?
T: Student C?

S: um so what if the birds make kids and they can’t fly-*gestures like he has feeble wings*
T: so baby birds can’t fly. Right, I like that thinking.
T: Student T, have you heard of a bird that **can't** fly?
S: um, maybe one bird had a broken wing.
T: so Maybe if the bird is hurt they can't or won't be able to fly.
T: have you guys heard of any **KINDS** of birds that can't fly?
T: keep thinking, think real hard.
T: think of a bird that might not be able to fly, Student C ?
S: a chicken
T: that's that's an interesting one
T: cuz do we usually see chicken fly?
S: NO
T: but a fun fact a chicken CAN fly.
S: what?!
T: do all birds fly?
S: so*me students are shaking their heads yes some students are shaking their heads no*
T: you don't think so?
T: no you don't think so?
S: all birds can fly
T: so you think all birds can fly
T: Let's read and find out…
S: Ducks don't fly
T: What?
T: ducks don’t fly?
T: ducks don’t fly?
T: are ducks birds?
S: yeah
T: do ducks fly?
S: *boy shakes his head no*
S: *other children shake their head yes*
S: ducks fly
S: and chickens don't fly
T: you know what?
T: chickens can fly for a short amount

Teacher A-RT

T: do you know of any birds that don't fly?
S: penguins?
S: babies?
S: penguin, no
T: {penguins and ostriches are birds and have wings but they do not fly}
T: penguins and the ostrich, they can't fly.
S: duck can't fly too?

T: what two birds can't fly?
S: penguins?
T: penguins and
S: *Something inaudible!*
S: ducks?
T: ducks can fly
S: no
T: yeah
S: tiger?
T: ostrich, bird
S: ducks don't fly -*the student says again with his arms in a shrug to the other students*
T: tiger, tiger's an animal
T: but it's not a bird

The thesis of both texts clarified that birds are a category not because they fly or lay eggs but because they have feathers. At the end of many read alouds, regardless of text type, when asked the question about what they learned about birds, most often there was at least one student who responded that birds fly. In other words, students did not often seem to understand the main thesis of the book at least in that moment.

Below is an example of how difficult categories are for young children. After an initial incorrect or confused answer, the teacher supports the child to lead them to a more correct answer by providing some scaffolding questions:

Teacher D–RT

T: student D- what do you learn about birds?
S: not everything that has wings are birds
T: that's awesome
T: can you say that again?
S: not every bird is a bird
T: not every bird is a bird you said that not every bird that has….
S: wings
T: all animals that have wings, are they birds?
S: no
T: how about all animals that lay eggs, are they birds?
S: no
T: what do all birds have in common?

T: what do they all have?
T: what do they all have?
S: wings to fly–t*his was said by the same boy who just said that all animals that have wings are not birds*

Still, the child cannot give up the idea that birds fly and that characteristic is what defines the category of birds for this young student. Regardless of the text and the teacher, at least some of the students left the read aloud with misconceptions intact.

The following excerpt highlights the difficulty a child has in processing the more conceptual information he learned during the read aloud.

Teacher D-SIT

T: I'm sorry Student S, what did you learn about birds today?
S: birds have feathers and feathers have wings and I lost two feathers

Here is another example of the persistence of misconception from another teacher.

Teacher A-RT

T: what is one thing you learned about birds?
S: Fly
T: last but not least Student A
S: what I learned about birds today is that they fly

Teacher A-SIT

T: now tell me one thing you learned about the birds today?
S: they can fly
T: they can fly?

And yet another instance of a persistent misconception and how a teacher gets backed into a corner about how to correct the child:

Teacher A-SIT

T: Student J, what is one thing you learned about the birds today?
S: birds can fly

T: yeah they can fly.
T: how do they fly?
T: they fly with their feathers.

Another example of a child struggling to understand how a bird might not fly by applying his background knowledge to this unsettling and new idea of non-flying birds. His inference (bolded) is incorrect, but he is trying to make sense of what he is learning.

Teacher B-RT

T: {Well scientists agree that this is not true. Many birds fly, as insects like bees and ladybugs fly. In fact some birds do not fly.}
T: Did you know that?
S: *kids are really seeming to quiet down and listen closely until the question is asked*
S: Various responses from children including;
S: that's owls, owls don't fly in the morning

Primary-aged students are proud of knowing things, and it can be hard for them to admit they did not know something. The pride of knowing something, even if it is inaccurate, can be difficult to relinquish. This pride is shown here in this comment claiming that the only thing he learned was about snakes, and that he knew everything else the text had to offer.

Teacher B –RT

T: Student J said he didn't know that snakes lay eggs
S: that's the only thing I didn't know *this is Student J*

Authentic Exchanges Happened Among Teachers and Students

There were instances where authentic inquiries about the text topic between students and teacher occurred. I distinguish authentic inquiries from a more typical pattern in the read-aloud sessions where teachers ask and engage in known-answer questioning of students. The more authentic moments, although rare, are important to note because they exemplify what engagement can look like-both from the student and teacher.

Pen and ink

Teacher G–SIT

S: where did you find these
T: that's a good question
T: that's a mystery
T: I'm all about mystery
S: mystery I know where feathers are I've seen some before sometimes I use feathers that look like a pen does a feather write does a feather even write
T: oh yeah some people used to put ink inside the rachis a long time ago
T: the rachis would have to be big enough to put ink inside
T: but you can put stuff inside
S: do you have ink
T: I don't, these are the small feathers

How many?

Teacher E–RT

T: hey so this is the part that connects to the bird's body all right
T: and it's keeping all these little tiny parts of the feather together
S: but the birds need more than one of the feathers to fly?
T: So you guys think if a bird just had one of these feathers would it help them lift up into the air?
S: No, they need lots of feathers.

Stealing an Egg

Teacher B–RT

T: {oystercatchers do not make nests, they just lay their eggs on the sand}
S: what if somebody takes one?
T: well they would maybe have to be careful about where they put it l
T: like putting it in a place where people don't normally go but
T: what do you think would happen if someone found it
S: take it they would probably take one
T: they might take it
T: what if you were on the sand and you saw an egg
T: would you take it or would you say let's leave that alone
S: do not take it
T: I would say don't take it because it probably belongs to a bird who's trying to hatch their egg

S: *Various responses from students in agreement literally they're all talking at the same time about their experiences with taking eggs one boy, Student G, is explaining how his sister took an egg and cracked it open*
T: if you see eggs out in the wild you should probably leave them alone right?
S: except if they have a little something to eat inaudible *other kids shake their head and say yes in agreement*

Astonished to Learn that Penguins Have Feathers

Teacher B–RT

T: {it is feathers that make a bird a bird feathers are the special thing for birds because only birds have feathers and all birds have feathers}
S: I know that
S: so that black feather is connected to that
S: **wait penguins have feathers??** *the boy says to himself with a scrunched-up face*

As the teacher reads more about the purposes of feathers, Student J reveals more of his thought process:

T: they have two different kinds of feathers to help them do different things.
T: {feathers keep birds warm like a blanket in cold weather}
S: Student J exclaims "Oh!!" *because he now has the reason why penguins might have feathers*
S: "Oh like a penguin" he says smiling
T: Maybe that's why penguins have feathers. -*Teacher B says pointing and smiling and shaking her head AT Student J*
T: Student J sit on your bottom

More Than One Feather

Teacher B–RT

S: *one boy starts flapping his wings and saying this is going to fly me up*
T: Why do you think you can't fly if you have a feather?
S: I have no idea
T: you have no idea?
S: it's cuz you don't have enough feathers
T: maybe we don't have enough feathers
S: *all the children are pretending that they're flying and falling*
T: maybe if we were covered with feathers

Real Feathers Generated Talk and Joy

All teachers were given a bag full of feathers by the research team along with the two texts about birds. Teachers were not given any instructions with what to do with the feathers, they could use them as they saw fit. Teachers used these feathers in a variety of ways. One teacher passed out feathers for the students to look at before the lesson, but right after she had asked about their background knowledge.

Generally, teachers passed out the feathers after the lesson and students showed great interest and enthusiasm for the feathers. Teachers had students identify the parts of the feather including the barbs and the rachis, they had them describe the feathers, compare them, and share them with their classmates. This activity tended to generate some high production student talk. I note some examples of student talk during the feather activity below:

T: so we actually get to do something pretty cool
T: you guys are all going to check out these different parts
S: wow! *Kids are excited*
S: are these like actual feathers??!

S: this one **has** to be a peacock because look at the green on it

S: I've seen a feather before

T: and I want you to find the rachis and the barbs.
T: I'm going to give you two.
S: I found it!!!!
T: you found it already
T: I want you to feel the rachis.
T: does it feel stiff?
S: look I have the same color as you!
S: look we have the same color look!
S: we have the same one!
S: look we have the same polka dot the same polka dot!
S: this is colors this change colors too.
T: oh do you think the light reflects it in different ways?
S: mine's trying to get from brown to black.

S: what is that thing that's hard that goes right up the middle?

S: Ooh, I found the rachis

One teacher used the feathers to pose the question, “Do you think these feathers come from the same bird or from a different bird?” This teacher also asked for evidence for why the children thought it came from the same bird or a different bird. This was one of the only times a teacher asked for students to provide evidence.

Teacher E–SIT

T: see if you have the same or the different ones as your partner
S: I have the same as Student N's
T: how do you know it's the same one?
S: because his has green on top and mine has green on top
T: oh yeah so they both have green on top okay

Teacher E-SIT

T: Student C What do you think?
S: I do think it’s the same bird but I just recognized something, this one doesn't have the same mark and this one has black and brown
T: hmmm interesting, so you are noticing, we call that a pattern.

Teachers Were Not Always Confident in Their Knowledge About Science and Some Students Questioned Them

Many teachers were not familiar with some of the terms in the text, including rachis, barbs, echidna, and bald eagle and they struggled to pronounce them during the read aloud. There was also some evidence to suggest that a couple of teachers were unsure of what animals did qualify as birds. Two of the four teachers interviewed offered, without prompting, that they understood the point of each of the texts to be about supporting students to classify types of animals, but it was unclear if others understood this to be true. The limitations in knowledge sometimes stymied the teacher’s ability to support their students in engaging with the content. To be fair, the teachers were given the texts only about 24 hours before their read-aloud session, limiting the amount of time they had to prepare.

In the scenario below, the teacher tells her students that the term “rachis” is new to her. Many other teachers did this as well. On numerous occasions, teachers asked someone from the research team to pronounce the terms, so they could pronounce it correctly for the students during the read aloud. Most teachers emphasized this rare vocabulary word during their read aloud.

Teacher C-RT

T: What's this called? *points to the rachis*
S: that's kind of a silly name
T: what's this called?
T: say rachis
T: it's kind of a funny name right, rachis?
T: this is a new word for MISS Teacher C, I've never known that word before …

I observed moments of contention between students and a teacher when a student noticed that their teacher had incorrect information, or at least they doubted the teacher’s accuracy. In this example the boy is *sure* that the teacher is wrong, and he lets her know in front of the class.

Teacher D-SIT

T: look at these bold eagle’s wing feathers!
T: look at that!
S1: Bald not bold
Edited for relevance
T: look at the bold eagle's tail feathers
S2: wow
T: can you sit up please?
S1: it's bald eagle okay!
T: but they're saying that the eagle is bold.
T: what does it mean when something is bold?
S2: I don't know

S3: bald head
T: it's not bald, it's bold
S1: Although it's pronounced bald
T: yes, it means you're bold.
T: what does it mean when you're bold?
S3: It means you're strong *huge smile on student*
T: YES, it means your strong
S1: although it's pronounced bald *the boy looks resigned but frustrated*

In the following example, a student gets perturbed with his teacher, even though she is correct, when he is convinced that the animal in the book is a hedgehog and not an echidna, as the teacher insists.

Teacher F-SIT

T: {here's another interesting fact about birds let's learn about birds' beaks all birds have beaks just like other animals like squids and echidnas}
T: *looks at the camera since she's not sure how to say it*- {have beaks}
S: that looks like a hedgehog
T: see they have beaks too, squid
T: oh, I didn't know about a squid
S: well, that's a hedgehog
T: it's called an echidna–can you say echidna
S: Echidna
T: {look at how birds' beaks have different shapes, sizes, and colors}
S: well, everybody else calls it a hedgehog
T: Maybe it is

Another example of a teacher unfamiliar with a certain animal, many of the teachers never heard of an echidna before and struggled to pronounce it with their students

Teacher C-RT

T: so here's an animal I'd never heard of
S: it's a hedgehog, a hedgehog
T: It looks like a hedgehog but it's not a hedgehog
T: it's an Australian and New Guinea animal called an echidna, *the teacher struggles to pronounce it accurately*
T: can you say that?

T: say echidna
S: echidna

In this example, the teacher says that she is not sure about whether chickens are birds.

Teacher C-RT

S: And chickens don't fly
T: You know what?
T: Chickens can fly for a short amount
T: I wonder if they're birds too
T: I don't know if they are
T: I don't think they are
S: They are
T: You think they are

Along with the examples above, there were other examples of questions students had about the text or a picture in the text and the teacher did not answer their question. This may simply be because the teacher felt it was important to move the lesson along and not stall out; however, it seems plausible that the teacher simply did not know *how* to respond so chose not to. Earlier I discussed the exchange between the boy who wanted to know more about snakes' eggs as an example of a student's capacity for inferential thought. However, the moment also demonstrates a missed opportunity wherein the teacher could have spoken more about how snakes make eggs because the child was so fascinated. I do not know why the teacher chose not to engage with the question, and that reason may have nothing to do with her knowledge of such things.

Teacher A-SIT

/S: how did they lay them? *snake eggs*
T: they lay the eggs
/S: from what? *the boy's brow is scrunched because he's slightly confused by snakes laying eggs and her not answering*
T: so we got the snakes right here,

In the following example the teacher shares her confusion about animal categories with a student who wants to know more about snakes. This exchange could represent a pedagogical or rhetorical style; however it is not clear from the exchange.

S: snakes have how do they lay so big eggs?
T: I don't know
S: snakes lay eggs
T: do fish lay eggs
S: YES
S: all reptiles lay eggs
T: do crabs lay eggs?
S: YES
T: are they Birds?
S: NO
T: I am so confused

In the same read aloud the teacher exclaims again that she is not sure.

T: do penguins and oystercatchers build nests?
S: no
T: they don't
T: do ants and bunnies build nests?
S: yes
T: are they Birds?
S: no
T: oh I'm getting confused…

The Refutation Text Got Reactions from Teachers and Students Alike

I asked four teachers if they noticed any differences in student responses to either book. The teachers knew the texts as "Text A," the standard expository style, and "Text B," the refutation text. Teachers did not know that Text B was called a refutation text. Teacher B reported that, "I like the question part of the first text, which was text B. I feel like the inquisitive nature of text B was a little more engaging, and helped me come up with more questions."

Teacher A reported that she observed increased engagement with the refutation text. She said, "the type A book was more like, a lot more factual and had a lot more facts where the type

B book, it had some questions, ‘What makes a bird a bird?’ so it made that connection for them in a way, right, with the type B book, because of those questions and those connections that it made, the students were like, ‘Oh, interesting!’ And then it was like, “well, scientists think that this is not true…” that part of it made it a little bit different in the group, because then it made them think about that, putting like birds into categories, whereas the other one, because it was like a lot more factual. They weren't really thinking."

Teacher H reported that Text B, the refutation text, was “more difficult for them to follow,” She thought the syntax presented something challenging for her newcomer students. However, during the read aloud, Teacher H rephrased some of the wording of the text so that she was able to maintain high engagement with her students, as evidenced by their enthusiastic desire to respond to the refutation and recurring question in the text *Some people think that all animals that fly are birds. Do you?.*

Teacher E said that both texts A and B flowed well and produced engagement, “There was similar engagement between the two {texts}.” However, this teacher felt strongly that he as the teacher was responsible for keeping the engagement high with the text, “I think the read aloud is a real good time to collaborate and talk through a lot of these different things.” He also added, “I can get students to understand pretty well.” I interpret this to mean that while science texts vary, he thinks the extratextual talk is what makes a book accessible and interesting to his students. He added, “That’s why being able to kind of have those little brief moments of conversation and dialogue to help the text teach what it's meant to.”

The refutation text stated the common misconception, for example, concerning the “all birds fly” misconception the text says, “Some people think animals that fly are birds. Do you?

Oftentimes teachers would rephrase the question in their own wording or restate the question as is. Student responses to this type of text got vocal and physical reactions. On more than one occasion students who were ostensibly not paying attention, drew closer to the teacher to listen more carefully. Student responses were overlapping, and sometimes even frenetic, while often the response was a simple "yes" or "no" or head shake, there was palpable engagement. Here are some of my field notes and transcription notes.

Teacher B-RT

total excitement about this point [while reading the refutation part of the text]- one boy says that he knows that-lots of exclaiming among students.

Teacher H-RT

(each S: is a different student talking)
T: did you know that there are some birds out there that **don't** fly?
S: *lots of responses, mostly yeses overlapping*
S: I didn't know that!).
S: *one student is saying, "The penguins and the ostrich," while others are exclaiming inaudible comments*
S: a penguin is a bird, and they **don't fly**.

Teacher H-RT

S: I didn't know that!.
S: *one child squeals in delight after getting the "correct" answer*
T: here's another question: are you ready for it?
S: yeah! *Many children respond*

Teacher B-RT

T: {Birds are all around us flying, singing and nesting. Let's learn more about birds. some people think animals that fly are birds}
T: yeah *other students say something in agreement* penguins are still birds even though they don't fly
T: {Do you? Do you think animals that fly are birds?}
T: *kids get a little bit quieter and pay attention*
T: {Well scientists agree that this is not true . Many birds fly as insects like bees and ladybugs fly. In fact some birds do not fly.}

T: Did you know that?
S: *kids are really seeming to quiet down and listen closely until the question is asked*
S: *Lots of various responses and chatter from the children*

Teacher B-RT

T: {while scientists agree that this is not true many birds build nests as other animals like ants and rabbits build nests}
S: Rabbits?
T: {As a matter of fact some birds do not build nests. penguins do not make nests instead father penguins carry their eggs on top of their feet}
S: *Various responses from children including surprise laughter pointing excitement*

Teacher B- RT

T: {some other people think that animals that lay eggs are birds, do you?}
S: *lots of responses from kids in agreement*
S: usually chickens are the ones you can eat but if they're if they're a boy then they make chickens
S: other responses that are hard to make out because of all the overlapping speech

Teacher B-RT

T: {some other people think that animals that have beaks are birds, do you?}
T: {while scientists agree that this is not true. all birds have beaks as other animals like squids and echidnas have beaks}
S: *total excitement about this point- one boy says that he knows that lots of exclaiming*
T: I think the squid's beak is kind of hidden down here at the bottom
S: How? sometimes those have beaks and when they see an animal and they want to eat it and they like it they can eat it and when they go in their mouth they can just close their mouth
T: so beaks help them eat
S: *the boy shakes his head yes*

Additional examples of engagement with the refutation text include instances of high response rate, overlapping speech, children drawing physically closer to the teacher and the text, enthusiasm, side talk with other students, and in general a heightened energy.

In field notes I took during six read aloud sessions (the read aloud sessions took place simultaneously each day), I wrote the following observations during the refutation text sessions. These observational notes are from four different read-aloud sessions:

> "Student D scoots across the rug to go in closer during the refutation part."
>
> "The three boys are furrowing their brows when they learn that all birds do not fly, one boy exclaims, "No all birds do not fly. No. Chickens, because chickens don't fly."
>
> Students' responses and energy swell right after Teacher C reads the question from the text, "Some people think all animals that lay eggs are birds. Do you?"
>
> Student V is beside herself trying to answer the refutation question–raising her hand enthusiastically. Others are gasping to be called upon to share their responses.

Teacher Interview Findings

I interviewed four of the participating teachers using a semi-structured process and a common set of questions (please see Appendix A). Below I report findings from these interviews across the four teachers in four themes including: 1) beliefs about the read aloud, 2) observations about students, 3) observations about misconceptions, and 4) thoughts about the text differences.

Beliefs About Purpose of a Read Aloud

The four teachers expressed widespread ideas about the purpose of read alouds for their students. Teacher A said she liked to use books for read alouds that "relate to something they're going through." She mentioned social-emotional topics such as "how to be a good friend," and books that covered "skills to kind of calm themselves down," and "holidays" and the "first day of school." She said she likes to choose books that "give them that information that they might not use right now, but at least they will know." Because teacher A was a new teacher (one year of experience) she referenced her mentor's practices with read alouds, which tended to use fiction chapter books. However, Teacher A told me about a teacher who integrated science with his other subject areas. She was impressed by this teacher. She said "I remember one of the teachers, he was doing a whole thing on germs. I don't know if his class had a thing with germs, but you know those things that they like that they learn about. You know, you need to wash your hands for this number of seconds, and you know how germs spread. So, I guess giving them something like that. Not that, like science, knowledge that they need not only during science, but like all throughout the disciplines-in writing or during literacy, bringing those books in, maybe having them already in that curriculum."

A veteran teacher, Teacher C, talked about read alouds to "grow their [students'] vocabulary" because books have so many words that "we don't use in speaking." She also said that she likes to "build relationships with students" by finding what they're interested in and reading to them about those topics. Teacher C wanted to convey to her students "how important literacy is in being able to learn more about things that you want to learn more about." She also mentioned that she looked for "text that reflects the students I have. So, you know, Hijabi or Latino, or African, American or Black, or, you know, just making sure that there's a variety of those texts." Teacher C reported that she liked to use non-fiction texts with students, "What I found is they're more engaged with the non-fiction books than I would have guessed 20 years ago in my career. Particularly since the photography has gotten better and the availability of, you know, such beautiful non-fiction books that have language that is really accessible to younger kids but can throw in some of those challenge words at the same time."

"A read aloud teaches a lot of important skills and gives kids a lot of interesting knowledge," said Teacher E. He saw the read aloud as a "time to collaborate and talk through a lot of these different things" his students were learning about in school such as science. In fact, he conveyed his role as a kind of conduit between the texts and the students, he said he engaged in "brief moments of conversation and dialogue to help the text teach what it's meant to." This teacher shared that he chose books that will interest students and turned them onto learning more about the real world. He said that if his students, “just think that something school related is cool, like that’s enough for me.” Because Teacher E worked at a science-focused school, he said the school “talks a lot about sustainability” and the focus of his work was to get his students to “learn about things they need to know going forth” to reverse changes to the planet.

Teacher H reported that she was concerned about the rigor of the language in both texts, especially for her multilingual learners, and was worried her students’ “attention was kind of dwindling” during the read aloud because “they get lost.” This teacher, who had taught for at least ten years, was interested in using more decodable books for read alouds so that children could access the words and follow along word for word. She was interested in making sure her children could practice skills like phonemic awareness and phonics with the texts that she read aloud. However, she also said that her students “all really love science” and are “very interested” to learn more, especially those who “might have some prior knowledge.”

Observations About Students During the Read Aloud

Teacher C said that she was surprised by her students’ response to the read aloud, “Kids were way more engaged than I ever would have suspected.” She noted that some of her students had prior knowledge while others did not, although she wondered if it was just difficult for some to express their knowledge due to language limitations. She said that “kids listen and take in way more than I think.” Teacher C also noted, especially with one child who expressed a lot of prior knowledge, that this child “was able to integrate new knowledge quickly.” Teacher C observed that all the students loved the pictures in the texts and that they enjoyed playing the vocabulary game about birds.

Teacher A talked about how much her students loved the feathers and looking at the pictures. Teacher E noticed that his students were "trying to figure it out and they were working on doing that." He saw that his students had lots of questions about the book topic and struggled to figure out how birds fit into a category. Teacher E said, "I had a kid that lost his feather in the wind, and he came back and asked me the next day 'Can I get another feather?' That [the feather] was something that was important to him and that concept alone, that is something that he's going to be thinking about. He wanted another feather and that was something that interested him at that moment, so I think that's super important for kids."

Teacher H reported that she used "whole brain teaching" to keep students engaged during the read aloud. She used call and response techniques, and had students use gestures and repeat phrases from the text. When I observed her read aloud sessions, the children were participating enthusiastically, especially with the gestures and the call and response techniques she used.

Observations About Misconceptions

Teacher H did not notice that children held any misconceptions about birds or the concepts in the text. While Teacher C did not recall any misconceptions, the idea was resonant for her. She said, "I don't want to solidify misconceptions." And at the same time, she, "is careful not to shame kids" about what they do not know or have incorrect. She went on, "I usually say something like 'I can see how you would think that or that makes some sense, but what we know is, da da da da' or 'Oh, good! This is a chance for us to grow our brains because we didn't know that this is what it is now, so using that as an opportunity to grow, right?'" Teacher E mentioned the concept of animal classification and said "That's a concept that kids in general kind of struggle with." He went on, "In general, at this age, they're like 'Oh so why can't that animal do that?' like the ostrich we talked about." He added "I like to pose questions like 'Why do you think that animal can't fly?'" This is exactly what Teacher E reported enjoying as a teacher, to support "kids figuring things out."

Teacher A noticed misconceptions among her students. She remembered that her students thought that the only animals that could lay eggs were birds. She liked the fact that she could use the text to say, "Here in the text it says that they're not [the only animals to lay eggs]. I could refer back to the text." If given more time with the text, she said she would like to "Give them a little bit more information on that misconception that they might have or even do my own research because I may have that same misconception, because I am learning with them."

Teacher Thoughts on Text Differences (SIT and RT)

Teachers did not know the differences in the texts until the night before they were to give the read-aloud sessions. After delivering both read-aloud sessions, three of the four teachers noticed and reported on differences in the texts from the teacher perspective and the student perspective. Teacher E did not note any major differences between the two texts. He said, "I think in both texts they were probably pretty similarly engaged. I think both allowed them to ask questions and I think they both flowed pretty smoothly, so overall I think it was probably a similar engagement between the two." Teacher H thought some of the wording in the RT was difficult for her students to follow. She recounted her experience during the read-aloud session starting with re-reading an excerpt of the text, "'*While scientists agree that this is not true, do you*?' that language piece, like they have to get the first part, and then you're adding a second part for them to understand. And I just can see, like myself, as a multilingual learner getting confused, 'Like what? What is she saying?' You know, especially a newcomer, and I would say, half of them are newcomers. They're new to country from Ecuador and Mexico. So even when I was like, do you agree or do you disagree? (*She makes the gesture of thumbs up that she did with the children*) ‘Do you think that they do fly?’ (*She makes the gesture of flying that she did with the children*) It was kind of like a contradiction. It was hard to see what they were answering, because of the language.”

Teacher A on the other hand thought the RT added interest for the children. She said that “the type. A book (SIT) was a lot more factual and had a lot more facts where the type B (RT) book had some questions. I remember it was, ‘*Some people think that all animals that fly are birds. Do you?*’ And then it was, ‘*Well, scientists think that this is not true*.’ So that part of it made it a little bit different in the groups, because then it made them think about putting birds into categories. And then at the end it was saying, ‘*What makes a bird? A bird is a bird because of their feathers?*’ So it made that connection for them in a way.”

Finally, Teacher C thought that the RT helped her with asking the right kinds of questions to frame the text’s meaning. She said, “I like the question part of the first text, which was text B (RT). The inquisitive nature of text B (RT) was a little more engaging, and helped me come up with more questions.” Like Teacher H, she noted the difficulty of the language in the RT for students and observed, “I think the verbiage of ‘as scientists do’ was confusing for little kids. They don't typically use that language and hear that in speaking.”

Summary of Findings

My analysis of the read-aloud transcripts from two text conditions, one with standard informational text and one with refutation text, revealed patterns of extratextual talk. The most common and pervasive form of teacher extratextual talk was teacher questioning. A deeper analysis of teacher questioning showed a heterogeneity of questioning practices that varied by teacher and by text. Areas of greatest variability among teachers included the frequency of questioning, the level of question rigor, the use of closed questions versus open questions, and the use of rhetorical questions. My examination of questioning practices by text indicated that teachers asked more high-rigor questions in the refutation text condition, although this was not a statistically significant result.

The second most common form of extratextual talk was text commentary. Generally, teachers used this form of talk to narrate pictures, rephrase the text, or relay the meaning of vocabulary. The type of text commentary that was rare, called synthesis, is when teachers leveraged background knowledge, personal experience, and knowledge of the topic to support students' understanding of the text. Some teachers never engaged in synthetic comments about the text while one teacher's comments about the text were 25% synthetic in nature. Patterns of teacher questioning, and text commentary showed important differences among teachers that have implications for student learning, engagement, and equity.

My investigation of student talk surfaced patterns by text type and teacher in terms of quantity and quality. For example, the average number of words students produced was 391.53 words, but the standard deviation was 156.93 words. Similarly, high production student utterances varied widely by teacher. For example, in one teacher's read-aloud session, the percentage of high production student utterances was only 28.05% of the total student utterances, while in another teacher's read-aloud session, the percentage of high production student utterances was 78.49% of the total student utterances. Qualities of student utterances also varied greatly by teacher. The range of inferential student utterances was substantial among read-aloud sessions. In one teacher's session, 26.50% of the utterances were coded as inferential, while in another teacher's session, only 2.17% of students' utterances were coded as inferential.

Coding the transcripts surfaced some differences in extratextual talk patterns by text, too. The largest differences, although not statistically significant, were in two categories: 1) the number of Level 3 and Level 4 questions posed by teachers and 2) the number of inferential comments made by students. Analysis of other data including field notes taken during the read-aloud sessions and teacher interviews showed that the refutation text attracted positive notice and engagement from teachers and students respectively. Teachers said that the text helped them formulate questions for discussion and helped them understand the content differently and more deeply. Teachers also noted that students positively responded to the style of the refutation text over the standard informational text, however two teachers noted syntactic challenges in the RT. Field notes detailed students' lively responses to the argumentative style of the refutation text.

In my qualitative analysis of the data, I surfaced seven themes. These themes included: 1) students exhibited interest in the text topic and students showed capacity for inferential thought about the text, 2) students responded positively to the RT style, 3) students possessed a wide range of knowledge about birds, 4) students held misconceptions about birds, 5) authentic interactions between students and teachers were rare but happened and resulted in some of the most interesting extratextual talk, 6) the hands-on activity with feathers generated genuine student talk and joy, and 7) teachers were not always confident with science knowledge and students noticed. An inventory of evidence-based practices recommended for read aloud indicated that each of the eight teachers used at least *some* of the listed best practices, however several strategies were never observed, such as the use of graphic organizers and the use of student-centered talk structures. The qualitative themes illustrated and supported the quantitative findings that included frequency counts and descriptive statistics.

Through teacher interviews I learned that participant teachers held beliefs about the purpose of read alouds and these beliefs were sometimes discrepant from current research findings. I also found that teachers noticed differences in the two kinds of text; that teachers held beliefs about student capacity; and that teachers were excited by how much their students responded to the science topic in the read aloud.

In the next chapter I discuss the significance of the variability in these extratextual talk indicators. Namely, I argue that the variability of the read-aloud conditions around rigor and engagement create inequitable access to optimal conditions for knowledge building and knowledge revision. By using some of the extratextual talk indicators as a guide, I discuss how teachers can be supported through coaching and professional learning to enhance their read-aloud conditions by including such practices as: the use of open-ended questions; the use of a variety of student talk structures, the use of rigorous questions, the use of synthetic comments about the text to support comprehension and the use of graphic organizers to support knowledge revision and knowledge building.

Because the refutation text showed a positive impact on student learning and played an educative role with teachers, I make recommendations for how teachers might integrate these texts into their practice. Additionally, I examine the efficacy of the code book I adapted for this study and discuss its future application with research on read alouds with refutation texts to deepen educators' understanding of the effects of text and teacher on student talk. I also make recommendations for teacher professional learning around the findings that teachers lacked comfort and confidence in the science topic at hand and that teachers did not express a belief that knowledge-building was a key purpose for conducting the read aloud.

CHAPTER FIVE

DISCUSSION, IMPLICATIONS, AND CONCLUSIONS

Discussion

The purpose of this dissertation was to describe what, if any, were the differences between teachers' read alouds of a standard informational text compared to a refutational text of the same topic, to describe teachers' observations about their students' uptake of the information in these two kinds of texts, and finally to describe any differences in student engagement with two kinds of informational read-aloud texts. This investigation is important because of recent evidence that science content knowledge and reading share a bidirectional and positive relationship in elementary schooling, that early content knowledge predicts reading growth in elementary school, and that integrated literacy and content area instruction have a positive impact on vocabulary and comprehension (Hwang, 2020; Hwang et al., 2022; Hwang, McMaster, et al., 2023). Therefore, learning about science early in school can have a bootstrapping effect for reading and overall school academic success. Nevertheless, a potential obstacle for students to acquire science content knowledge is the presence of misconceptions which can interfere with learning accurate science knowledge if not directly addressed and understood. Refutation texts have been a successful intervention for older students to rectify scientific misconceptions, support accurate understanding, and even support the transfer of revised knowledge to new learning (Guzzetti et al., 1993b; Kendeou et al., 2014; Kendeou & O'Brien, 2014; Kendeou & van den Broek, 2005, 2007; J. Kim & Kendeou, 2021; Sinatra & Broughton, 2011; Tippett, 2010). Little is known about how refutation texts could be used by primary school teachers and what impact they might have on primary students' science learning.

As most primary students cannot yet read texts on their own, they rely on their teachers to read the text aloud. The extratextual talk that ensues during a read aloud can augment students' understanding of the text by supporting necessary inference making, knowledge acquisition, and overall engagement and interest (Glass & Oliveira, 2014; Hoffman, 2012; Hwang, Orcutt, et al., 2023; Kendeou et al., 2020; Wright, 2019). In my study, I analyzed the extratextual talk in 15 read-aloud sessions, seven of which were with refutation texts, and eight of which were standard informational texts. My findings revealed patterns of extratextual talk common to both kinds of texts as well as some promising patterns unique to refutational texts. Interviews with four teachers provided further insight on how teachers think about the purpose of the read aloud, their observations on how their students engaged with the read alouds, and the differences they saw in the two different read-aloud sessions they facilitated.

Findings on Questioning from a Cognitive Lens and a Sociocultural Lens

Questioning can support inference generation in students (Graesser & Franklin, 1990; Kendeou et al., 2020; K. McMaster et al., 2019; K. L. McMaster et al., 2012). Elementary students who need support with reading comprehension have benefited from interventions that provide questioning to prompt for the integration of information from the child's background knowledge with what the text provides (K. L. McMaster et al., 2012). Preschool children who participate in dialogic reading, whereby a teacher discusses the contents of the text with children, partially through questioning, can be better prepared for later reading comprehension when trained to generate inferences (van Kleeck, 2008). In addition to questioning, immediate feedback is also necessary for children to make inferences that are correct or were missing (K. L. McMaster et al., 2014). While there is consensus that *immediate* feedback is beneficial, there is more debate about whether the feedback is best delivered directly or in a scaffolded manner. Some research supports scaffolded feedback, meaning the feedback is not direct but given through more questioning and cuing to help the student "arrive" at the correct conclusion (Carnine, Kameenui, et al., 1982; Carnine, Stevens, et al., 1982; K. L. McMaster et al., 2014). Whether the approach is direct or indirect, research on multiple choice testing has revealed that without correction students may carry forth incorrect beliefs which can interfere with inference generation and reading comprehension (Roediger & Marsh, 2005). In other words, if not corrected, students who have misconceptions will solidify those misconceptions and continue to miss inference opportunities, make incorrect inferences, and lose out on future opportunities to gain more accurate information from text.

The function of questioning in my study expressed itself in less tidy ways than the literature just cited. Questions were both a positive force for student learning and presented some problems for learning conditions. My study of extratextual talk analysis revealed that across all the read aloud sessions teachers' most common form of extratextual talk was interrogative (Mean=40.16%). This finding is supported by other research on extratextual talk during read aloud sessions with young children, where approximately one-third of utterances are questions (de Rivera et al., 2005; Massey et al., 2008; Zucker et al., 2010). Teachers' questions served a variety of purposes, an idea consistent with sociocultural theorist Gee's assertion that single utterances can convey multiple actions (Gee, 2014). One purpose of questioning was "quizzing" students about the text. Teachers asked literal questions that dealt with information recently provided in the text read aloud. At times this appeared to be an engagement strategy to make sure children were paying attention; it also appeared to serve to check for understanding and ensure proper behavior. The literal questions were an average of 29.81% of all questions asked. Teachers also posed more rigorous questions that required inferential reasoning, but this varied by teacher (per session, the number of inferential questions by teacher was M=29.63, Mdn=21.00 SD=21.95). Inferential-type questions were an average of 33.99% of all questions asked. Several studies have shown a relationship between levels of teachers' questions and the levels of child responses (Snow, 1983; van Kleeck, 2008; Zucker et al., 2010). There are a number of benefits to students when teachers focus on inferential questions including longer student responses and more frequent opportunities to engage in inferential reasoning and talk, both of which can contribute to language development and the development of comprehension skills (Dickinson & Smith, 1994; McKeown & Beck, 2007; Palinscar & Brown, 1984; Snow, 1983; Zucker et al., 2010). Occasionally teachers asked questions that were authentic and unique to a particular organic conversation, but this was relatively rare. Most questions asked of students were also closed questions (M=58.99%) and this type of question, by its very grammar, does not bode well for a high production response from students. The most interesting finding and one that I think has the most implications for practice is the fact that a considerable percentage of questions asked to students were outside of the content of the text (M=22.79%). These questions served other purposes including giving managerial commands, providing conversational affirmation, correction, and text commentary. It is the ambiguity of the use of questioning for young students that raises questions about what the optimal conditions are for a read aloud for students to learn accurate science information and revise misconceptions. The ambiguity of the questions and the relatively high percentage of low-demand (literal) questions posed by teachers ultimately water down the rigor of the read-aloud experience for students.

Because questions were the most dominant form of extratextual talk in the read aloud sessions in my study, it is important to understand them through the sociocultural lens as well as a cognitive lens. In addition to knowledge-building events, the read-aloud sessions in my study were social and cultural events. Therefore, in addition to navigating the concepts in the text, engaging in inferential reasoning, and revising their misconceptions about birds, students were navigating the read aloud as a complex social and cultural practice. While questioning supports students' engagement and comprehension skills during the read aloud, it is important to think about the cultural role of questions as well as the role questions play for students who are reconfiguring their primitive models of science (in this case birds). There was evidence, often from the onset of the read aloud, that children had misconceptions about birds. Teachers in their attempts to engage students, and perhaps not discourage students, either did not have feedback on students' inaccuracies, or if they did, often took the indirect approach, perhaps aligned to what researchers called a scaffolded approach to immediate feedback. Much of the research that supports the scaffolded approach has been on older students, upper elementary (fourth and fifth grade).

The students in the read-aloud sessions were in kindergarten and first grade and new to the "grammar" and culture of school where teachers, instead of telling or making statements, ask questions. Oftentimes those very questions have different purposes, as found in the coding of questions in this study (tag, repair, turn-taking, actual). Understanding the context and purpose of those questions is a learned skill while students are in school and is a particular academic language, particular to the culture of school and one could even suggest it is related to the culture of whiteness. Lisa Delpit has written about this phenomenon of questioning in her piece, "Other

People's Children." Delpit states that Black children are not used to the interrogative form of commands within teacher communication and therefore struggle to translate and interpret the meaning of teacher questions. They sometimes suffer the consequences of being perceived as not following directions (Delpit, 2006). Kindergarten and first grade students are new to the culture of school and the interrogative nature of some communication that pervades the classroom culture. Most of the children in my study were students of Color and multilingual learners. Scaffolded feedback, often in the form of questioning, can be confusing for students who are trying to understand new science concepts that may be contrary to what they have understood about the world (misconceptions) while also learning English and the academic "language of the classroom" as well as how to behave as a student. Scaffolded, rather than direct feedback can be a burden for young children forming accurate science knowledge as they parse their teacher's questioning. A takeaway from this finding is that teachers can think about *when* to use the question form strategically. Teachers might consider if there is a finite amount of "question capitol" that they have in any given lesson. For example, they may want to use questions when students need scaffolded support to make a correct inference with revised information, and not when trying to soften a command, correct inaccurate information, or affirm a student's contribution.

There is a body of research and literature giving evidence to Delpit's claims of hegemony of the language patterns of the classroom. This research has found that linguistic environments and language socialization varies across cultures (Heath, 1982; Mehan, 2013; Waring, 2017). The culture and language of school is steeped in the dominant white culture's social and linguistic pattens (Apple, 2004) Researchers such as Heath, Waring, and Mehan have written extensively on how discourse responds to the meaning of social structures. These authors contend that discussion formats such as the initiation-response-feedback/evaluation (IRF/IRE) both express and replicate educational power structures. For example, Heath found in her anthropological research in North Carolina, that Black families did not engage in the kinds of questioning where the questioner asked someone a question when the questioner knew the answer. Whereas white families were engaged in this practice regularly. This kind of socialization advantaged the white students in school because could successfully navigate the discourse patterns their mostly white teachers engaged in because they were practiced them at home (Heath, 1982)

Text Differences in Question Levels

There was a difference in the teacher questioning patterns between the two texts. Paired sample Wilcoxen tests of several variables between the two texts showed that teachers asked more inferential questions with the refutational texts (effect size of the RT text on this measure was small, Cohen's d=0.2792). The effect size of the RT condition on students' inferential utterances was moderate (Cohen's d=0.6943). While the sample size for these Wilcoxen tests is small, there was other evidence to support the notion that the refutation text provided a framework that was helpful to teachers as they formulated questions and text commentary. Three of the four teachers stated during interviews that the RT gave them insights as to what the purpose of the text was about (animal categorization) and supported their ability to ask meaningful questions to help their students understand the text and talk about it. Therefore, findings from this study support the promise of refutation texts as a tool for educators to scaffold discussions, surface misconceptions students have about topics, and engage students in talk to integrate accurate science ideas into their knowledge structure. Teachers also reported how the text "lured" students in by framing the misconception as a debate: the RT text says, "some people think all animals that fly are birds, do you? Well scientists agree, that is not true." My field notes and the transcripts corroborate these teachers' observations. Students upon hearing the discourse in the RT drew in closer and listened. Students also responded enthusiastically in response to the question posed in the text asking for agreement or disagreement around the misconception. The invocation of scientists in the RT was also a point of interest for students and teachers alike ("Scientists agree that this is not true"). While the Wilcoxen test on the qualities (inferential and association) of student talk differences by text type did not produce a significant effect size, the averages for each of those items was higher in the RT condition. These findings, along with the qualitative evidence from teachers' comments during the interviews, reflect findings from other studies that show that children adjust their discourse to the level of adults and in the case with the RT condition, the teachers adjusted their discourse to the discourse of the text (Danis et al., 2000).

Questioning Differences by Teacher

All teachers controlled the talk of the read-aloud session by asking the questions and it was rare that students asked questions. The range among teachers of the kinds of questions they asked, and the relative cognitive demand of those questions is notable. For example, one teacher's questions were 48.57% literal, while another teacher's were only 8.16% literal. The variability in the rigor of these sessions is concerning. Several possibilities might explain this variability including teacher beliefs about students' abilities, teacher beliefs about the purpose of the read aloud, teacher experience, and teacher knowledge and comfort with the material covered in the text. During an interview, one teacher said the RT text was too difficult for her students, that the language was too complex, especially for her multilingual learners. This same teacher had the shortest read aloud sessions, the fewest inferential comments from students, some of the lowest amount of student talk, and the least amount of text commentary. In other words, her beliefs about what her students' capacity showed up in the frequency counts measuring student engagement and challenge. On the other hand, another teacher said he wanted to afford his students the opportunity to "explore the questions in their minds" as they learned about the challenging concept of animal classification. This teacher's read-aloud data showed some of the highest number of inferential questions posed, the highest number of inferential student comments, and text commentary that included disciplinary-specific statements about science. Research on student talk during science instruction shows that students need opportunities to use the language of science, such as argumentation and citing evidence (Glass & Oliveira, 2014; Gotwals et al., 2022; Russ et al., 2008). Teachers can play an important bridging role for students as they learn the language of science by intentionally using the register of science in partnership with the more familiar discourse of their students (Brown & Spang, 2008). Children also need opportunities for equitable engagement and participation in science discussions (Reveles et al., 2004). Disparities in classroom conditions for promoting science engagement and science talk as noted above is not equitable access.

Student Extratextual Talk

My finding about student extratextual talk was also interesting. Past empirical studies have shown that the amount of children's talk during a read-aloud session predicts later language and literacy skills (Weizman & Snow, 2001; Zucker et al., 2010). Perhaps in response to the proliferation of closed questions (an average of 58.99% of all questions were closed), the amount of talk students produced during the read-aloud sessions was low. Low production responses are two or fewer morphemes, and an average of 43.67% of children's responses were low production. Keep in mind that low production is two or fewer *morphemes.* Especially for young students, talk is a way to enter the discipline of science and literacy, enhance language skills, and improve science learning (Gotwals et al., 2022; Lemke, 1990; Mol et al., 2009)**.** I found that none of the teachers used student-centered discussion formats, such as think-pair-share or turn-and-talk. This finding may also have contributed to the low quantity of student talk. Although there is no statistical significance, the average number of student words produced and the frequency of higher production utterances by students was on average higher in the RT condition. The RT condition also produced a moderate effect size with students' production of inferential utterances, as mentioned earlier.

Knowledge Revision Through Text and Talk

According to the Knowledge Revision Components (KReC) framework, knowledge revision occurs when erroneous background knowledge is coactivated and integrated with new and correct information (Kendeou & O'Brien, 2014). The framework states that misconceptions get activated when explicitly called out while processing the refutation text (e.g., in the example of this study's refutation text, the call out to a misconception is in the line "some people think that all animals that fly are birds"). The job of the refutation text is to activate the misconception rather than letting it remain dormant. Without activation, the misconception is like a "wolf in sheep's clothing" and may not be corrected by information in the text because it remains un-activated in the mind. The refutation text can also facilitate *integration* by providing direct information necessary to establish coherence from cognitive conflicts caused by co-activation of misconception and correct information (Graesser & D'Mello, 2012; Posner et al., 1982). The information includes direct refutation of misconception, justification about why it is inaccurate, and explanation about what is correct and why it is correct. As noted earlier in my literature review, there's evidence that refutation texts are beneficial for older students, but there is not evidence to support their efficacy with primary-aged students. However, findings from this study show that the extratextual talk during a read-aloud session can also play an important role for coactivating misconceptions with accurate information (e.g."Scientists say that all animals that fly are not birds, many other animals fly like bees, and bats fly"). If students are talking and sharing their background knowledge and contributing their thoughts and personal experiences during the read aloud session, the likelihood that co-activation and integration will occur and be reinforced is higher the more students talk. Therefore, it is possible to extend the KReC framework to the extratextual talk facilitated by science texts, especially refutation science texts. Surfacing children's misconceptions through discussion is also supported by the Framework Theory Approach (Vosniadou, 2013) which states that misconceptions are not faulty knowledge, but productive knowledge if explicitly articulated and addressed by instruction.

Teachers' Dialogic Strategies for the Read-Aloud

While there's ample evidence that the read aloud can be a valuable practice for all kinds of positive student outcomes, the way the read aloud is facilitated matters a great deal. A skillful teacher plays an important role in creating optimal conditions for learning during the read aloud (Cabell et al., 2008; Justice et al., 2008; Kindle, 2011; Massey et al., 2008; McKeown & Beck, 2007). This is especially true for children from low SES backgrounds and emergent bilingual students who may not have access to texts in English outside of school (Lennox, 2013). When read alouds are done with dialogic strategies, they are positively associated with academic achievement, interest in reading and reading skills (Lennox, 2013; Wasik et al., 2016)). These dialogic strategies bring students into conversations about the text that stretch their linguistic and conceptual abilities. However, when read alouds are characterized by teacher-driven dialogue, known-answer questioning, and neglecting to build on children's attempts at topic initiation, children do not get to experience the kinds of language practice and the depth of exposure to science ideas they need to build robust knowledge networks (Dickinson et al., 2012; Gotwals et al., 2022; Wright & Gotwals, 2017). My analysis of teacher talk revealed that teachers varied in their skills to draw students into discussions about the science topic. For example, in terms of responses to students' comments, my findings showed the most common kind of teacher response to students was either a repair question, whereby teachers simply restated the child's response with a raise in pitch, a positive affirmation of the student response (41.30%), or a verbatim restatement of the student's response (19.52%). Some teachers only minimally interacted with children's comments at all. The degree of variability among teachers on this category of talk was quite high. On several indicators in this category including "expanding student responses" and "correcting student responses" the standard deviations exceeded the average scores. The category with the lowest standard deviation, "positive feedback to students," still varied with a standard deviation more than half of the average amount. Regardless of the degree of variability, teachers rarely followed-up or co-developed student's thinking and language use. My finding is not uncommon. One study on early childhood teachers found that teachers did little to initiate co-construction of knowledge or understanding about shared interests or topics (Gjems, 2011). The study found that the teachers rarely challenged children to explain or expand upon their ideas but simply accepted their ideas as a matter of course (Gjems, 2011). McKeown and Beck (2007) in their study on extratextual talk, reported teachers often accepted children's responses that were ‘‘on the road, but not in the lane’’ (p. 286), meaning there was more opportunity to expand and steer children's thinking about the topic through dialogue.

My analysis of teachers' comments about the text, the second most frequent type of teacher talk in my study, showed another pattern in teachers' read aloud pedagogy. Teachers' most common type of text commentary was to narrate the pictures and to closely restate or rephrase the text. Only occasionally (an average of 10% of the time) did teachers make comments that explained the concepts of the text using the vernacular or background knowledge and experience that might be more easily understood by students. Researchers that study science education cite educators' ability to do this language and concept brokering as an important aspect of building science literacy, understanding, and engagement in students. Sandoval and Millwood (2005) said, "students are being apprenticed cognitively into the reasoning and discursive practices of particular scientific disciplines" (p. 24). This can be especially important for language minority students and students of Color who may benefit from such a language bridge as they may see themselves as cultural outsiders to the domain of science (Brown & Spang, 2008). When a teacher engages with students in co-constructing meaning, students benefit (Hoffman, 2012). In one example of a synthetic comment made by a teacher from this study, the teacher framed for the children in simple terms that they were engaging in categorizing birds based on their attributes, "Even though birds share some qualities with other animals, some other animals have beaks, some other animals make nests, some other animals can fly, but feathers are the special thing about birds." This comment models the kind of synthesis that we want children to do while reading and it also helps to make the larger concepts in the text accessible to students.

Purpose of the Read-Aloud

Only one of the four teachers interviewed for this study stated that the purpose of a read aloud was to increase student knowledge about the world, especially science. While teachers shared other valid reasons for the purpose of the read aloud, including, to expose them to decodable words, to practice phonemic awareness, to develop interests, to build relationships, to learn about emotional coping strategies and proper behavior in school, there was only one nod to the purpose of a read aloud being about students developing a network of domain knowledge. One teacher even said that both texts should be completely decodable for the students so that they would not have to guess at any of the words. This lack of purpose and urgency to promote knowledge building can explain the meandering nature of questioning and engagement strategies posed by teachers during the read alouds. Roughly one third of the content questions asked were literal, posed a light cognitive load, and tended to test if students were paying attention. Student oral discourse around science topics is a gateway to science literacy and academic literacies in general; giving students plenty of opportunity to use the language of science is critical (Snow, 2010).

Refutation Texts Hold Promise as an Educative Tool for Teachers

Recent studies have found that teachers continue to neglect the use of informational text in the texts they read aloud (Conradi Smith et al., 2022; Donovan & Smolkin, 2001; Duke, 2004;

Jacobs et al., 2000; Varelas & Pappas, 2006). Part of the reason for this may be because teachers report and have been found to lack the science knowledge necessary for science instruction (Pine et al., 2001; Romance & Vitale, 2012). Recent studies have also found that academic content, such as science, gets short shrift during the instructional day, especially in the primary grades (Connor et al., 2017; Hwang et al., 2020). This is in spite of recent evidence that science and literacy are bidirectionally linked to success in reading comprehension, science knowledge, and academic success (Hwang, McMaster, et al., 2023). As the structure of the English Language Arts (ELA) block begins to incorporate more science content into curricular materials, teachers will need support with teaching science. This is already happening in the state of Minnesota, as the state's only recommended ELA curriculum, called a "knowledge building curricula" is "Wit and Wisdom-Great Minds." The Wit and Wisdom program contains many science-focused ELA units (Great Minds, 2017). From interviews with teachers and the analysis of the transcripts of read aloud sessions, it became evident that teachers were not always confident in their knowledge about the topic of the text. My analysis also suggested that if teachers were aware of student misconceptions, they were not sure what to do when they arose during the read-aloud session. Three teachers mentioned during interviews that the RT text helped them understand that the main point of the text was to support students' understanding of animal classification. Teachers also mentioned that it helped them to pose questions to build towards that understanding more than the other text. The refutation text did have more instances of student inferential comments than the SIT as well as more instances of the Level 3 and Level 4 types of questions. Multiple experimental studies support the use of higher-level questioning to promote language and reading growth over lower-level questions (Reese & Cox, 1999; Taylor et al., 2003; Walsh et al., 2016).

My study was part of a larger study that investigated the effect of two kinds of informational texts on students' knowledge about birds and students' knowledge revision about birds. The larger study found that both texts increased students' knowledge about the science topic as measured by a research-created post test. The refutation text condition performed better on the post-test (β=.22) and the delayed post-test (β=.21) for science knowledge about birds than the standard informational text (Hwang et al., 2024).

In addition to the findings of the larger RAISE Learning study, my qualitative findings revealed the refutation text's superiority to the standard text. Teachers commented that the RT provided them topic framing for the read aloud and ideas about how to ask students questions. My field notes showed that students responded well to the argumentative style by drawing closer to the teacher during the read aloud and engaging enthusiastically to the questions of debate posed in the text. Additionally, frequency counts of the transcripts showed that students made more inferential comments during the RT text condition and teachers asked more level 3 and 4 questions during the RT text condition (Hwang et al., 2024). Taken together, these findings show that the RT is a promising tool for educators.

Implications

The findings from my study have implications for curriculum development, teacher professional development, teacher preparation, and policy. In the following sections, I describe the implications for each area.

Teacher Professional Development

While the bridge from research to practice always takes time, elementary education needs to quickly rid itself of the widely-held paradigm that primary students are just learning to read and not reading to learn (Farley-Ripple, 2021). Researchers must share evidence that students can begin to build significant knowledge networks from the onset of school and that reading informational texts aloud, with the support of strategic extratextual talk, is a critical tool for doing so (Hwang, Orcutt, et al., 2023; Neuman & Kaefer, 2018; Wright, 2019).

The findings from my study about the qualities and quantities of student talk suggest that teachers will also benefit from learning about the role of student talk in learning about science and other academic subjects (Gotwals et al., 2022). The more students get to try on the scientific register through supported talk during read alouds, the more likely they will be engaged in the topic and gain important language and inferential reasoning skills (Donovan & Smolkin, 2001). To increase student talk, teachers can be supported to use student-centered discussion formats, pose open-ended questions, follow-up on students' thoughts and questions, and pose questions that require inferential thought (Hoffman, 2012; K. McMaster et al., 2019; Menninga et al., 2017; Monteira & Jiménez-Aleixandre, 2016).

Given the efficacy of refutational texts for knowledge revision, teachers can benefit from professional learning about the genre of refutation texts. In doing so, teachers necessarily also learn about the role of knowledge in reading and how misconceptions interfere with building a robust network of knowledge. The RAISE Learning study investigated the efficacy of a refutation text for *student* knowledge revision. My study, nested within the RAISE Learning study, investigated how refutation texts could enhance *teacher* knowledge about the role of knowledge in comprehension, how knowledge gets revised, the use of questioning, the use of student talk, and the use of the refutation texts to support students' knowledge revision.

The current study highlights that there may be a need for professional learning about science instruction in the early grades. Not only can teachers learn about the role of student misconceptions in science, but they can boost their knowledge and comfort with science terms, and the kinds of thinking that science engenders such as argumentation, use of evidence, and categorization. My study showed that teachers were not familiar with some of the concepts and terms in the texts and in several instances during this study that fact undermined students' confidence in their teachers' knowledge.

Curriculum Development

The present study points to the need for the availability of refutation texts for primary and elementary school students. Along with the availability of these kinds of texts, teachers could benefit from a guide for text-based questions, especially those that prompt for inferential reasoning. In the likelihood that refutation texts are not available to teachers and schools, teachers can make slight adjustments to existing science informational texts to turn them into more of a refutation style text, perhaps with widely available AI tools such as ChatGPT.

Policy

The literacy block can be leveraged to integrate academic topics such as social studies and science through the inclusion of informational texts in literacy curricula. Policies at the school and district level can support teachers to dedicate instructional minutes to knowledge-building activities during the literacy block and in the science and social studies blocks.

Some educators struggle to find time for supporting multilingual students with English Language Development (ELD) instruction. Unfortunately, MLL (multilingual learners) students get pulled from social studies and science classes to fulfill their ELD needs. Since science and social studies are ways to build important language skills for MLL students, this decision should be avoided if possible.

Limitations

My study had several limitations. The sample size of read-aloud sessions was small and therefore it was difficult to calculate robust statistical results. This research took place in a summer school setting. The summer school setting is different from the regular school for several reasons. The students enrolled did not necessarily reflect the student population during the regular school year, there were more boys than girls for example. In this study, teachers did not necessarily teach the grade they normally do. Also, because of the short summer school term, teachers may not have had the same kinds of close relationships with students as they normally would have during the school year. These factors could have altered the way teachers led read-aloud sessions. The levels of abstraction for the content questions were adapted from other studies (van Kleeck et al., 1997, 2003; Zucker et al., 2010), none of which were for analyzing informational text read aloud sessions. Another limitation is that I did not track individual students’ talk but instead pooled students’ talk into one entity. Doing so limited the precision of data analysis. I also did not make allowances for language differences for kindergarten students vs first grade students.

Future Research

Future research on refutation text use in primary classrooms is worthwhile. Research on extratextual talk with refutation texts will benefit from continuing to adapt the codebook I developed for extratextual talk for knowledge revision and science learning. This modified codebook could be applied to read-aloud sessions with standard informational and refutation text conditions. More precise research on student extratextual talk would also be beneficial, specifically by examining the student talk *just as* the explicit statement of the misconception is given in the text as well as by examining the student talk *just after* the accurate information is supplied in the refutation text. Another study could examine the extratextual talk of teachers and students using at least one kind of student-to-student talk format during the read-aloud session. Research to replicate the conditions in this study with more teachers and better student microphones would also be beneficial.

Furthermore, research on prolonged exposure, i.e. multiple read-aloud sessions on the same topic, to topics with refutation texts and standard informational texts. Tracking student talk over multiple sessions will help us understand how children change their ideas over multiple exposures with different genres of text. Similarly, research on read aloud conditions with various talk structures (i.e. think pair share, turn and talk, concept mapping, etc.) and different informational text types would also be beneficial to understand how student talk supports knowledge revision over multiple sessions.

Final Thoughts

This study contributes to the field's understanding of how teachers use and students respond to refutation texts during read-aloud sessions to build accurate science knowledge in primary-aged students. This study is important because refutation texts offer teachers an educative tool to support students with science learning and knowledge revision. The study also supports researchers' and practitioners' understanding of how students respond to refutation texts in read-aloud sessions. Because content-based literacy instruction will likely gain traction in primary classrooms due to mounting evidence of its importance from research, teachers will need curriculum and professional knowledge to create optimal read-aloud sessions that promote knowledge building for their students using informational texts. Research on the use of refutation texts as read alouds or in primary classrooms has not been studied until now. My study showed that refutation texts are a promising text genre for students and teachers for learning science and for engaging students in science talk.

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APPENDIX

APPENDIX A

TEACHER QUESTIONS

1. What did you notice about how your students responded to each of the read aloud texts?
2. Which text (from RAISE) do you think students found more engaging? And why?
3. How, if at all, did students respond differently to Text A vs Text B?
4. What, if any science misconceptions came up during the read aloud from your students about birds or other animals?
5. How do you typically address those misconceptions during the read aloud?
6. What ways can teachers correct their misconceptions about science during read aloud or instruction?
7. In your opinion, what purposes does the read aloud serve for students' learning?
8. What are some ways you've had success engaging students during a read aloud?
9. How often do you typically read aloud to your students during the school day?
10. Can you please talk about how you select texts for read-aloud instruction?
11. What has been your experience with science text read alouds with your K/1 students?
12. What are some ways to make science texts accessible to young students during the read aloud?